Projects

Over $750,000

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Volume II

Over $5,000,000

Project 1

Perform Boiler Condition Assessment and Miscellaneous Upgrades

(2026)

Holyrood

Perform Boiler Condition Assessment and Miscellaneous Upgrades (2026)

Location: Holyrood

Investment Classification: Renewal

Asset Category: Thermal Plant

Estimated Cost: $9,600,000

Executive Summary

To support the continued safe and reliable operation of the Holyrood Thermal Generating Station (“Holyrood TGS”) at its rated output, Newfoundland and Labrador Hydro (“Hydro”) is proposing to continue with the annual Boiler Condition Assessment and Miscellaneous Upgrades project in 2026.

This project has been completed on an annual basis since 2017 and has been integral in supporting the safe and reliable operation of steam supply systems at the Holyrood TGS. As identified through the *Reliability and Resource Adequacy Study Review* proceeding (“*RRA Study Review*”),[1] the Holyrood TGS shall remain available for a “Bridging Period”[2] until 2030, or until such time that sufficient alternative generation is commissioned, adequate performance of the Labrador-Island Link (“LIL”) is proven, and generation reserves are met. At this time, capital investment related to the generation function of the Holyrood TGS, such as the perform boiler condition assessment and miscellaneous upgrades, is necessary to support system reliability and maintain Hydro’s ability to meet customer demand during peak periods.

The boilers and associated high-energy piping are exposed to multiple degradation mechanisms and require regular inspection and analysis to monitor wear rates and plan interventions. Failure of any steam system while in service could result in generation outages with a duration of weeks or months, depending on the magnitude of the failure. The continuation of the Boiler Condition Assessment and

[1] “2024 Resource Adequacy Plan – An Update to the Reliability and Resource Adequacy Study,” Newfoundland and Labrador Hydro, rev. August 26, 2024 (originally filed July 9, 2024).
[2] Hydro considers the Bridging Period to be from the present to 2030. During the Bridging Period, the system would rely primarily on existing sources of generation capacity to maintain reliability while new generation capacity is being built. The primary, readily available supply options in this period are extending the retirements of the Holyrood TGS, Stephenville Gas Turbine and the Hardwoods Gas Turbine until their capacities can be adequately replaced.

Miscellaneous Upgrades project into 2026 is required to support Hydro's safety and reliability standards, including Hydro's ability to meet customer demand during peak periods.

The project will be completed in 2026. The majority of the work will be performed during the planned outages for each generating unit. The estimated cost for work executed under this project is $9,600,000.

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1.0 Introduction

Hydro is proposing to continue with the Boiler Condition Assessment and Miscellaneous Upgrades project in 2026. This project will support the continued safe and reliable operation of Holyrood TGS. The scope of this project includes a Level 2 Condition Assessment related to internal components of the main steam generators (boilers) and associated external high-energy piping, as well as the proposal and execution of various upgrades and replacements to support the reliable operation of the steam generation equipment.

This project has been completed annually since 2017 and has been integral in supporting the safe and reliable operation of steam supply systems at the Holyrood TGS. As identified through the *RRA Study Review,* the Holyrood TGS shall remain available for a Bridging Period until 2030, or until such time that sufficient alternative generation is commissioned, adequate performance of the LIL is proven, and generation reserves are met. At this time, capital investment related to the generation function of the Holyrood TGS, such as the perform boiler condition assessment and miscellaneous upgrades, is necessary to support system reliability and maintain Hydro's ability to meet customer demand during peak periods.

The recommendation to continue this project is also consistent with the Life Extension Condition Assessment ("LECA")[3] as conducted by third-party assessors as part of the *RRA Study Review,* and refreshed in March 2025.[4]

The boilers and associated steam supply systems are the focus of the Perform Boiler Condition Assessment and Miscellaneous Upgrades project. A specialized boiler service contractor has been retained under a maintenance service agreement to perform all remedial work on the boiler, including this project.

Annual boiler condition assessments maintain reliability by discovering damaged or deteriorated components that are at risk of failure. Examples of damage or deterioration discovered in past boiler condition assessments include the following:

[3] "*Reliability and Resource Adequacy Study Review* – Assessment to Determine the Potential Long-Term Viability of the Holyrood Thermal Generating Station," Newfoundland and Labrador Hydro, March 31, 2022, att. 2.
[4] "*Reliability and Resource Adequacy Study Review* – Holyrood Thermal Generating Station Capital Plan Refresh," Newfoundland and Labrador Hydro, March 7, 2025, att. 1.

- Cracking of various components that are subject to thermal cycling;
- Critical damage to material or failure of structural components;
- Critical damage to refractory materials;
- Duct erosion; and
- Thinning of the boiler tube walls due to corrosion and erosion.

Deterioration of boiler components identified during Level 2 Condition Assessments is typically corrected during the next available outage period unless they are determined to be critical, in which case, they are addressed immediately as part of this project if such critical items are determined to be capital in nature.

Following the receipt of the 2025 Capital Budget Application ("CBA") Board of Commissioners of Public Utilities ("Board") Order No. P.U. 28(2024), Hydro conducted a review of the classification of its programs within the 2025 CBA and determined that, due to the nature of the assets being replaced, the scope of work contained in the Perform Boiler Condition Assessment and Miscellaneous Upgrades proposal was more appropriately defined as a project. As a result, Hydro has provided the information within this proposal as required by the provisional CBA Guidelines[5] relating to projects.

2.0 Project Description and Justification

The primary work for the 2026 project scope is to perform a Level 2 Condition Assessment on the internal components of the boilers and associated external high-energy piping to determine what refurbishments or replacements are required before the 2026–2027 winter operating season. The project also includes miscellaneous upgrades identified in the 2025 and 2026 condition assessments, scheduled for completion in 2026 to support the continued safe and reliable operation. Additionally, for upgrades identified and executed in 2026 that are material in dollar value and meet capitalization criteria, Hydro proposes to implement and communicate these items to the Board in its 2026 Capital Expenditures and Carryover Report.[6]

[5] "Capital Budget Application Guidelines (Provisional)," Board of Commissioners of Public Utilities, January 2022.
[6] Hydro's 2026 Capital Expenditures and Carryover Report is to be filed on or before April 1, 2027.

Hydro will contract a specialized boiler service company to complete boiler and high-energy piping assessments and upgrades. Hydro personnel will assist the contracted company when required, oversee the work protection application, and provide overall management and liaison for the upgrades.

Miscellaneous upgrades that have been identified in previous condition assessments and are scheduled for completion in 2026 include the following:

- Replacement of boiler expansion joints;
- Replacement of boiler refractory;
- Replacement of air heater baskets;
- Replacement of exhaust gas expansion joints;
- Upgrade boiler crane and hoists; and
- Replacement of high-pressure heater.

3.0 Asset Overview

3.1 Asset Background

The Holyrood TGS is equipped with three thermal generating units (Units 1, 2, and 3), all of which can be used for power production. Unit 3 is also capable of functioning as a synchronous condenser to assist with system voltage regulation. Each unit is supplied with steam by one of three dedicated boilers fired with Bunker C fuel.

3.2 Historical Reliability

Level 2 Condition Assessments aim to reduce in-service failures of boiler systems, with a focus on boiler tubes and pressure piping, as they present a safety and reliability risk if they fail while in service; however, there are situations where unforeseen in-service failures occur.

The primary issues Hydro has experienced with the boilers relate to boiler tube failures. The boiler tubes are exposed to multiple degradation mechanisms, such as corrosion, thermal fatigue,[7] creep,[8] stress corrosion cracking, and erosion. Previous Level 2 Condition Assessments indicated that boiler tubes

[7] Deterioration resulting from stresses caused by cyclic heating and cooling of components.
[8] Deformation of material caused by sustained high temperatures or other stressors.

were at risk of failure due to degradation, and replacements or repairs by applying pad welds were completed.

3.3 Asset Condition

The existing main steam generators (boilers) and associated high-energy piping (main steam piping, hot reheat piping, cold reheat piping, and high-pressure feed water piping) are exposed to degradation mechanisms such as high temperatures, high pressure, corrosive boiler gas, and erosive flows. In its 2021 LECA, Hatch Ltd. ("Hatch") found the boilers and high-energy piping for all three units to be in adequate condition.

3.4 Condition-Based Remaining Life

A condition assessment of the boilers and associated high-energy piping by Hatch determined that these systems are in adequate condition and are expected to remain serviceable until at least 2030. While these systems are generally in adequate condition, this project is required annually to address components or sections of the boilers and associated high-energy piping systems at risk of failure in the near term.

3.5 Asset Ages

The boilers for Units 1 and 2 were designed by the Combustion Engineering Company[9] and began operating in 1969 and 1970, respectively. The Unit 3 boiler was designed by the Babcock & Wilcox Enterprises, Inc.; it began operating in 1979.

4.0 Analysis

4.1 Evaluation of Alternatives

Hydro evaluated the following alternatives:

- Deferral; and
- Perform condition assessment.

[9] Currently General Electric.

Hydro has not identified any viable alternative strategies for the continued safe and reliable operation of the boilers for Units 1, 2, and 3 and associated high-energy piping through the Bridging Period until the capacity of Holyrood TGS can be adequately replaced.

4.1.1 Deferral

This project is required annually, and deferral of inspections for deteriorated components that are approaching critical time to failure would preclude Hydro from assessing the unit boilers and high-energy steam piping and intervening to prevent in-service failure of the assets, which would present a risk to safe and reliable operations of the Holyrood TGS. Hydro's experience with this project has demonstrated that assessment and miscellaneous upgrades are required on an annual basis.

4.1.2 Perform Condition Assessment

Under this alternative, the condition of internal components of the boilers and associated external high-energy piping continues to be assessed annually through inspections. Hydro has found this approach to be effective in supporting the safe and reliable operation of the Holyrood TGS boilers.

4.2 Least-Cost Evaluation

As there are no viable alternatives to this project conducive to the safe and reliable operation of the Holyrood TGS, a least-cost evaluation was not performed. In a case where the condition assessment shows that a deteriorated component is reaching a critical time to failure before the next condition assessment, and may impact the safe and reliable operation of the boiler systems, least-cost evaluations would be considered on a case-by-case basis to evaluate and determine the most viable alternative to address the issue.

4.3 Recommended Alternative

Hydro recommends proceeding with the Boiler Condition Assessment and Miscellaneous Upgrades project in 2026.

Regular inspections and condition assessments are required to monitor the deterioration rates of systems and perform remedial work on an annual basis to reduce the risk of failures during operation. This approach allows Hydro to complete repairs in a planned, measured manner while continuing to operate the Holyrood TGS boilers safely and reliably. Hydro's experience with this approach has proven effective.

4.3.1 Risk of Asset Stranding

The risk of asset stranding is less imminent as a result of the decision to extend Holyrood TGS to remain available through the Bridging Period. As Hydro expects continued operation of all three units at the Holyrood TGS through the Bridging Period until its capacity can be adequately replaced to ensure reliable operation for customers, capital expenditures for this facility to operate as a generator continue to be required. Depreciation is required to be calculated on an accelerated basis (i.e., monthly depreciation = capital investment ÷ remaining months of service life).[10]

4.3.2 Risk Mitigation

Hydro assessed the pre- and post-implementation risk of the scope of work for the 2026 project in accordance with Hydro's Capital Risk Assessment process as outlined in Section 7.0 of Schedule 1. The outcome of this assessment is provided in Table 1.

Table 1: Risk Scoring Pre- and Post-Implementation

	Impact	Likelihood	Score
Pre-Implementation	5	4	**20**
Post-Implementation	5	1	**5**
		Risk Mitigated	**15**
		Risk Mitigated per $1 Million	**1.6**

5.0 Scope of Work

The scope of work includes the following:

- Level 2 Condition Assessment on the internal components of the boilers and associated external high-energy piping; and
- Completion of miscellaneous upgrades identified in the 2025 investigation and required interventions identified during the 2026 assessment that are necessary to support safe and reliable operation through the 2026–2027 winter operating season.

[10] Due to the extension of the Holyrood TGS through the Bridging Period, Hydro submitted an application to the Board to extend the Holyrood Accelerated Depreciation Deferral Account. The extension of the account and related amendments were approved in Board Order No. P.U. 1(2024). Hydro was also directed to file a report on the account in its next general rate application.

5.1 Project Budget

The estimate for the 2026 project is shown in Table 2. In addition to the defined scope of work, the project budget in 2026 has been informed by additional identified work for the 2025 Boiler Condition Assessment and Miscellaneous Upgrade project forecast, and the actual contract cost in 2024,[11] which reflects both higher component and contract costs.

Table 2: Project Estimate ($000)

Project Cost	2026	2027	Beyond	Total
Material Supply	30.0	0.0	0.0	**30.0**
Labour	553.5	0.0	0.0	**553.5**
Consultant	0.0	0.0	0.0	**0.0**
Contract Work	7,704.3	0.0	0.0	**7,704.3**
Other Direct Costs	0.0	0.0	0.0	**0.0**
Interest and Escalation	483.4	0.0	0.0	**483.4**
Contingency	828.8	0.0	0.0	**828.8**
Total	**9,600.0**	**0.0**	**0.0**	**9,600.0**

5.2 Project Schedule

The schedule for the project is shown in Table 3.

Table 3: Project Schedule

Activity	Start Date	End Date
Planning:		
Complete planning documentation.	January 2026	January 2026
Procurement:		
Order long lead parts.	February 2026	March 2026
Construction:		
Perform condition assessment[12] and upgrade work.	April 2026	October 2026
Closeout:		
Prepare closeout documentation.	November 2026	December 2026

[11] Please refer to Section 1.1.3 of the 2024 Capital Expenditures and Carryover Report provided as Appendix B of Schedule 5 of this application.

[12] The condition assessment and upgrade work will take place during the outage period for each of the three boilers.

6.0 Conclusion

To support the continued safe and reliable operation of the Holyrood TGS through the 2026–2027 winter operating season, Hydro recommends proceeding with the Boiler Condition Assessment and Miscellaneous Upgrades project in 2026, as historically it has been effective and supports the optimal timing of refurbishment and replacement. This measured, planned approach is prudent and supports the safe and reliable operation of the boilers and high-energy piping.

Project 2

L23/24 Steel-Tower Transmission Line Renewal

(2026–2029)

L23/24 Steel-Tower Transmission Line Renewal (2026–2029)

Location: Churchill Falls to Wabush

Investment Classification: Renewal

Asset Category: Transmission

Estimated Cost: $8,577,400

Executive Summary

Newfoundland and Labrador Hydro ("Hydro") operates two parallel 230 kV steel tower transmission lines (L23 and L24) between Churchill Falls and Wabush. The lines are of high criticality and service both residential and Industrial customers, with only a limited alternate supply from Fermont, Québec (L40), which is unable to meet customer demand. The lines were originally built in the late 1960s and early 1970s as a part of the Twin Falls/Churchill Falls Projects and were transferred to Hydro's regulated lines of business in 2017.

Maintenance inspections were completed in 2020 by Hydro operations crews and resulted in the identification of tower deficiencies, including, but not limited to, damaged tower members, missing tower members, and incorrect tower members.

Stantec Consulting Ltd. ("Stantec") was engaged in 2023 to complete follow-up site inspections with drone technology and confirm the details of the previously identified deficiencies, as well as a significant number of other observations. Stantec simulated the deficiencies in the applicable tower models to analyze structural impacts and performance, then developed work methods to either accept or remedy each tower site's deficiencies with a subsequent cost estimate. The estimate included costs for engineering (detailed member design, temporary support design), materials (galvanized steel angle bars, connection plates, bolts, nuts, washers, etc.), and construction, including all labour costs for member replacements and temporary support as required.

The engineering analysis recommended that all critical and undersized bracings identified be replaced with members having adequate structural capacity. The project is essential for maintaining the lifespan of L23/L24 and providing safe, least-cost, environmentally responsible, and reliable power for customers. This project has a multi-year approach, with completion planned in 2029 at an estimated cost of $8,577,400.

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1.0 Introduction

Hydro operates two parallel 230 kV steel tower transmission lines between Churchill Falls and Wabush. These lines are critical to the province's electricity grid and are used to supply safe and reliable power to residents, as well as both commercial and Industrial customers in the Wabush area. These assets were transferred over to Regulated Hydro assets in 2017 and were previously operated by Churchill Falls.

Maintenance inspections were completed in 2020 by Hydro operations crews, which were followed up with an inspection by Stantec in 2023 as a result of various deficiencies identified. In 2024, Stantec completed another, more extensive assessment to review additional deficiencies identified during the 2023 inspection. Drone technology was used to identify visible defects and deficiencies, including damaged, deformed or bent tower members, missing tower members, and altered tower members. Stantec simulated the deficiencies in the applicable tower models to analyze structural impacts and performance, then developed work methods to either accept or remedy each tower site's deficiencies. This analysis recommended that all deficient members be addressed, as over time, non-linear structure displacement caused by deficient tower members increases the likelihood of overstressing the main tower legs, especially during an extreme weather event, which could lead to full-scale tower failure.[1]

2.0 Project Description and Justification

Following Hydro's initial assessment and subsequent third-party inspections, 142 structure locations were identified as either high or medium priority and needed repair.[2,3] This assessment aligns with the consultant's recommendation that all deficient members be addressed to reduce the risk of overstressing the main tower legs. This risk increases the potential for a full-scale tower failure, which could have major impacts on the overall reliability of the line. A failure of this nature could result in a lengthy unplanned outage to the region while the line is being repaired. The engineering analysis by the consultant designated the members as either high, medium or low priority and strongly recommends that all critical and undersized bracings identified be replaced with members having adequate structural capacity.

[1] Please refer to Attachment B for further details on this analysis.
[2] Low-priority structure locations will be monitored with regular inspections for evidence of increased torsional displacement or continued structural deterioration. As stated in Section 5.0 of Attachment B, low-priority locations have no observed negative impacts of deficient members on tower structural integrity.
[3] Please refer to Table 2 for further information.

3.0 Asset Overview

3.1 Asset Background

L23 and L24 are two parallel 230 kV steel tower transmission lines between Churchill Falls and Wabush. The transmission lines are each approximately 215 km in total length, with approximately 175 km running from Twin Falls to Wabush Substation (L23 and L24), and approximately 40 km running from Churchill Falls to Twin Falls Substation (L23A and L24A).

The lines were originally constructed in sections as follows:

- L23 – Twin Falls to Wabush – completed in 1962;
- L24 – Twin Falls to Wabush – completed in 1964;
- L23A – Churchill Falls to Twin Falls – completed in 1974; and
- L24A – Churchill Falls to Twin Falls – completed in 1974.

L23 and L24 were constructed using only self-support towers for tangent, angle, and dead-end types. L23A and L24A were constructed using guyed V towers for tangent types and self-supported towers for angle and dead-end types.

3.2 Historical Reliability

No major outages due to structural concerns have occurred on L23 or L24 to date. In 2013, damage to a tower crossarm on Structure 533 of L24 was observed when completing a helicopter patrol of the infrastructure. At the time of the investigation, the damage was presumed to be the result of an unbalanced ice condition and was repaired during a scheduled outage in the Fall of that year.

3.3 Asset Condition

The drone inspections completed by Stantec in 2023 revealed 503 cases of member deficiencies across 396 distinct tower locations. Of the 396 locations, 142 have been identified as either high or medium priority and require repair.

4.0 Analysis

4.1 Evaluation of Alternatives

Hydro has evaluated the following alternatives:

- Deferral;

- Upgrade life extension; and
- Like-for-like replacement.

4.1.1 Deferral

Deferral is not a viable alternative for this project. Due to the 142 structures identified through inspection and engineering analysis as either high or medium priority, deferring this work and maintaining the status quo would result in an unacceptable risk to public safety. Additionally, the high possibility of the subsequent reduced structural capacity would cause an increased likelihood of failure on these lines and would also result in reduced reliability for the customers it serves. Due to the criticality of the lines and the importance of the supply for residential and industrial customers, deferral is not deemed to be a viable option.

4.1.2 Upgrade Life Extension

This project involves targeted capital maintenance/refurbishment to extend the asset's useful life.

4.1.3 Like-for-Like Replacement

The only alternative to repairing the identified deficiencies on L23 and L24 would be to construct new lines between Churchill Falls and Wabush and decommission L23 and L24. Construction of new transmission lines was not considered to be a viable alternative to this project, as the existing lines have not reached the end of their useful service lives. A new transmission line(s) would also be much more costly than the alternative of targeted remediation and extending the useful life of the existing assets.[4]

4.2 Least-Cost Evaluation

Hydro has not identified any viable alternatives to facilitate a detailed least-cost evaluation.

4.3 Recommended Alternative

Hydro's recommended alternative is upgrade life extension. Hydro recommends the repair and refurbishment of the 142 structure locations requiring member replacements using higher capacity galvanized steel angle bars, connection plates, and associated mounting hardware.

[4] A new 230 kV transmission line in this area would cost in the order of $1 million per km to develop, or higher depending on site-specific conditions, thereby increasing the cost significantly.

4.3.1 Risk of Asset Stranding

Electricity demand in western Labrador is forecasted to increase, and ensuring the long-term reliability of L23 and L24 is of critical importance. As such, the risk of asset stranding is low.

4.3.2 Risk Mitigation

Hydro assessed the pre- and post-implementation risk of the scope of work for this project in accordance with Hydro's Capital Risk Assessment process, as outlined in Section 7.0 of Schedule 1. The outcome of this assessment is provided in Table 1.

Table 1: Risk Scoring Pre- and Post-Implementation

	Impact	Likelihood	Score
Pre-Implementation	5	4	**20**
Post-Implementation	5	1	**5**
		Risk Mitigated	**15**
		Risk Mitigated per $1 Million	**1.7**

5.0 Scope of Work

The post-deficiency structural analysis provided by Stantec had a priority ranking for remedial actions. Hydro has recommended a repair of high- and medium-priority structure locations, while low-priority structures that do not pose an inherent risk at this time are excluded from this project, and will be monitored with regularly scheduled inspections. The definitions are listed below.

- **High:** Critical structure locations where deficient member(s) with high usage (more than 100%) exist and structure integrity is at risk. All dead-end and heavy anchor structure types are included in this category.
- **Medium:** Second level of priority where deficient members adversely impact the tower, but structural integrity is still intact. With overall structure usage of more than 90% or a sudden jump in structure usage.
- **Low:** Remaining towers with deficient members but no observed negative impacts of deficient members on tower structural integrity. Remedy work on these structures is recommended for further improvement of line reliability and to mitigate propagation of failures to other tower members in the future.

Table 2 shows structure locations that require repair on each circuit, with priority levels assigned.

Table 2: L23 and L24 Number of Distinct Structure Repair Locations[5]

	L23	L24	L23A	L24A	Total
High Priority	28	49	1	3	**81**
Medium Priority	31	30	0	0	**61**
Low Priority	120	133	0	1	**254**
Total	**179**	**212**	**1**	**4**	**396**

The work will take place over four years. The engineering phase will take approximately six months to complete the detailed design of reinforcements for all identified deficiencies. Due to the nature of the scope of work, engineering is to commence a year before construction, as noted in the project schedule provided in Section 5.2. Material procurement and fabrication begin in the first year of the project.

For project execution, two separate crews will work in parallel for a three-month period (June–August) on each of the last three years of the schedule. All engineering and construction will be completed by an experienced consultant. Hydro will provide technical and project management support throughout the four-year project. Use of a helicopter will be considered for the sites without easily accessible access roads.

Almost all identified deficient members are located at the lower part of the towers, and no outage will be required for their reinforcement/replacements. There are two locations where repair work will be in proximity to phase conductors, and an outage may be required during construction. If an outage to facilitate repairs is required, work will be scheduled to take place during the regular annual outage date for these lines.

It is anticipated that fabrication and galvanizing the steel parts (100 metric tonnes) will take three to four months in year one of the project. The procurement processes will be established and a manufacturer selected, so that fabrication can be started with minimal gap after completion of detailed design.

[5] As provided in Table 1 of Attachment A. Please refer to Attachment A for further information.

5.1 Project Budget

The estimate for this project is shown in Table 3. The consultant, material supply, and construction costs used to prepare the project estimate were taken from the Stantec report[6] with internal labour, interest, escalation and contingency applied by Hydro.

Table 3: Project Estimate ($000)[7]

Project Cost	2026	2027	Beyond	Total
Material Supply	0.0	302.3	0.0	**302.3**
Labour	28.1	175.8	291.1	**495.0**
Consultant	460.0	0.0	0.0	**460.0**
Contract Work	0.0	1,655.5	3,311.0	**4,966.6**
Other Direct Costs	0.0	0.0	0.0	**0.0**
Interest and Escalation	39.3	305.4	1,138.0	**1,482.7**
Contingency	48.8	296.1	525.8	**870.7**
Total	**576.2**	**2,735.3**	**5,265.8**	**8,577.4**

5.2 Project Schedule

The project is expected to start in January 2026 and conclude in 2029. The schedule for this project is shown in Table 4**.**

Table 4: Project Schedule

Activity	Start Date	End Date
Planning:		
Resource planning.	January 2026	March 2026
Request for proposal development.	March 2026	April 2026
Design:		
Engineering design (Consultant).	May 2026	October 2026
Procurement:		
Order material (Consultant).	September 2026	October 2026
Construction:		
2027 member replacement (Consultant).	June 2027	August 2027
2028 member replacement (Consultant).	June 2028	August 2028
2029 member replacement (Consultant).	June 2029	August 2029
Closeout:		
Complete closeout documentation.	September 2029	October 2029

[6] Please refer to Table 8 of Attachment A.
[7] Numbers may not add due to rounding.

6.0 Conclusion

Through assessment and subsequent drone inspections, 503 cases of member deficiencies across 396 distinct tower locations were identified on L23 and L24. Of the 396 locations, 142 have been identified as either high or medium priority and need repair. Engineering analysis has strongly recommended that the critical and undersized bracings identified be replaced with members having adequate structural capacity.

The project is essential for maintaining the lifespan of L23/L24 and providing safe and reliable power for the customers it serves.

Attachment 1

L23/L24 Tower Remediation Cost Estimate

Stantec

L23/L24 Tower Remediation Cost Estimate

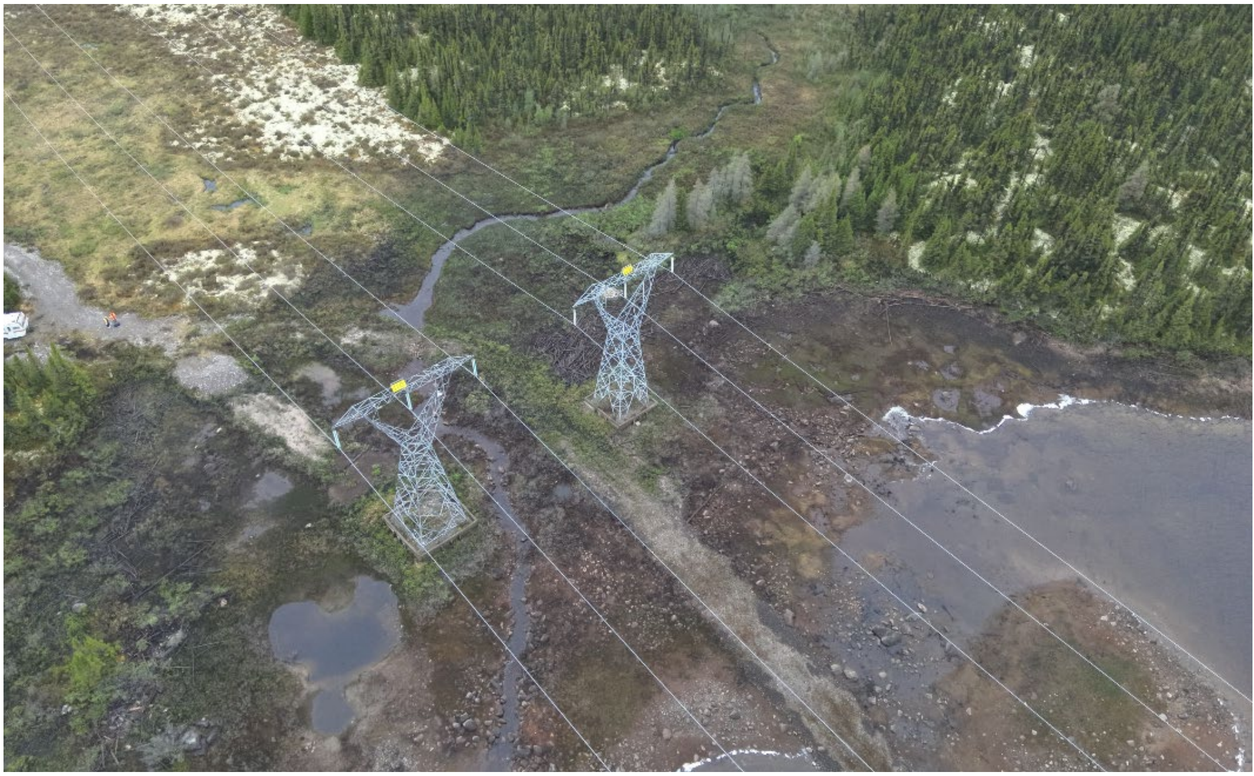
Cost estimate for proposed structural reinforcements, repair and member replacements of steel lattice towers for the 230kV transmission lines between Churchill Falls and Wabush (L23, L23A, L24 and L24A)

Prepared for:
NL Hydro

April 2, 2025

Prepared by:
Stantec Consulting

Project/File:
118212722



Stantec Consulting Ltd.

Revision Schedule

Revision	Description	Author	Date	Quality Check	Date
0	Initial	R. Ashtari	3/31/2025	B. Cristescu	3/31/2025
1	Updated after comments	R. Ashtari	4/2/2025	B. Cristescu	4/2/2025

Disclaimer

The conclusions in the Report titled L23/L24 Tower Remediation Cost Estimate are Stantec's professional opinion, as of the time of the Report, and concerning the scope described in the Report. The opinions in the document are based on conditions and information existing at the time the scope of work was conducted and do not take into account any subsequent changes. The Report relates solely to the specific project for which Stantec was retained and the stated purpose for which the Report was prepared. The Report is not to be used or relied on for any variation or extension of the project, or for any other project or purpose, and any unauthorized use or reliance is at the recipient's own risk.

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1 Background

Newfoundland and Labrador Hydro (NLH) operates two parallel 230 kV steel tower transmission lines between Churchill Falls and Wabush. These lines are critical to NLH's grid and are used to supply safe and reliable power to residents as well as both commercial and industrial customers in the Wabush area. The lines were originally constructed in sections as follows:

- L23 - Twin Falls to Wabush – completed in 1962.
- L24 - Twin Falls to Wabush – completed in 1964.
- L23A - Churchill Falls to Twin Falls – completed in 1974.
- L24A - Churchill Falls to Twin Falls – completed in 1974.

L23 and L24 were constructed using only self-support towers for tangent, angle, and dead-end types. L23A and L24A were constructed using guyed V towers for tangent types and self-supported towers for angle and dead-end types.

Stantec completed an inspection in 2023 using drone technology to identify visible defects and deficiencies including damaged, deformed or bent tower members, missing tower members, and altered tower members. Stantec transmission line engineering team also completed a detailed structural analysis in 2023 and 2024 to simulate the deficiencies in the applicable tower models and assess structural impacts and performance, then developed work to remedy each individual tower site's deficiencies.

Stantec has prepared this Class 3 cost estimate for remediating L23/L24 tower deficiencies based on previous analysis as recommended in the structural reports from 2023 and 2024. The estimate includes costs for engineering (detailed member design, temporary support design), materials (galvanized steel angle bars, connection plates, bolts, nuts, washers, etc.) and construction including all labour costs for member replacements and temporary support as required.

2 Tower Remediation Work

The drone inspections revealed 503 cases of member deficiencies across 396 distinct tower locations. The post-deficiency structural analysis provided a priority ranking (P1 to P7) for remedial actions. For this cost estimate, the repair work has been re-organized (from the engineering assessment priority system) into three new priority categories (High, Medium, and Low) based on the definition below:

- High: Critical structure locations where deficient member(s) with high usage (more than 100%) exist and structure integrity is at risk. All dead-end and heavy anchor structure types are included in this category. This aligns with priority P1 from the 2023 and 2024 Stantec reports.
- Medium: Second level of priority where deficient members have adversely impacted the tower, but structural integrity is still intact. With overall structure usage of more than 90% or sudden jump in structure usage, this aligns with priority levels P2 and P3 from the 2023 and 2024 Stantec reports.
- Low: Remaining towers with deficient members but no observed negative impacts of deficient members on tower structural integrity. This category aligns with remaining levels P4 to P7 from the 2023 and 2024 Stantec reports. Remedy work on these structures is recommended for further improvement of line reliability and to mitigate propagation of failures to other tower members in the future.

Table 1 shows number of structure locations that require repair on each circuit with priority levels assigned.

Table 1. Number of Distinct Structure Repair Locations and Priority Level

	L23	L24	L23A	L24A	Total
High Priority	28	49	1	3	**81**
Medium Priority	31	30	0	0	**61**
Low Priority	120	133	0	1	**254**
Total	179	212	1	4	**396**

Appendix A shows list of all deficient structure and members that require reinforcement.

Almost all identified deficient members are at lower part of the towers and no outage will be required for their reinforcement/replacements. There are two locations where repair work will be in proximity of phase conductors and an outage may be required during construction:

Circuit #	Str. #	Deficient Member #
L23	570	12
L24	130	101

3 Cost Estimate

3.1 Approach and Assumptions

- The cost estimate is based on the findings of drone inspections and structural analysis reports prepared by Stantec in previous stages as summarized in Section 2 above.
- The cost estimate reflects only the engineering, material, and construction aspect of the work and excludes forward escalation, owner's costs (cost of land, staffing costs, financing costs, etc.), new access road, regulatory process and permitting costs (if needed), taxes and insurance.
- The access to individual towers is assumed per the provided kmz file by NL Hydro. It is assumed only 80% of the towers are accessible. The estimate does not include any cost for construction of new access road (if eventually determined to be required). Use of helicopter from companies who provide these services is considered in the cost estimate for the sites without access road.
- It is assumed that construction window will be from May to October in any given year.
- Replacement/Reinforcement is considered for all identical tower members in four (4) tower quadrants, even if only one is found with deficiency (i.e., complete member subgrouping replacement is assumed for a more consistent and robust approach).
- All costs are in CAD.

3.2 Engineering

Engineering phase will include detailed design of reinforcements, preparation of fabrication details for member replacements, member additions, temporary support design and installation instructions for different found tower/member deficiencies. There are total of 72 unique "Tower Type – Member" that require detailed engineering plus 16 locations that require temporary support design which will comprise of a temporary large-size beam to connect tower legs horizontally while replacing diagonal members.

It is anticipated that two team of structural engineers/drafter will require about 8 to 9 months to complete detail design work. The associated fee for engineering services is estimated to be around $660,000.

3.3 Materials

For weight estimation of galvanized steel materials (member replacements), angle profiles with longer web width and higher thickness are assumed (without any detailed analysis). An additional 25% of calculated steel weights are added for connection plates, bolts, nuts and washers. Table 2 shows the estimated weight of steel materials for the repair and replacement works.

Table 2. Estimated Weight of Steel Materials (Kg)

	L23	L24	L23A	L24A	Total
High Priority	6,219	17,925	181	316	**24,641**
Medium Priority	5,596	9,029	-	-	**14,625**
Low Priority	24,742	32,791	-	7	**57,540**
Total	36,557	59,745	181	323	**96,806**

For cost estimate of galvanized steel components, it is assumed that materials will be supplied by a Canadian mill/fabricator and unit price of $7.7 per Kg is assumed after labour, galvanizing and freight. Table 3 summarizes the calculated cost for galvanized steel materials.

Table 3. Estimated Cost of Steel Materials (CAD)

	L23	L24	L23A	L24A	Total
High Priority	$47,886	$138,023	$1,394	$2,433	$189,736
Medium Priority	$43,089	$69,523	-	-	$112,613
Low Priority	$190,513	$252,491	$-	$54	$443,058
Total	$281,489	$460,037	$1,394	$2,487	**$745,406**

3.4 Construction

Stantec has sub-contracted ECP (East Coast Powerline) company to provide Class 3 cost estimate for the labour and installation work. The approximate “Crew Days” required to finish all the reinforcement and replacement work is about 418 crew-days as shown in Table 4.

Table 4. Estimated Number of Crew-Days

	L23	L24	L23A	L24A	Total
Required Crew-Days	148	268	1	1	**418**

ECP has prepared two estimates for construction and installations: 1-Year program and 5-Year program.

3.4.1 1-Year Program

The 1-Year program assumes that the remediation work will be completed in one year including all High, Medium and Low priority locations. Considering construction windows from May to October, three (3) separate crews will have to work in parallel. Table 5 shows the estimated cost for 1-Year program.

Table 5. Estimated Construction Cost for 1-Year Program

		Indirect, Yard & Mobilizations	Helicopter Support	Crews (x3)	Total
1-Year Program	Scheduled Days	154	126	140	
	Construction Costs (CAD)	$1,711,329	$3,403,200	$3,116,294	**$8,230,823**

3.4.2 5-Year Program

The 5-Year program assumes that the remediation work will be completed in within five years starting with High priority locations and then proceeding with Medium and Low priorities.

For this program, two (2) separate crews will have to work in parallel for two months (June and July) on each of the five years. With the spread of the work over five years, the associated indirect costs, mobilization/demobilization as well as helicopter costs will be higher compared to 1-Year program. No yearly escalation on materials and labours is assumed. Table 6 shows the estimated cost for 5-Year program.

Table 6. Estimated Construction Cost for 5-Year Program

		Indirect, Yard & Mobilizations	Helicopter Support	Crews (x2)	Total
Year 1	Scheduled Days	55	34	42	
	Construction Costs (CAD)	$980,875	$864,225	$594,441	**$2,439,540**
Year 2	Scheduled Days	55	34	42	
	Construction Costs (CAD)	$980,875	$864,225	$594,441	**$2,439,540**
Year 3	Scheduled Days	55	34	44	
	Construction Costs (CAD)	$980,875	$864,225	$622,747	**$2,467,847**
Year 4	Scheduled Days	55	34	43	
	Construction Costs (CAD)	$980,875	$864,225	$608,594	**$2,453,694**
Year 5	Scheduled Days	55	34	45	
	Construction Costs (CAD)	$980,875	$864,225	$636,901	**$2,482,000**
Total					**$12,282,622**

3.4.3 3-Year Program

The 3-Year program assumes the remediation work will be completed within three years covering only the High and Medium priority.

For this program, two (2) separate crews will have to work in parallel for 6 weeks months (through June and July) on each of the three years. Table 7 shows the estimated cost for 3-Year program.

Table 7. Estimated Construction Cost for 3-Year Program

		Indirect, Yard & Mobilizations	Helicopter Support	Crews (x2)	Total
Year 1	Scheduled Days	44	24	30	
	Construction Costs (CAD)	$784,700	$648,229	$222,592	**$1,655,521**
Year 2	Scheduled Days	44	24	30	
	Construction Costs (CAD)	$784,700	$648,229	$222,592	**$1,655,521**
Year 3	Scheduled Days	44	24	30	
	Construction Costs (CAD)	$784,700	$648,229	$222,592	**$1,655,521**
Total					**$4,966,563**

3.5 Summary

Table 8 shows summary of cost estimate for Engineering, Materials and Construction.

Table 8. Cost Estimate Summary

		Engineering[1]	Material	Construction	Sum	Total
1-Year Program		$660,000	$745,406	$8,230,823		**$9,636,229**
5-Year Program	Year 1	$460,000[2]	$302,348[2]	$2,439,540	$3,201,888	**$13,688,028**
	Year 2	$200,000[3]	$443,058[3]	$2,546,897	$3,082,598	
	Year 3	-	-	$2,620,877	$2,467,847	
	Year 4	-	-	$2,720,454	$2,453,694	
	Year 4	-	-	$2,831,911	$2,482,000	
3-Year Program[4]	Year 1	$460,000	$302,348	$1,655,521	$2,417,869	**$5,728,911**
	Year 2	-	-	$1,655,521	$1,655,521	
	Year 3	-	-	$1,655,521	$1,655,521	

Notes:
1. The cost of Engineering is shown to be part of Year 1, but Engineering phase should be started a year ahead.
2. Engineering and Material cost in Year 1 will cover both High and Medium priority repairs.
3. Engineering and Material cost in Year 2 will cover Low priority repairs.
4. 3-Year program will cover only High and Medium priority repairs.

4 Schedule

Engineering phase will take approximately 8 to 9 months to complete detailed design of reinforcements for all identified deficiencies. By focusing only on High and Medium priority locations, this timeframe could be reduced to about 6 months. It must be noted that the Engineering should commence a year ahead of construction, however the cost of engineering as shown in table 8 above is included in the first year.

It is anticipated that fabrication and galvanizing the steel parts (~100 metric tonnes) will take 3 to 4 months provided that procurement processes has been established in advance and a manufacturer has been selected, so that fabrication of steel parts can be started with minimal gap after completion of detail design.

Preliminary construction schedule for all three programs (1-Year, 5-Year and 3-Year) are shown in Appendix C. the summary of timelines are as follows:

- For 1-Year program, the construction works starts from May 2026 through first week of October 2026.
- For 5-Year program, the construction works will be from end of May to late July (approximately 2 months) for each of the five years from 2026 till 2030.
- For 3-Year program, the construction works (on High and Medium priority locations) will be from early June to mid July (approximately 1.5 months) for each of the three years from 2026 till 2028.

The High priority tower remediation work consists of approximately 25% of the total work and Medium and Low priority works will be around 15% and 60% of total work respectively.

Appendix A List of Deficient Structures-Members

NL Hydro - L23/L24/L23A/L24A Tower Remediation
Appendix A -List of Deficient Structures-Members

Circuit #	Str. #	Circuit | Str #	Tower Type & Extension	Deficient Member	Reinforcement Angle Bar Details: New Angle Bar Size	Angle Bar Length (mm)	Qty per tower	Total Weight(Kg)	Repair Method	Priority	Temporary Support Required
L23	5	L23 | 5	A_+0+0+0+0	109	L3x3x1/4	4042	8	296	R1	P6	
L23	9	L23 | 9	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P7	
L23	10	L23 | 10	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P6	
L23	13	L23 | 13	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P7	
L23	15	L23 | 15	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P4	
L23	16	L23 | 16	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P7	
L23	17	L23 | 17	S_+5+5+5+5	136	L2.5x2.5x3/16	5565	8	256	R1	P1	
L23	18	L23 | 18	S_+5+5+5+5	136	L2.5x2.5x3/16	5565	8	256	R1	P2	
L23	19	L23 | 19	S_+5+5+5+5	136	L2.5x2.5x3/16	5565	8	256	R1	P1	
L23	21	L23 | 21	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P6	
L23	22	L23 | 22	S_+5+5+5+5	136	L2.5x2.5x3/16	5565	8	256	R1	P1	
L23	23	L23 | 23	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P7	
L23	25	L23 | 25	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P7	
L23	32	L23 | 32	S_+5+5+5+5	136	L2.5x2.5x3/16	5565	8	256	R1	P1	
L23	38	L23 | 38	S_+0+0+0+0	133	L2x2x3/16	1303	8	49	R1	P6	
L23	44	L23 | 44	S_+5+5+5+5	136	L2.5x2.5x3/16	5565	8	256	R1	P7	
L23	49	L23 | 49	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P7	
L23	54	L23 | 54	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P4	
L23	62	L23 | 62	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P5	
L23	63	L23 | 63	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P6	
L23	75	L23 | 75	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P3	
L23	79	L23 | 79	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P3	
L23	90	L23 | 90	S_+0+0+0+0	129	L3.5x3.5x5/16	3060	4	166	R2	P4	
L23	90	L23 | 90	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P4	
L23	94	L23 | 94	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P7	
L23	95	L23 | 95	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P1	
L23	96	L23 | 96	S_-5-5-5-5	127	L2x2x3/16	3104	8	115	R1	P7	
L23	100	L23 | 100	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P7	
L23	101	L23 | 101	S_+5+5+5+5	140	L2x2x3/16	1196	4	23	R1	P1	
L23	101	L23 | 101	S_+5+5+5+5	136	L2.5x2.5x3/16	5565	8	256	R1	P1	
L23	104	L23 | 104	S_+15+15+15+15	154	L3.5x3.5x5/16	8441	8	912	R1	P7	
L23	104	L23 | 104	S_+15+15+15+15	152	L3.5x3.5x5/16	7737	4	418	R2	P7	
L23	107	L23 | 107	S_-5-5-5-5	127	L2x2x3/16	3104	8	115	R1	P6	
L23	109	L23 | 109	T_+0+0+0+0	124	L2x2x3/16	4580	8	170	R1	P1	
L23	113	L23 | 113	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P7	
L23	114	L23 | 114	S_-5-5-5-5	115	L2.5x2.5x3/16	3220	8	149	R1	P3	
L23	116	L23 | 116	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P7	
L23	117	L23 | 117	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P7	
L23	134	L23 | 134	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P4	
L23	139	L23 | 139	S_+5+5+5+5	136	L2.5x2.5x3/16	5565	8	256	R1	P1	
L23	145	L23 | 145	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P4	
L23	151	L23 | 151	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P7	
L23	152	L23 | 152	S_-5-5-5-5	127	L2x2x3/16	3104	8	115	R1	P7	
L23	153	L23 | 153	S_-5-5-5-5	127	L2x2x3/16	3104	8	115	R1	P6	
L23	153	L23 | 153	S_-5-5-5-5	118	L2.5x2.5x3/16	5162	4	119	R1	P6	
L23	167	L23 | 167	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P5	
L23	168	L23 | 168	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P7	
L23	169	L23 | 169	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P7	
L23	170	L23 | 170	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P6	
L23	171	L23 | 171	S_-5-5-5-5	118	L2.5x2.5x3/16	5162	4	119	R1	P7	
L23	172	L23 | 172	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P5	
L23	173	L23 | 173	S_+5+5+5+5	136	L2.5x2.5x3/16	5565	8	256	R1	P1	
L23	174	L23 | 174	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P7	
L23	175	L23 | 175	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P3	
L23	178	L23 | 178	S_+5+5+5+5	136	L2.5x2.5x3/16	5565	8	256	R1	P2	
L23	179	L23 | 179	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P2	
L23	181	L23 | 181	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P7	
L23	184	L23 | 184	S_+10+10+10+10	144	L3x3x3/16	6975	8	391	R1	P7	
L23	188	L23 | 188	S_-5-5-5-5	127	L2x2x3/16	3104	8	115	R1	P6	
L23	189	L23 | 189	S_-5-5-5-5	127	L2x2x3/16	3104	8	115	R1	P1	
L23	190	L23 | 190	S_-5-5-5-5	127	L2x2x3/16	3104	8	115	R1	P6	
L23	190	L23 | 190	S_-5-5-5-5	118	L2.5x2.5x3/16	5162	4	119	R1	P6	

Circuit #	Str. #	Circuit | Str #	Tower Type & Extension	Deficient Member	Reinforcement Angle Bar Details: New Angle Bar Size	Angle Bar Length (mm)	Qty per tower	Total Weight(Kg)	Repair Method	Priority	Temporary Support Required
L23	205	L23 | 205	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P5	
L23	206	L23 | 206	S_+5+5+5+5	136	L2.5x2.5x3/16	5565	8	256	R1	P2	
L23	222	L23 | 222	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P2	
L23	225	L23 | 225	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P5	
L23	228	L23 | 228	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P7	
L23	235	L23 | 235	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P4	
L23	239	L23 | 239	S_-5-5-5-5	127	L2x2x3/16	3104	8	115	R1	P3	
L23	241	L23 | 241	S_-5-5-5-5	127	L2x2x3/16	3104	8	115	R1	P6	
L23	244	L23 | 244	S_-5-5-5-5	118	L2.5x2.5x3/16	5162	4	119	R1	P1	
L23	245	L23 | 245	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P4	
L23	247	L23 | 247	S_-5-5-5-5	127	L2x2x3/16	3104	8	115	R1	P2	
L23	248	L23 | 248	S_+5+5+5+5	136	L2.5x2.5x3/16	5565	8	256	R1	P3	
L23	249	L23 | 249	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P5	
L23	251	L23 | 251	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P7	
L23	255	L23 | 255	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P7	
L23	260	L23 | 260	S_+10+10+10+10	144	L3x3x3/16	6975	8	391	R1	P7	
L23	262	L23 | 262	S_+10+10+10+10	144	L3x3x3/16	6975	8	391	R1	P7	
L23	263	L23 | 263	S_+5+5+5+5	136	L2.5x2.5x3/16	5565	8	256	R1	P1	
L23	264	L23 | 264	S_-5-5-5-5	127	L2x2x3/16	3104	8	115	R1	P5	
L23	269	L23 | 269	S_-5-5-5-5	127	L2x2x3/16	3104	8	115	R1	P7	
L23	271	L23 | 271	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P7	
L23	272	L23 | 272	S_-5-5-5-5	127	L2x2x3/16	3104	8	115	R1	P1	
L23	273	L23 | 273	S_-5-5-5-5	127	L2x2x3/16	3104	8	115	R1	P2	
L23	274	L23 | 274	S_-5-5-5-5	127	L2x2x3/16	3104	8	115	R1	P6	
L23	276	L23 | 276	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P7	
L23	278	L23 | 278	T_+0+0+0+0	124	L2x2x3/16	4580	8	170	R1	P1	
L23	278	L23 | 278	T_+0+0+0+0	119	L2.5x2.5x3/16	4534	8	209	R1	P1	
L23	279	L23 | 279	S_-5-5-5-5	127	L2x2x3/16	3104	8	115	R1	P6	
L23	279	L23 | 279	S_-5-5-5-5	118	L2.5x2.5x3/16	5162	4	119	R1	P6	
L23	280	L23 | 280	S_-5-5-5-5	118	L2.5x2.5x3/16	5162	4	119	R1	P6	
L23	282	L23 | 282	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P7	
L23	284	L23 | 284	S_-5-5-5-5	127	L2x2x3/16	3104	8	115	R1	P3	
L23	286	L23 | 286	S_-5-5-5-5	127	L2x2x3/16	3104	8	115	R1	P5	
L23	287	L23 | 287	S_-5-5-5-5	127	L2x2x3/16	3104	8	115	R1	P2	
L23	293	L23 | 293	S_+5+5+5+5	136	L2.5x2.5x3/16	5565	8	256	R1	P3	
L23	299	L23 | 299	S_+5+5+5+5	136	L2.5x2.5x3/16	5565	8	256	R1	P3	
L23	300	L23 | 300	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P5	
L23	303	L23 | 303	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P6	
L23	305	L23 | 305	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P2	
L23	306	L23 | 306	S_-5-5-5-5	127	L2x2x3/16	3104	8	115	R1	P3	
L23	308	L23 | 308	S_-5-5-5-5	127	L2x2x3/16	3104	8	115	R1	P3	
L23	309	L23 | 309	S_-5-5-5-5	127	L2x2x3/16	3104	8	115	R1	P7	
L23	313	L23 | 313	S_-5-5-5-5	127	L2x2x3/16	3104	8	115	R1	P6	
L23	318	L23 | 318	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P4	
L23	319	L23 | 319	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P7	
L23	320	L23 | 320	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P7	
L23	322	L23 | 322	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P5	
L23	323	L23 | 323	T_+0+0+0+0	124	L2x2x3/16	4580	8	170	R1	P1	
L23	324	L23 | 324	T_+0+0+0+0	124	L2x2x3/16	4580	8	170	R1	P1	
L23	337	L23 | 337	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P2	
L23	340	L23 | 340	S_-5-5-5-5	127	L2x2x3/16	3104	8	115	R1	P3	
L23	342	L23 | 342	S_-5-5-5-5	127	L2x2x3/16	3104	8	115	R1	P7	
L23	347	L23 | 347	S_-5-5-5-5	127	L2x2x3/16	3104	8	115	R1	P2	
L23	349	L23 | 349	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P6	
L23	350	L23 | 350	S_+10+10+10+10	144	L3x3x3/16	6975	8	391	R1	P7	
L23	351	L23 | 351	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P7	
L23	357	L23 | 357	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P7	
L23	363	L23 | 363	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P7	
L23	364	L23 | 364	S_-5-5-5-5	127	L2x2x3/16	3104	8	115	R1	P1	
L23	367	L23 | 367	S_-5-5-5-5	127	L2x2x3/16	3104	8	115	R1	P2	
L23	369	L23 | 369	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P6	
L23	371	L23 | 371	T_+0+0+0+0	124	L2x2x3/16	4580	8	170	R1	P1	
L23	372	L23 | 372	S_+10+10+10+10	144	L3x3x3/16	6975	8	391	R1	P5	
L23	374	L23 | 374	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P6	
L23	381	L23 | 381	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P2	

					Reinforcement Angle Bar Details						
Circuit #	Str. #	Circuit | Str #	Tower Type & Extension	Deficient Member	New Angle Bar Size	Angle Bar Length (mm)	Qty per tower	Total Weight(Kg)	Repair Method	Priority	Temporary Support Required
L23	382	L23 | 382	S_+10+10+10+10	144	L3x3x3/16	6975	8	391	R1	P7	
L23	382	L23 | 382	S_+10+10+10+10	150	L2x2x3/16	1623	8	61	R1	P7	
L23	385	L23 | 385	S_-5-5-5-5	127	L2x2x3/16	3104	8	115	R1	P7	
L23	388	L23 | 388	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P7	
L23	401	L23 | 401	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P6	
L23	402	L23 | 402	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P3	
L23	405	L23 | 405	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P7	
L23	405	L23 | 405	S_+0+0+0+0	129	L3.5x3.5x5/16	3060	4	166	R2	P7	
L23	407	L23 | 407	C_+0+0+0+0	122	L3.5x3.5x5/16	4737	8	512	R1	P1	
L23	409	L23 | 409	S_+5+5+5+5	136	L2.5x2.5x3/16	5565	8	256	R1	P1	
L23	412	L23 | 412	C_+0+0+0+0	123	L2x2x3/16	2019	8	75	R1	P1	
L23	418	L23 | 418	T_+0+0+0+0	124	L2x2x3/16	4580	8	170	R1	P1	
L23	419	L23 | 419	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P7	
L23	420	L23 | 420	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P7	
L23	422	L23 | 422	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P7	
L23	423	L23 | 423	T_+0+0+0+0	124	L2x2x3/16	4580	8	170	R1	P1	
L23	424	L23 | 424	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P5	
L23	426	L23 | 426	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P7	
L23	427	L23 | 427	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P5	
L23	428	L23 | 428	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P5	
L23	429	L23 | 429	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P7	
L23	430	L23 | 430	T_+0+0+0+0	124	L2x2x3/16	4580	8	170	R1	P1	
L23	432	L23 | 432	T_+0+0+0+0	124	L2x2x3/16	4580	8	170	R1	P1	
L23	438	L23 | 438	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P3	
L23	442	L23 | 442	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P5	
L23	450	L23 | 450	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P3	
L23	451	L23 | 451	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P5	
L23	455	L23 | 455	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P7	
L23	458	L23 | 458	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P4	
L23	466	L23 | 466	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P7	
L23	470	L23 | 470	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P6	
L23	474	L23 | 474	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P7	
L23	477	L23 | 477	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P7	
L23	481	L23 | 481	S_+10+10+10+10	144	L3x3x3/16	6975	8	391	R1	P7	
L23	488	L23 | 488	T_+0+0+0+0	124	L2x2x3/16	4580	8	170	R1	P1	
L23	488	L23 | 488	T_+0+0+0+0	126	L2x2x3/16	1465	8	55	R1	P1	
L23	488	L23 | 488	T_+0+0+0+0	125	L2x2x3/16	1893	8	71	R1	P1	
L23	490	L23 | 490	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P7	
L23	491	L23 | 491	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P7	
L23	492	L23 | 492	C_+0+0+0+0	122	L3.5x3.5x5/16	4737	8	512	R1	P1	
L23	494	L23 | 494	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P5	
L23	496	L23 | 496	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P7	
L23	499	L23 | 499	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P5	
L23	500	L23 | 500	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P7	
L23	502	L23 | 502	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P6	
L23	503	L23 | 503	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P7	
L23	504	L23 | 504	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P6	
L23	507	L23 | 507	S_-5-5-5-5	127	L2x2x3/16	3104	8	115	R1	P6	
L23	517	L23 | 517	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P7	
L23	521	L23 | 521	S_-5-5-5-5	127	L2x2x3/16	3104	8	115	R1	P7	
L23	522	L23 | 522	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P7	
L23	530	L23 | 530	S_-5-5-5-5	127	L2x2x3/16	3104	8	115	R1	P7	
L23	530	L23 | 530	S_-5-5-5-5	118	L2.5x2.5x3/16	5162	4	119	R1	P7	
L23	534	L23 | 534	S_-5-5-5-5	118	L2.5x2.5x3/16	5162	4	119	R1	P2	
L23	534	L23 | 534	S_-5-5-5-5	127	L2x2x3/16	3104	8	115	R1	P2	
L23	538	L23 | 538	S_+0+0+0+0	131	L2.5x2.5x3/16	4249	8	196	R1	P4	
L23	549	L23 | 549	S_-5-5-5-5	116	L2x2x3/16	3128	8	116	R1	P6	
L23	555	L23 | 555	S_-5-5-5-5	127	L2x2x3/16	3104	8	115	R1	P7	
L23	556	L23 | 556	S_-5-5-5-5	118	L2.5x2.5x3/16	5162	4	119	R1	P6	
L23	556	L23 | 556	S_-5-5-5-5	127	L2x2x3/16	3104	8	115	R1	P6	
L23	559	L23 | 559	S_+5+5+5+5	136	L2.5x2.5x3/16	5565	8	256	R1	P3	
L23	563	L23 | 563	S_-5-5-5-5	127	L2x2x3/16	3104	8	115	R1	P2	
L23	566	L23 | 566	S_-5-5-5-5	127	L2x2x3/16	3104	8	115	R1	P7	
L23	567	L23 | 567	S_-5-5-5-5	127	L2x2x3/16	3104	8	115	R1	P6	
L23	568	L23 | 568	C_+10+10+10+10	140	L2.5x2.5x3/16	2114	8	98	R1	P1	

Circuit #	Str. #	Circuit | Str #	Tower Type & Extension	Deficient Member	Reinforcement Angle Bar Details: New Angle Bar Size	Angle Bar Length (mm)	Qty per tower	Total Weight(Kg)	Repair Method	Priority	Temporary Support Required
L23	570	L23 | 570	A_+0+0+0+0	12	L2x2x3/16	1565	2	15	R1	P7	
L23A	2	L23A | 2	RT-0_+5+5+5+5	167	L2x2x3/16	4886	8	181	R1	P1	
L24	4	L24 | 4	H_+20+20+20+20	125	L2x2x3/16	1370	8	51	R1	P1	X
L24	4	L24 | 4	H_+20+20+20+20	124	L2x2x3/16	1395	8	52	R1	P1	X
L24	4	L24 | 4	H_+20+20+20+20	106/107	L3.5x3.5x5/16	9762	8	1055	R1	P1	X
L24	5	L24 | 5	B_+5+5+5+5	30/31	L2x2x3/16	1939	8	72	R1	P1	
L24	5	L24 | 5	B_+5+5+5+5	21/22	L3x3x1/4	5173	8	378	R1	P1	
L24	9	L24 | 9	BB_+0+0+0+0	75	L2.5x2.5x3/16	2772	4	64	R1	P2	
L24	9	L24 | 9	BB_+0+0+0+0	229/230	L2x2x3/16	1027	8	39	R1	P2	
L24	9	L24 | 9	BB_+0+0+0+0	227/228	L3x3x1/4	3788	8	277	R1	P2	
L24	10	L24 | 10	BB_+10+10+10+10	277/278	L3x3x1/4	6588	8	481	R1	P6	
L24	11	L24 | 11	BB_+5+5+5+5	252/253	L3x3x1/4	5159	8	377	R1	P6	
L24	11	L24 | 11	BB_+5+5+5+5	260/261	L2x2x3/16	679	8	26	R1	P6	
L24	13	L24 | 13	BB_+0+0+0+0	227/228	L3x3x1/4	3788	8	277	R1	P7	
L24	16	L24 | 16	BB_+5+5+5+5	251	L3x3x1/4	4923	4	180	R2	P1	X
L24	16	L24 | 16	BB_+5+5+5+5	252/253	L3x3x1/4	5159	8	377	R1	P1	X
L24	17	L24 | 17	BB_+5+5+5+5	252/253	L3x3x1/4	5159	8	377	R1	P3	
L24	18	L24 | 18	BB_+5+5+5+5	252/253	L3x3x1/4	5159	8	377	R1	P1	
L24	19	L24 | 19	BB_+5+5+5+5	252/253	L3x3x1/4	5159	8	377	R1	P1	
L24	20	L24 | 20	BB_+0+0+0+0	227/228	L3x3x1/4	3788	8	277	R1	P2	
L24	20	L24 | 20	BB_+0+0+0+0	28/29	L2x2x3/16	1316	8	49	R1	P2	
L24	21	L24 | 21	BB_-5-5-5-5	236/237	L2.5x2.5x3/16	2542	8	117	R1	P1	
L24	23	L24 | 23	BB_+0+0+0+0	227/228	L3x3x1/4	3788	8	277	R1	P6	
L24	24	L24 | 24	BB_+0+0+0+0	227/228	L3x3x1/4	3788	8	277	R1	P6	
L24	24	L24 | 24	BB_+0+0+0+0	231/232	L2x2x3/16	1707	8	64	R1	P6	
L24	29	L24 | 29	BB_+5+5+5+5	252/253	L3x3x1/4	5159	8	377	R1	P7	
L24	31	L24 | 31	BB_+0+0+0+0	227/228	L3x3x1/4	3788	8	277	R1	P3	
L24	33	L24 | 33	BB_+20+20+20+20	62/63	L2x2x3/16	373	8	14	R1	P7	
L24	35	L24 | 35	BB_+0+0+0+0	227/228	L3x3x1/4	3788	8	277	R1	P7	
L24	36	L24 | 36	BB_-5-5-5-5	236/237	L2.5x2.5x3/16	2542	8	117	R1	P6	
L24	37	L24 | 37	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P6	
L24	40	L24 | 40	BB_-5-5-5-5	236/237	L2.5x2.5x3/16	2542	8	117	R1	P6	
L24	49	L24 | 49	BB_+0+0+0+0	75	L2.5x2.5x3/16	2772	4	64	R1	P1	
L24	51	L24 | 51	BB_+5+5+5+5	252/253	L3x3x1/4	5159	8	377	R1	P7	
L24	57	L24 | 57	BB_+5+5+5+5	252/253	L3x3x1/4	5159	8	377	R1	P7	
L24	58	L24 | 58	BB_-5-5-5-5	236/237	L2.5x2.5x3/16	2542	8	117	R1	P6	
L24	58	L24 | 58	BB_-5-5-5-5	233/234	L2x2x3/16	1175	8	44	R1	P6	
L24	58	L24 | 58	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P6	
L24	61	L24 | 61	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P6	
L24	67	L24 | 67	BB_+0+0+0+0	75	L2.5x2.5x3/16	2772	4	64	R1	P7	
L24	72	L24 | 72	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P6	
L24	73	L24 | 73	BB_+0+0+0+0	75	L2.5x2.5x3/16	2772	4	64	R1	P5	
L24	73	L24 | 73	BB_+0+0+0+0	227/228	L3x3x1/4	3788	8	277	R1	P5	
L24	75	L24 | 75	BB_+0+0+0+0	227/228	L3x3x1/4	3788	8	277	R1	P6	
L24	81	L24 | 81	BB_+5+5+5+5	256/257	L2x2x3/16	1670	8	62	R1	P7	
L24	89	L24 | 89	BB_+0+0+0+0	227/228	L3x3x1/4	3788	8	277	R1	P7	
L24	91	L24 | 91	BB_-5-5-5-5	236/237	L2.5x2.5x3/16	2542	8	117	R1	P3	
L24	92	L24 | 92	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P7	
L24	93	L24 | 93	BB_+5+5+5+5	252/253	L3x3x1/4	5159	8	377	R1	P7	
L24	100	L24 | 100	BB_+5+5+5+5	252/253	L3x3x1/4	5159	8	377	R1	P7	
L24	107	L24 | 107	BB_-5-5-5-5	233/234	L2x2x3/16	1175	8	44	R1	P7	
L24	108	L24 | 108	BB_+0+0+0+0	227/228	L3x3x1/4	3788	8	277	R1	P7	
L24	111	L24 | 111	EE_-5-5-5-5	175	L2.5x2.5x3/16	3300	4	76	R1	P1	
L24	117	L24 | 117	BB_+0+0+0+0	227/228	L3x3x1/4	3788	8	277	R1	P6	
L24	119	L24 | 119	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P6	
L24	121	L24 | 121	EE_-5-5-5-5	175	L2.5x2.5x3/16	3300	4	76	R1	P1	
L24	129	L24 | 129	BB_+10+10+10+10	277/278	L3x3x1/4	6588	8	481	R1	P7	
L24	130	L24 | 130	EE_+5+5+5+5	101	L3x3x1/4	3500	2	64	R2	P1	
L24	131	L24 | 131	BB_+0+0+0+0	227/228	L3x3x1/4	3788	8	277	R1	P4	
L24	131	L24 | 131	BB_+0+0+0+0	231/232	L2x2x3/16	1707	8	64	R1	P4	
L24	134	L24 | 134	BB_-5-5-5-5	236/237	L2.5x2.5x3/16	2542	8	117	R1	P6	
L24	134	L24 | 134	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P6	
L24	137	L24 | 137	BB_+0+0+0+0	227/228	L3x3x1/4	3788	8	277	R1	P7	
L24	142	L24 | 142	BB_+10+10+10+10	277/278	L3x3x1/4	6588	8	481	R1	P1	X
L24	143	L24 | 143	BB_+10+10+10+10	277/278	L3x3x1/4	6588	8	481	R1	P6	

					Reinforcement Angle Bar Details						
Circuit #	**Str. #**	**Circuit | Str #**	**Tower Type & Extension**	**Deficient Member**	**New Angle Bar Size**	**Angle Bar Length (mm)**	**Qty per tower**	**Total Weight(Kg)**	**Repair Method**	**Priority**	**Temporary Support Required**
L24	145	L24 | 145	BB_+0+0+0+0	75	L2.5x2.5x3/16	2772	4	64	R1	P6	
L24	146	L24 | 146	BB_+5+5+5+5	252/253	L3x3x1/4	5159	8	377	R1	P6	
L24	146	L24 | 146	BB_+5+5+5+5	75	L2.5x2.5x3/16	2772	4	64	R1	P6	
L24	148	L24 | 148	BB_+5+5+5+5	252/253	L3x3x1/4	5159	8	377	R1	P1	
L24	150	L24 | 150	BB_+10+10+10+10	277/278	L3x3x1/4	6588	8	481	R1	P3	
L24	151	L24 | 151	BB_+0+0+0+0	226	L3x3x1/4	3085	4	113	R2	P2	
L24	151	L24 | 151	BB_+0+0+0+0	227/228	L3x3x1/4	3788	8	277	R1	P2	
L24	153	L24 | 153	BB_+5+5+5+5	252/253	L3x3x1/4	5159	8	377	R1	P7	
L24	155	L24 | 155	BB_+0+0+0+0	227/228	L3x3x1/4	3788	8	277	R1	P1	
L24	155	L24 | 155	BB_+0+0+0+0	75	L2.5x2.5x3/16	2772	4	64	R1	P1	
L24	168	L24 | 168	BB_+0+0+0+0	227/228	L3x3x1/4	3788	8	277	R1	P7	
L24	169	L24 | 169	BB_+10+10+10+10	277/278	L3x3x1/4	6588	8	481	R1	P7	
L24	169	L24 | 169	BB_+10+10+10+10	295	L2x2x3/16	2688	8	100	R1	P7	
L24	170	L24 | 170	BB_+5+5+5+5	252/253	L3x3x1/4	5159	8	377	R1	P1	
L24	171	L24 | 171	BB_-5-5-5-5	236/237	L2.5x2.5x3/16	2542	8	117	R1	P7	
L24	172	L24 | 172	BB_-5-5-5-5	236/237	L2.5x2.5x3/16	2542	8	117	R1	P1	
L24	172	L24 | 172	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P1	
L24	173	L24 | 173	BB_+0+0+0+0	227/228	L3x3x1/4	3788	8	277	R1	P3	
L24	173	L24 | 173	BB_+0+0+0+0	229/230	L2x2x3/16	1027	8	39	R1	P3	
L24	174	L24 | 174	BB_+10+10+10+10	277/278	L3x3x1/4	6588	8	481	R1	P1	X
L24	175	L24 | 175	BB_-5-5-5-5	236/237	L2.5x2.5x3/16	2542	8	117	R1	P6	
L24	175	L24 | 175	BB_-5-5-5-5	23	L3x3x3/16	2303	8	129	R1	P6	
L24	175	L24 | 175	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P6	
L24	176	L24 | 176	BB_+5+5+5+5	252/253	L3x3x1/4	5159	8	377	R1	P7	
L24	177	L24 | 177	BB_-5-5-5-5	233/234	L2x2x3/16	1175	8	44	R1	P6	
L24	177	L24 | 177	BB_-5-5-5-5	233/234	L2x2x3/16	1175	8	44	R1	P6	
L24	177	L24 | 177	BB_-5-5-5-5	236/237	L2.5x2.5x3/16	2542	8	117	R1	P6	
L24	177	L24 | 177	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P6	
L24	177	L24 | 177	BB_-5-5-5-5	74	L2x2x3/16	3975	4	74	R1	P6	
L24	177	L24 | 177	BB_-5-5-5-5	28/29	L2x2x3/16	1316	8	49	R1	P6	
L24	178	L24 | 178	BB_+10+10+10+10	277/278	L3x3x1/4	6588	8	481	R1	P1	X
L24	179	L24 | 179	BB_+0+0+0+0	226	L3x3x1/4	3085	4	113	R2	P1	
L24	179	L24 | 179	BB_+0+0+0+0	227/228	L3x3x1/4	3788	8	277	R1	P1	
L24	179	L24 | 179	BB_+0+0+0+0	75	L2.5x2.5x3/16	2772	4	64	R1	P1	
L24	180	L24 | 180	BB_-5-5-5-5	233/234	L2x2x3/16	1175	8	44	R1	P1	
L24	180	L24 | 180	BB_-5-5-5-5	233/234	L2x2x3/16	1175	8	44	R1	P1	
L24	180	L24 | 180	BB_-5-5-5-5	236/237	L2.5x2.5x3/16	2542	8	117	R1	P1	
L24	181	L24 | 181	BB_+5+5+5+5	26	L3x3x3/16	3923	8	220	R2	P3	
L24	186	L24 | 186	EE_+0+0+0+0	199/200	L3x3x1/4	3850	8	282	R1	P1	
L24	186	L24 | 186	EE_+0+0+0+0	199/200	L3x3x1/4	3850	8	282	R1	P1	
L24	188	L24 | 188	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P7	
L24	189	L24 | 189	BB_-5-5-5-5	236/237	L2.5x2.5x3/16	2542	8	117	R1	P6	
L24	189	L24 | 189	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P6	
L24	190	L24 | 190	BB_+0+0+0+0	227/228	L3x3x1/4	3788	8	277	R1	P3	
L24	191	L24 | 191	BB_-5-5-5-5	236/237	L2.5x2.5x3/16	2542	8	117	R1	P6	
L24	196	L24 | 196	BB_-5-5-5-5	236/237	L2.5x2.5x3/16	2542	8	117	R1	P6	
L24	196	L24 | 196	BB_-5-5-5-5	74	L2x2x3/16	3975	4	74	R1	P6	
L24	197	L24 | 197	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P1	
L24	197	L24 | 197	BB_-5-5-5-5	236/237	L2.5x2.5x3/16	2542	8	117	R1	P1	
L24	213	L24 | 213	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P7	
L24	213	L24 | 213	BB_-5-5-5-5	236/237	L2.5x2.5x3/16	2542	8	117	R1	P7	
L24	221	L24 | 221	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P1	
L24	221	L24 | 221	BB_-5-5-5-5	233/234	L2x2x3/16	1175	8	44	R1	P1	
L24	222	L24 | 222	BB_+0+0+0+0	227/228	L3x3x1/4	3788	8	277	R1	P6	
L24	224	L24 | 224	BB_-5-5-5-5	236/237	L2.5x2.5x3/16	2542	8	117	R1	P3	
L24	231	L24 | 231	BB_+20+20+20+20	52/53	L3x3x1/4	9579	8	700	R1	P3	X
L24	234	L24 | 234	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P2	
L24	235	L24 | 235	BB_-5-5-5-5	236/237	L2.5x2.5x3/16	2542	8	117	R1	P6	
L24	236	L24 | 236	BB_+0+0+0+0	227/228	L3x3x1/4	3788	8	277	R1	P6	
L24	239	L24 | 239	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P6	
L24	245	L24 | 245	BB_+0+0+0+0	227/228	L3x3x1/4	3788	8	277	R1	P2	
L24	247	L24 | 247	BB_+5+5+5+5	252/253	L3x3x1/4	5159	8	377	R1	P7	
L24	249	L24 | 249	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P7	
L24	249	L24 | 249	BB_-5-5-5-5	236/237	L2.5x2.5x3/16	2542	8	117	R1	P7	
L24	249	L24 | 249	BB_-5-5-5-5	233/234	L2x2x3/16	1175	8	44	R1	P7	

Circuit #	Str. #	Circuit | Str #	Tower Type & Extension	Deficient Member	Reinforcement Angle Bar Details: New Angle Bar Size	Angle Bar Length (mm)	Qty per tower	Total Weight(Kg)	Repair Method	Priority	Temporary Support Required
L24	253	L24 | 253	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P1	
L24	254	L24 | 254	BB_+5+5+5+5	252/253	L3x3x1/4	5159	8	377	R1	P6	
L24	256	L24 | 256	BB_-5-5-5-5	236/237	L2.5x2.5x3/16	2542	8	117	R1	P6	
L24	262	L24 | 262	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P6	
L24	270	L24 | 270	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P1	
L24	270	L24 | 270	BB_-5-5-5-5	233/234	L2x2x3/16	1175	8	44	R1	P1	
L24	270	L24 | 270	BB_-5-5-5-5	235	L3x3x1/4	1837	4	68	R2	P1	
L24	270	L24 | 270	BB_-5-5-5-5	236/237	L2.5x2.5x3/16	2542	8	117	R1	P1	
L24	273	L24 | 273	BB_-5-5-5-5	233/234	L2x2x3/16	1175	8	44	R1	P3	
L24	273	L24 | 273	BB_-5-5-5-5	236/237	L2.5x2.5x3/16	2542	8	117	R1	P3	
L24	278	L24 | 278	BB_+5+5+5+5	252/253	L3x3x1/4	5159	8	377	R1	P7	
L24	280	L24 | 280	BB_-5-5-5-5	74	L2x2x3/16	3975	4	74	R1	P6	
L24	280	L24 | 280	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P6	
L24	280	L24 | 280	BB_-5-5-5-5	233/234	L2x2x3/16	1175	8	44	R1	P6	
L24	280	L24 | 280	BB_-5-5-5-5	236/237	L2.5x2.5x3/16	2542	8	117	R1	P6	
L24	281	L24 | 281	BB_+0+0+0+0	75	L2.5x2.5x3/16	2772	4	64	R1	P6	
L24	282	L24 | 282	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P6	
L24	282	L24 | 282	BB_-5-5-5-5	233/234	L2x2x3/16	1175	8	44	R1	P6	
L24	282	L24 | 282	BB_-5-5-5-5	236/237	L2.5x2.5x3/16	2542	8	117	R1	P6	
L24	285	L24 | 285	BB_-5-5-5-5	236/237	L2.5x2.5x3/16	2542	8	117	R1	P6	
L24	285	L24 | 285	BB_-5-5-5-5	233/234	L2x2x3/16	1175	8	44	R1	P6	
L24	285	L24 | 285	BB_-5-5-5-5	235	L3x3x1/4	1837	4	68	R2	P6	
L24	289	L24 | 289	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P6	
L24	290	L24 | 290	BB_+10+10+10+10	277/278	L3x3x1/4	6588	8	481	R1	P7	
L24	291	L24 | 291	BB_+10+10+10+10	277/278	L3x3x1/4	6588	8	481	R1	P6	**X**
L24	294	L24 | 294	BB_+0+0+0+0	227/228	L3x3x1/4	3788	8	277	R1	P7	
L24	301	L24 | 301	BB_-5-5-5-5	74	L2x2x3/16	3975	4	74	R1	P6	
L24	301	L24 | 301	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P6	
L24	301	L24 | 301	BB_-5-5-5-5	236/237	L2.5x2.5x3/16	2542	8	117	R1	P6	
L24	306	L24 | 306	BB_-5-5-5-5	23	L3x3x3/16	2303	8	129	R1	P6	
L24	308	L24 | 308	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P7	
L24	311	L24 | 311	BB_-5-5-5-5	74	L2x2x3/16	3975	4	74	R1	P6	
L24	311	L24 | 311	BB_-5-5-5-5	233/234	L2x2x3/16	1175	8	44	R1	P6	
L24	311	L24 | 311	BB_-5-5-5-5	236/237	L2.5x2.5x3/16	2542	8	117	R1	P6	
L24	313	L24 | 313	BB_+0+0+0+0	75	L2.5x2.5x3/16	2772	4	64	R1	P7	
L24	314	L24 | 314	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P6	
L24	316	L24 | 316	BB_+20+20+20+20	52/53	L3x3x1/4	9579	8	700	R1	P1	**X**
L24	318	L24 | 318	BB_+0+0+0+0	227/228	L3x3x1/4	3788	8	277	R1	P6	
L24	320	L24 | 320	BB_+10+10+10+10	277/278	L3x3x1/4	6588	8	481	R1	P7	
L24	322	L24 | 322	EE_-5-5-5-5	175	L2.5x2.5x3/16	3300	4	76	R1	P1	**X**
L24	327	L24 | 327	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P6	
L24	329	L24 | 329	BB_+10+10+10+10	277/278	L3x3x1/4	6588	8	481	R1	P6	**X**
L24	331	L24 | 331	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P6	
L24	334	L24 | 334	BB_+10+10+10+10	277/278	L3x3x1/4	6588	8	481	R1	P6	
L24	336	L24 | 336	BB_+20+20+20+20	52/53	L3x3x1/4	9579	8	700	R1	P4	**X**
L24	337	L24 | 337	BB_+5+5+5+5	252/253	L3x3x1/4	5159	8	377	R1	P7	
L24	338	L24 | 338	BB_+5+5+5+5	252/253	L3x3x1/4	5159	8	377	R1	P4	
L24	342	L24 | 342	BB_-5-5-5-5	236/237	L2.5x2.5x3/16	2542	8	117	R1	P7	
L24	342	L24 | 342	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P7	
L24	344	L24 | 344	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P6	
L24	345	L24 | 345	BB_-5-5-5-5	74	L2x2x3/16	3975	4	74	R1	P2	
L24	347	L24 | 347	BB_+5+5+5+5	252/253	L3x3x1/4	5159	8	377	R1	P4	
L24	348	L24 | 348	BB_+5+5+5+5	252/253	L3x3x1/4	5159	8	377	R1	P1	
L24	349	L24 | 349	BB_+15+15+15+15	312/313	L3x3x1/4	8074	8	590	R1	P7	
L24	351	L24 | 351	BB_+5+5+5+5	252/253	L3x3x1/4	5159	8	377	R1	P4	
L24	361	L24 | 361	BB_+0+0+0+0	227/228	L3x3x1/4	3788	8	277	R1	P1	
L24	361	L24 | 361	BB_+0+0+0+0	229/230	L2x2x3/16	1027	8	39	R1	P1	
L24	361	L24 | 361	BB_+0+0+0+0	231/232	L2x2x3/16	1707	8	64	R1	P1	
L24	362	L24 | 362	BB_+5+5+5+5	252/253	L3x3x1/4	5159	8	377	R1	P6	
L24	364	L24 | 364	BB_-5-5-5-5	236/237	L2.5x2.5x3/16	2542	8	117	R1	P6	
L24	365	L24 | 365	BB_+0+0+0+0	227/228	L3x3x1/4	3788	8	277	R1	P6	
L24	365	L24 | 365	BB_+0+0+0+0	75	L2.5x2.5x3/16	2772	4	64	R1	P6	
L24	366	L24 | 366	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P1	
L24	369	L24 | 369	EE_+5+5+5+5	175	L2.5x2.5x3/16	3300	4	76	R1	P1	**X**
L24	371	L24 | 371	BB_-5-5-5-5	236/237	L2.5x2.5x3/16	2542	8	117	R1	P6	

					Reinforcement Angle Bar Details						
Circuit #	Str. #	Circuit | Str #	Tower Type & Extension	Deficient Member	New Angle Bar Size	Angle Bar Length (mm)	Qty per tower	Total Weight(Kg)	Repair Method	Priority	Temporary Support Required
L24	377	L24 | 377	BB_+0+0+0+0	227/228	L3x3x1/4	3788	8	277	R1	P7	
L24	378	L24 | 378	BB_+0+0+0+0	227/228	L3x3x1/4	3788	8	277	R1	P6	
L24	379	L24 | 379	BB_+10+10+10+10	277/278	L3x3x1/4	6588	8	481	R1	P1	X
L24	380	L24 | 380	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P6	
L24	387	L24 | 387	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P6	
L24	390	L24 | 390	BB_+10+10+10+10	277/278	L3x3x1/4	6588	8	481	R1	P7	X
L24	394	L24 | 394	BB_+0+0+0+0	227/228	L3x3x1/4	3788	8	277	R1	P6	
L24	395	L24 | 395	BB_+10+10+10+10	277/278	L3x3x1/4	6588	8	481	R1	P7	
L24	397	L24 | 397	BB_+5+5+5+5	252/253	L3x3x1/4	5159	8	377	R1	P2	
L24	399	L24 | 399	BB_-5-5-5-5	236/237	L2.5x2.5x3/16	2542	8	117	R1	P3	
L24	399	L24 | 399	BB_-5-5-5-5	233/234	L2x2x3/16	1175	8	44	R1	P3	
L24	400	L24 | 400	BB_+0+0+0+0	227/228	L3x3x1/4	3788	8	277	R1	P1	
L24	404	L24 | 404	BB_+10+10+10+10	277/278	L3x3x1/4	6588	8	481	R1	P7	
L24	406	L24 | 406	BB_+10+10+10+10	277/278	L3x3x1/4	6588	8	481	R1	P2	X
L24	410	L24 | 410	HH_-5+-5+-5+-5	22/23	L2x2x3/16	1240	8	46	R1	P1	
L24	412	L24 | 412	BB_+5+5+5+5	258/259	L2x2x3/16	1313	8	49	R1	P7	
L24	415	L24 | 415	EE_-5-5-5-5	201/202	L3x3x1/4	2642	8	193	R1	P1	
L24	415	L24 | 415	EE_-5-5-5-5	207/208	L2x2x3/16	1200	8	45	R1	P1	
L24	415	L24 | 415	EE_-5-5-5-5	175	L2.5x2.5x3/16	3300	4	76	R1	P1	
L24	416	L24 | 416	EE_-5-5-5-5	201/202	L3x3x1/4	2642	8	193	R1	P1	
L24	416	L24 | 416	EE_-5-5-5-5	207/208	L2x2x3/16	1200	8	45	R1	P1	
L24	416	L24 | 416	EE_-5-5-5-5	201/202	L3x3x1/4	2642	8	193	R1	P1	
L24	416	L24 | 416	EE_-5-5-5-5	207/208	L2x2x3/16	1200	8	45	R1	P1	
L24	417	L24 | 417	BB_-5-5-5-5	235	L3x3x1/4	1837	4	68	R2	P2	
L24	417	L24 | 417	BB_-5-5-5-5	236/237	L2.5x2.5x3/16	2542	8	117	R1	P2	
L24	418	L24 | 418	BB_+0+0+0+0	227/228	L3x3x1/4	3788	8	277	R1	P1	
L24	418	L24 | 418	BB_+0+0+0+0	226	L3x3x1/4	3085	4	113	R2	P1	
L24	419	L24 | 419	BB_-5-5-5-5	236/237	L2.5x2.5x3/16	2542	8	117	R1	P6	
L24	419	L24 | 419	BB_-5-5-5-5	233/234	L2x2x3/16	1175	8	44	R1	P6	
L24	420	L24 | 420	BB_+5+5+5+5	252/253	L3x3x1/4	5159	8	377	R1	P5	
L24	421	L24 | 421	EE_-5-5-5-5	201/202	L3x3x1/4	2642	8	193	R1	P1	
L24	421	L24 | 421	EE_-5-5-5-5	201/202	L3x3x1/4	2642	8	193	R1	P1	
L24	422	L24 | 422	BB_+0+0+0+0	227/228	L3x3x1/4	3788	8	277	R1	P7	
L24	423	L24 | 423	BB_+0+0+0+0	227/228	L3x3x1/4	3788	8	277	R1	P7	
L24	423	L24 | 423	BB_+0+0+0+0	75	L2.5x2.5x3/16	2772	4	64	R1	P7	
L24	424	L24 | 424	BB_+5+5+5+5	252/253	L3x3x1/4	5159	8	377	R1	P7	
L24	425	L24 | 425	BB_-5-5-5-5	233/234	L2x2x3/16	1175	8	44	R1	P6	
L24	426	L24 | 426	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P6	
L24	427	L24 | 427	BB_-5-5-5-5	236/237	L2.5x2.5x3/16	2542	8	117	R1	P7	
L24	428	L24 | 428	EE_-5-5-5-5	201/202	L3x3x1/4	2642	8	193	R1	P1	
L24	428	L24 | 428	EE_-5-5-5-5	207/208	L2x2x3/16	1200	8	45	R1	P1	
L24	428	L24 | 428	EE_-5-5-5-5	201/202	L3x3x1/4	2642	8	193	R1	P1	
L24	428	L24 | 428	EE_-5-5-5-5	207/208	L2x2x3/16	1200	8	45	R1	P1	
L24	428	L24 | 428	EE_-5-5-5-5	175	L2.5x2.5x3/16	3300	4	76	R1	P1	
L24	429	L24 | 429	BB_+5+5+5+5	252/253	L3x3x1/4	5159	8	377	R1	P6	
L24	430	L24 | 430	EE_-5-5-5-5	201/202	L3x3x1/4	2642	8	193	R1	P1	
L24	431	L24 | 431	BB_+5+5+5+5	252/253	L3x3x1/4	5159	8	377	R1	P6	
L24	434	L24 | 434	BB_+0+0+0+0	227/228	L3x3x1/4	3788	8	277	R1	P3	
L24	435	L24 | 435	BB_+0+0+0+0	75	L2.5x2.5x3/16	2772	4	64	R1	P6	
L24	440	L24 | 440	BB_+0+0+0+0	226	L3x3x1/4	3085	4	113	R2	P2	
L24	440	L24 | 440	BB_+0+0+0+0	231/232	L2x2x3/16	1707	8	64	R1	P2	
L24	440	L24 | 440	BB_+0+0+0+0	227/228	L3x3x1/4	3788	8	277	R1	P2	
L24	440	L24 | 440	BB_+0+0+0+0	75	L2.5x2.5x3/16	2772	4	64	R1	P2	
L24	442	L24 | 442	BB_+10+10+10+10	277/278	L3x3x1/4	6588	8	481	R1	P7	
L24	443	L24 | 443	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P6	
L24	444	L24 | 444	BB_+0+0+0+0	227/228	L3x3x1/4	3788	8	277	R1	P1	
L24	445	L24 | 445	BB_+0+0+0+0	74	L2x2x3/16	3975	4	74	R1	P6	
L24	448	L24 | 448	BB_-5-5-5-5	23	L3x3x3/16	2303	8	129	R1	P6	
L24	448	L24 | 448	BB_-5-5-5-5	233/234	L2x2x3/16	1175	8	44	R1	P6	
L24	448	L24 | 448	BB_-5-5-5-5	74	L2x2x3/16	3975	4	74	R1	P6	
L24	448	L24 | 448	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P6	
L24	456	L24 | 456	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P6	
L24	461	L24 | 461	BB_+0+0+0+0	227/228	L3x3x1/4	3788	8	277	R1	P7	
L24	464	L24 | 464	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P1	
L24	464	L24 | 464	BB_-5-5-5-5	236/237	L2.5x2.5x3/16	2542	8	117	R1	P1	

Circuit #	Str. #	Circuit | Str #	Tower Type & Extension	Deficient Member	Reinforcement Angle Bar Details: New Angle Bar Size	Angle Bar Length (mm)	Qty per tower	Total Weight(Kg)	Repair Method	Priority	Temporary Support Required
L24	466	L24 | 466	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P7	
L24	468	L24 | 468	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P1	
L24	469	L24 | 469	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P6	
L24	471	L24 | 471	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P6	
L24	472	L24 | 472	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P2	
L24	472	L24 | 472	BB_-5-5-5-5	235	L3x3x1/4	1837	4	68	R2	P2	
L24	473	L24 | 473	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P7	
L24	479	L24 | 479	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P6	
L24	482	L24 | 482	HH_-5-5-5-5	62	L2.5x2.5x3/16	3015	4	70	R1	P1	
L24	484	L24 | 484	BB_+5+5+5+5	252/253	L3x3x1/4	5159	8	377	R1	P6	
L24	489	L24 | 489	BB_+5+5+5+5	252/253	L3x3x1/4	5159	8	377	R1	P6	
L24	490	L24 | 490	HH_-5-5-5-5	24	L3x3x1/4	4260	4	156	R2	P1	
L24	490	L24 | 490	HH_-5-5-5-5	22/23	L2x2x3/16	1240	8	46	R1	P1	
L24	491	L24 | 491	BB_+0+0+0+0	227/228	L3x3x1/4	3788	8	277	R1	P2	
L24	491	L24 | 491	BB_+0+0+0+0	226	L3x3x1/4	3085	4	113	R2	P2	
L24	492	L24 | 492	BB_+0+0+0+0	227/228	L3x3x1/4	3788	8	277	R1	P1	
L24	495	L24 | 495	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P3	
L24	496	L24 | 496	BB_-5-5-5-5	236/237	L2.5x2.5x3/16	2542	8	117	R1	P6	
L24	497	L24 | 497	BB_+0+0+0+0	229/230	L2x2x3/16	1027	8	39	R1	P6	
L24	498	L24 | 498	BB_+5+5+5+5	252/253	L3x3x1/4	5159	8	377	R1	P7	
L24	499	L24 | 499	BB_-5-5-5-5	236/237	L2.5x2.5x3/16	2542	8	117	R1	P7	
L24	499	L24 | 499	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P7	
L24	500	L24 | 500	BB_-5-5-5-5	233/234	L2x2x3/16	1175	8	44	R1	P6	
L24	502	L24 | 502	BB_+10+10+10+10	277/278	L3x3x1/4	6588	8	481	R1	P2	
L24	503	L24 | 503	HH_-5-5-5-5	62	L2.5x2.5x3/16	3015	4	70	R1	P1	
L24	503	L24 | 503	HH_-5-5-5-5	24	L3x3x1/4	4260	4	156	R2	P1	
L24	503	L24 | 503	HH_-5-5-5-5	22/23	L2x2x3/16	1240	8	46	R1	P1	
L24	503	L24 | 503	HH_-5-5-5-5	20	L3x3x1/4	2800	8	205	R1	P1	
L24	505	L24 | 505	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P6	
L24	513	L24 | 513	BB_+0+0+0+0	227/228	L3x3x1/4	3788	8	277	R1	P7	
L24	519	L24 | 519	BB_-5-5-5-5	235	L3x3x1/4	1837	4	68	R2	P3	
L24	519	L24 | 519	BB_-5-5-5-5	236/237	L2.5x2.5x3/16	2542	8	117	R1	P3	
L24	521	L24 | 521	BB_+5+5+5+5	252/253	L3x3x1/4	5159	8	377	R1	P1	
L24	529	L24 | 529	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P6	
L24	532	L24 | 532	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P6	
L24	532	L24 | 532	BB_-5-5-5-5	236/237	L2.5x2.5x3/16	2542	8	117	R1	P6	
L24	536	L24 | 536	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P6	
L24	536	L24 | 536	BB_-5-5-5-5	236/237	L2.5x2.5x3/16	2542	8	117	R1	P6	
L24	542	L24 | 542	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P2	
L24	543	L24 | 543	BB_+10+10+10+10	277/278	L3x3x1/4	6588	8	481	R1	P2	
L24	546	L24 | 546	BB_+0+0+0+0	75	L2.5x2.5x3/16	2772	4	64	R1	P1	
L24	546	L24 | 546	BB_+0+0+0+0	226	L3x3x1/4	3085	4	113	R2	P1	
L24	546	L24 | 546	BB_+0+0+0+0	227/228	L3x3x1/4	3788	8	277	R1	P1	
L24	555	L24 | 555	BB_-5-5-5-5	75	L2.5x2.5x3/16	2772	4	64	R1	P6	
L24	561	L24 | 561	BB_-5-5-5-5	21/22	L3x3x1/4	4877	4	179	R2	P2	
L24	568	L24 | 568	H_+0+0+0+0	54	L2.5x2.5x3/16	3031	4	70	R1	P1	**X**
L24	568	L24 | 568	H_+0+0+0+0	16	L3x3x1/4	3888	8	284	R1	P1	**X**
L24A	2	L24A | 2	RT-0_+5+5+5+5	171	L2x2x3/16	1351	8	50	R1	P1	
L24A	3	L24A | 3	RT-0_+20+20+10+10	175	L3x3x1/4	6301	4	230	R1	P1	
L24A	4	L24A | 4	RT-0_+5+5+5+0	161	L2x2x3/16	3810	2	36	R1	P1	
L24A	63	L24A | 63	GV-0	148	L2x2x3/16	726	2	7	R1	P7	

Appendix B Construction Cost Estimate (from ECP)

East Coast Powerline

Newfoundland Hydro - Steel Reinforcements L23, L24, L23a & L24a

Preliminary Construction Schedule - 1 Year Program

V.01 - March 27, 2025

Task No.	Task Description	Aprox. Members to Replace	Crew Days	20-Apr	27-Apr	04-May	11-May	18-May	25-May	01-Jun	08-Jun	15-Jun	22-Jun	29-Jun	06-Jul	13-Jul	20-Jul	27-Jul	03-Aug	10-Aug	17-Aug	24-Aug	31-Aug	07-Sep	14-Sep	21-Sep	28-Sep	05-Oct	12-Oct	19-Oct	26-Oct	02-Nov	09-Nov
	Yard & Management																																
L23	**Steel Reinforcement L23**	**1486**	**148**																														
	Str 5 to 522	1384	140																														
	Str 530 to 570	102	8																														
L24	**Steel Reinforcement L24**	**2030**	**268**																														
	Str 4 to 291	1046	138																														
	Str 294 to 588	984	130																														
L23a	**Steel Reinforcement L23a**	**8**	**1**																														
L24a	**Steel Reinforcement L24a**	**16**	**1**																														

Items	Est. Cost	Est. Days Scheduled	Notes
Indirects, Yard & Mobilizations	$ 1,711,328.67	154	Overhead Management, Yard Support, Flights, Mob In and Out
Helicopter Support	$ 3,403,200.00	126	1x 407 / A350
Crew 1	$ 1,048,541.23	140	
Crew 2	$ 1,019,211.40	138	
Crew 3	$ 1,048,541.23	139	
Total Est. Cost	**$ 8,230,822.53**		

Assumptions and Inclusions

- Overhead Management, Yard Support, Flights, Mob In and Out with a 5 month duration.
- 1x 407 / A350
- 80% of structures are Heli access.
- Construction Window May through first week of October.
- Heli and Crew weather 6 days included.
- Crews working 7 days a week, 12 hour days. Conctractor to manage resources and rotations to continue work flow.
- Estimated headcount to complete work of 20-22 workers, including management and heli support crew.

East Coast Powerline

Newfoundland Hydro - Steel Reinforcements L23, L24, L23a & L24a

Preliminary Construction Schedule - 5 Year Program

V.01 - March 27, 2025

Task No.	Task Description	Aprox. Members to Replace	Aprox. Crew Days	2026 25-May	01-Jun	08-Jun	15-Jun	22-Jun	29-Jun	06-Jul	13-Jul	20-Jul	2027 24-May	31-May	07-Jun	14-Jun	21-Jun	28-Jun	05-Jul	12-Jul	19-Jul
	Yard & Management																				
L23	**Steel Reinforcement L23**	**1486**	**148**																		
	Str 5 to Str 169	368	38																		
	Str 170 to Str 286	356	41																		
	Str 287 to Str 430	428	42																		
	Str 432 to Str 570	334	29																		
L24	**Steel Reinforcement L24**	**2030**	**268**																		
	Str 4 to Str 92	328	42																		
	Str 93 to Str 177	322	42																		
	Str 178 to Str 273	300	44																		
	Str 278 to Str 345	256	43																		
	Str 347 to Str 377	108	13																		
	Str 378 to Str 445	396	45																		
	Str 448 to Str 568	320	42																		
L23a	**Steel Reinforcement L23a**	**8**	**1**																		
L24a	**Steel Reinforcement L24a**	**16**	**1**																		

Crew 1
Crew 2

Items	2026 Est. Cost	2026 Est. Days Scheduled	2027 Est. Cost	2027 Est. Days Scheduled
Indirects, Yard & Mobilizations	$ 980,874.85	55	$ 1,015,205.47	55
Helicopter Support	$ 864,225.00	34	$ 894,472.88	34
Crew Labour and Equipment	$ 594,440.51	42	$ 637,219.00	42
Total Est. Cost	**$ 2,439,540.36**		**$ 2,546,897.35**	

Total Est. Cos

Assumptions and Inclusions

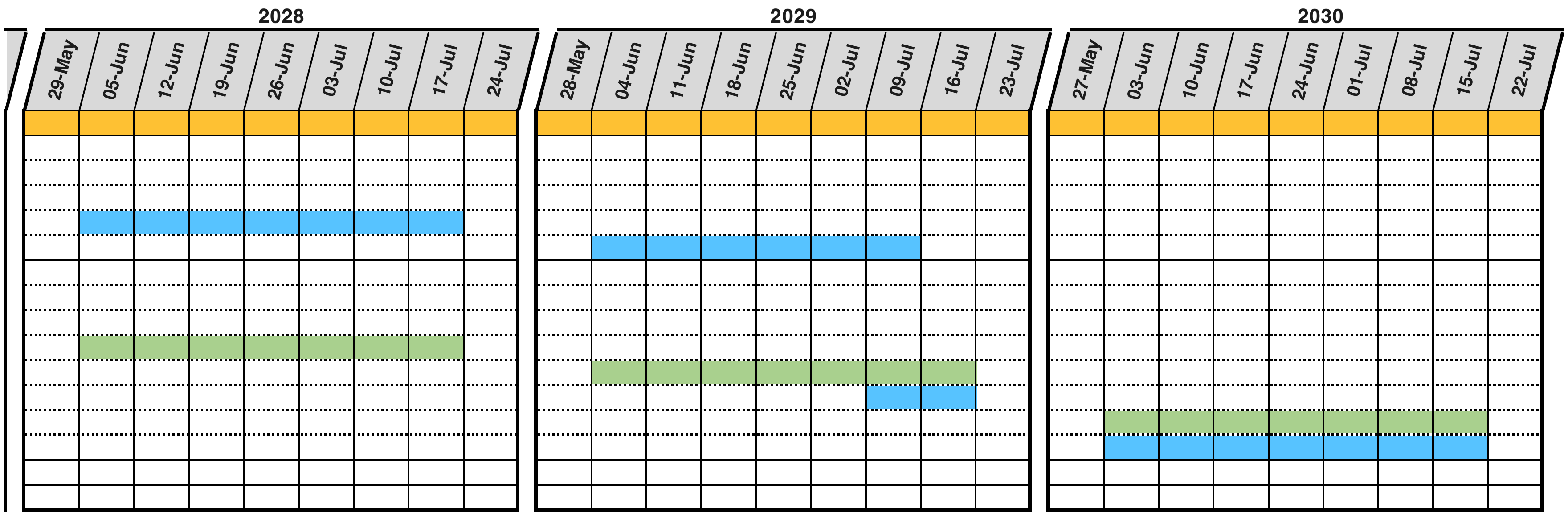
Overhead Management, Yard Support, Flights, Mob In and Out with a 2 month duration per year.
1x 407 / A350
80% of structures are Heli access.
Construction Window May through first week of October.
Heli and Crew weather 3 days included per year.
Est. 3.5% escalation on costs per year.
Crews working 7 days a week, 12 hour days. Conctractor to manage resources and rotations to continue work flow.
Estimated headcount to complete work of 13-15 workers, including management and heli support crew.

East Coast Powerline

Newfoundland Hydro - Steel Reinforcements L23, L24, L23a & L24a

Preliminary Construction Schedule - 5 Year Program

V.01 - March 27, 2025



2028 Est. Cost	2028 Est. Days Scheduled	2029 Est. Cost	2029 Est. Days Scheduled	2030 Est. Cost	2030 Est. Days Scheduled	
$ 1,050,737.67	55	$ 1,087,513.48	55	$ 1,125,576.46	55	
$ 925,779.43	34	$ 958,181.71	34	$ 991,718.07	34	
$ 644,360.25	44	$ 674,758.89	43	$ 714,616.74	45	Est. 5yr Total
st $ 2,620,877.34	Total Est. Cost	$ 2,720,454.08	Total Est. Cost	$ 2,831,911.26		$13,159,680.40

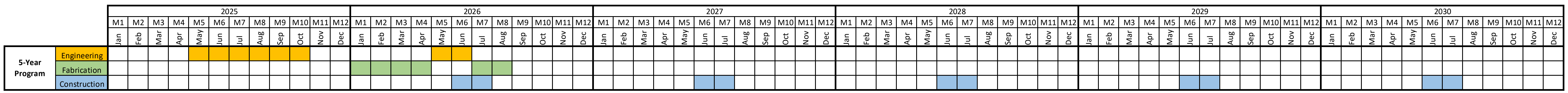
Appendix C Schedule

L23/L24 Tower Remediation Cost Estimate
Appendix C Schedule

		2025												2026											
		M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1-Year Program	Engineering																								
	Fabrication																								
	Construction																								

L23/L24 Tower Remediation Cost Estimate
Appendix C Schedule

		2025												2026												2027												2028											
		M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3-Year Program	Engineering																																																
	Fabrication																																																
	Construction																																																


2025
2026
2027
2028
2029
2030
M1 M2 M3 M4 M5 M6 M7 M8 M9 M10 M11 M12
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
5-Year Program
Engineering
Fabrication
Construction

Stantec

Stantec is a global leader in sustainable engineering, architecture, and environmental consulting. The diverse perspectives of our partners and interested parties drive us to think beyond what's previously been done on critical issues like climate change, digital transformation, and future-proofing our cities and infrastructure. We innovate at the intersection of community, creativity, and client relationships to advance communities everywhere, so that together we can redefine what's possible.

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Attachment 2

Deficiencies Analysis of Lines L23, L24, L23A, L24A-Results Summary and Remedy Planning

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NEWFOUNDLAND AND LABRADOR HYDRO 230KV TOWERS – DEFICIENCIES ANALYSIS OF LINES L23, L24

Results Summary and Remedy Planning

November 8, 2023

Prepared for:
Newfoundland and Labrador Hydro

Prepared by:
Stantec Consulting Ltd.

Project Number:
118212548

Revision	Description	Author	Date	Quality Check	Date	Independent Review	Date
0A	Issued for client review	Bogdan Cristescu	Oct. 6, 2023	Reza Ashtari	Oct. 6, 2023	Chris Eun	Oct. 6, 2023
0B	Updated per client comments	Bogdan Cristescu	Nov. 8, 2023	Reza Ashtari	Nov. 8, 2023	Chris Eun	Nov. 7, 2023

The conclusions in the Report titled Newfoundland and Labrador Hydro 230kV Towers – Deficiencies Analysis of Lines L23, L24 are Stantec's professional opinion, as of the time of the Report, and concerning the scope described in the Report. The opinions in the document are based on conditions and information existing at the time the scope of work was conducted and do not take into account any subsequent changes. The Report relates solely to the specific project for which Stantec was retained and the stated purpose for which the Report was prepared. The Report is not to be used or relied on for any variation or extension of the project, or for any other project or purpose, and any unauthorized use or reliance is at the recipient's own risk.

Stantec has assumed all information received from Newfoundland and Labrador Hydro (the "Client") and third parties in the preparation of the Report to be correct. While Stantec has exercised a customary level of judgment or due diligence in the use of such information, Stantec assumes no responsibility for the consequences of any error or omission contained therein.

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Prepared by: Cristescu, Bogdan — Digitally signed by Cristescu, Bogdan Date: 2025.06.16 14:27:41 -04'00'

Signature

Bogdan Cristescu, P. Eng.

Printed Name

Reviewed by: Ashtari, Reza — Digitally signed by Ashtari, Reza Date: 2025.06.16 08:49:09 -07'00'

Signature

Reza Ashtari, P. Eng.

Printed Name

Approved by: Eun, Chris — Digitally signed by Eun, Chris Date: 2025.06.16 09:33:15 -07'00'

Signature

Chris Eun, P. Eng.

Printed Name

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1 Project Background

Newfoundland and Labrador Hydro (NLH) operates two parallel 230 kV steel tower transmission lines between Churchill Falls and Wabush. These lines are critical to NLH's grid and are used to supply safe and reliable power to residents as well as both commercial and industrial customers in the Wabush area. The lines were originally constructed in sections as follows:

- L23 - Twin Falls to Wabush – completed in 1962.
- L24 - Twin Falls to Wabush – completed in 1964.
- L23A - Churchill Falls to Twin Falls – completed in 1974.
- L24A - Churchill Falls to Twin Falls – completed in 1974.

L23 and L24 were constructed using only self-support towers for tangent, angle, and dead-end types. L23A and L24A were constructed using guyed V towers for tangent types and self-supported towers for angle and dead-end types.

Maintenance inspections were completed in 2020 by NLH operations crews and resulted in the identification of tower deficiencies, including but not limited to damaged tower members, missing tower members, and incorrect tower members.

The overall scope of Stantec's work assignment was to complete follow-up site inspections and confirm the details previously identified deficiencies, simulate the deficiencies in the applicable tower models to analyze structural impacts and performance, then develop work methods to either accept or remedy each individual tower site's deficiencies.

This document summarizes the transmission line design criteria, methodology, and assumptions that were followed to carry out the described structural analysis work. Results from engineering analysis are also included along with recommendations. For the inspection work, Stantec has subcontracted Connect Atlantic Utility Services. This document does not cover the full details pertaining to the survey work, but Appendix A can be referenced for more information.

2 Scope of Work

The transmission line engineering scope mainly consisted of structural analysis of existing towers using the PLS TOWER software. The goal was to evaluate the impact of flagged deficiencies on structural reliability and produce remedy/repair work methods for structures in the scope.

The available existing PLS TOWER models were reviewed in detail for completeness and correctness based on the corresponding structure detail drawings. The models were appropriately "trued up" per the details covered in this document prior to structural analysis and assessment. Once the flagged deficiencies were confirmed via field inspection and site data indicating the condition of affected members/sections was reviewed, the PLS tower models were updated for deficiency simulation.

A summary of structural analysis results and capacity checks is provided for all impacted tower sections/members. Based on the results of the investigation, preliminary mitigation measures (e.g. member replacement, connection reinforcement, member upsizing, addition of bracing) are proposed for all identified deficiencies to facilitate the decision-making process for potential remedial repairs.

No changes have been anticipated/accounted for to the as-received PLS-CADD line models described in Section 3 of this document (e.g. wires, sagging). It is assumed that the conductor sections are properly sagged to LiDAR data with correct tensions based on the line conditions at the time of survey. No analysis of clearances was completed under this project scope.

The deficiencies scope table provided by NLH captures a total of 170 structure locations throughout the lines of interest. Table 1 and Table 2 below provide breakdowns of identified deficiencies by line and structure/tower type.

Table 1 – Deficiencies Breakdown for Line L23

Tower Type	Description	Count
S	Suspension/tangent, no ground wire	44
A	Suspension/tangent, with ground wire	0
T	Semi-anchor, no ground wire	2
C	Heavy anchor, with ground wire	1

Table 2 – Deficiencies Breakdown for Line L24

Tower Type	Description	Count
BB	Suspension/tangent, no ground wire	115
B	Suspension/tangent, with ground wire	1
EE	Semi-anchor, no ground wire	3
HH	Heavy anchor, no ground wire	3
H	Heavy anchor, with ground wire	1

Referring to the summary of tower types for each line that NLH has included on the Request for Proposal (RFP) document, it appears that not all tower types/families are covered by the deficiencies scope. Furthermore, only structures in the main/original line segments L23 and L24 are covered. No structures on the more recently built extension segments L23A and L24A have been flagged for deficiencies.

Detailed drone inspection of the whole line revealed additional defects beyond the original (known) list of deficiencies. The high level quantities of the newly identified deficiencies are summarized in table below but not analysed in this study. All the assessments completed and shown in this report are limited to the original list of deficiencies.

Table 3 – Additional Deficiencies Found by Inspection (Not Part of Assessment Scope)

Line	# of Additional Defects Found
L23	143
L24	97
L23A	2
L24A	4

No calculations and analysis of tower structure foundations are included in the project scope.

3 Project Files, References, and Applicable Standards

In support of the assigned work, NLH has provided the following key reference files:

- Request for Proposal (RFP) document covering various details for this project.
- RFP Appendix A – tower structure detail drawings and original load tables for various families.
- RFP Appendix B – structure lists, structure data sheets (SDS).
- RFP Appendix C – tower deficiencies scope table.
- PLS-CADD backup files for L23, L24, L23A, L24A segments, complete with PLS TOWER structure models and graphically sagged to LiDAR point data based on operating conditions.
- 2020 Manitoba Hydro structure and line modelling and analysis report for L23, L24, L23A, L24A. The Manitoba Hydro project is the source of the PLS-CADD files that will be used on this project.
- 1982 report frost prevention program for the Twin Falls – Wabush area (L23, L24).
- 2011 report for NLH tower inspection program carried out on L23, L24, L23A, L24A.
- Various appendices from an AECOM report, including tower drawings list and vector loads summaries/calculations.

PLS TOWER models were first validated against the detail drawings provided, but this exercise was only be completed for the tower families covered by the deficiencies scope. Tower detail drawings for line L24 Type EE and Type HH were not available from NLH. As such, the PLS TOWER models for these structure types could not be "trued up" for detailed analysis. The as-received tower models were relied upon for analysis of towers belonging to these two families.

A total of 78 discrepancies have been identified between the deficiencies scope table and other project files provided by NLH. In particular, tower types outlined in the deficiencies table are in contradiction with the structure data sheets and PLS-CADD files, the latter two of being in agreement with each other. Table 4 below provides a breakdown of the structure/tower type discrepancies observed.

Table 4 – Tower Type Discrepancies Breakdown

Line	Structure Type		Discrepancy Count	Comment
	Deficiencies Table	SDS and PLS-CADD		
L23	A	S	22	No evidence of ground wire to indicate Type A tower
L23	C	T	1	No evidence of ground wire to indicate Type C tower
L24	B	BB	43	No evidence of ground wire to indicate Type B tower
L24	EE	H	1	41° angle at structure; heavy anchor more logical
L24	GV-0	BB	11	GV-0 guyed suspension/tangent only on L23A, L24A

For the purpose of completing the project, the structure types stated in the SDS and PLS-CADD data were treated as correct because the tower modelling completed matches the LiDAR point data collected.

The following codes and standards are applicable given the project scope:

- CSA 22.3 No.1 -2020 Overhead Design Systems
- CSA 22.3 No.60826 -2019 Design Criteria of Overhead Transmission Lines
- CAN/CSA-S16, "Limit States Design of Steel Structures"
- CSA C83-17: Communication and Power Line Hardware
- CSA C411.1-10: AC Suspension Insulators
- CSA-G12, Zinc Coated Steel Wire Strand
- CAN/CSA C57–98 (R2011): Electric Power Connectors for Use in Overhead Line Conductors
- ASCE 10: Design of Latticed Steel Transmission Structures
- CSA G40.20 General Requirements for Rolled or Welded Structural Quality Steel
- CSA G40.21 Structural Quality Steel
- ASTM A394: Standard Specification for Steel Transmission Tower Bolts, Zinc-Coated and Bare
- ASTM A123/123M: Standard Specification for Zinc (Hot Dip Galvanized Coatings on Iron and Steel Products)

4 Inspection Results

The full set of inspection results are in included in Appendix A. The following constitutes a list of all key deficiencies captured by CAUS at the time of structure inspections. The impact of these deficiencies on tower structure performance under defined loadings was assessed.

- Member is bent.
- Member is broken.
- Member is missing.
- Member is installed incorrectly.
- Member is missing bolts.
- Member is altered.

The following constitutes a list of additional deficiencies flagged that were not considered relevant for structural performance assessment and subsequent structural remedy/repair planning. These deficiencies can be categorized as geotechnical, environmental, or operation/serviceability issues.

- Tower is leaning.
- Tower base fill is too high or low.
- Tower base is overgrown by vegetation.
- Insulator is worn.
- Insulator is porcelain (not considered a deficiency by NLH, just flagged in standard inspection).
- Insulator is not plumb.
- Raptor nest at structure.

Table 5 provides a basic breakdown of key deficiency counts on lines L23 and L24 by quantity of structures where the deficiencies occur. Note that the same structure could be included in multiple counts if multiple deficiency types occur at that structure.

Table 5 – Deficiencies Breakdown (by # of structures)

Circuit	Member Deficiency Type					
	Bent	Broken	Missing	Incorrect Install	Missing Bolts	Altered
L23	43	6	0	0	0	3
L24	119	8	9	1	1	1

The field inspectors manually assigned severity level of low, medium, or high to each individual deficiency flagged throughout both lines. The criteria for severity were subjective based on the nature of the visually observed deficiency, the member of the tower where it occurs, and the intensity of the deficiency (e.g. degree of deformation). However, this deficiency rating does not necessarily corelate to critical members and was not directly used to develop the recommended priority system for repairs discussed later on.

Table 6 provides a break down of the key deficiency types by severity level. Note that this refers to individual deficiency counts as opposed to structure counts.

Table 6 – Severities Breakdown (by # of deficiencies)

Circuit	Severity Level	Member Deficiency Type					
		Bent	Broken	Missing	Incorrect Install	Missing Bolts	Altered
L23	Low	107	3	0	0	0	4
	Medium	1	4	0	0	0	0
	High	0	0	0	0	0	0
L24	Low	414	4	2	2	1	1
	Medium	3	10	32	0	0	0
	High	1	1	0	0	0	0

90% of the key deficiencies observed were bent members (low severity). Trends were observed in which member was bent on each specific tower type. Table 7 and Figure 1 provide a summary of this for L23.

Table 7 – Bent Members on Line L23 (by % of occurences)

Member ID	Description	Tower Type	Frequency
118	Horizontal diaphragm (belt member)	S	11%
124	Main leg diagonal bracing (0ft leg extension)	T	6%
127	Main leg diagonal bracing (-5ft leg extension)	S	34%
131	Main leg diagonal bracing (0ft leg extension)	S	31%
136	Main leg diagonal bracing (5ft leg extension)	S	11%

Figure 1 – Predominant Deficient Members, L23 Type S Tower

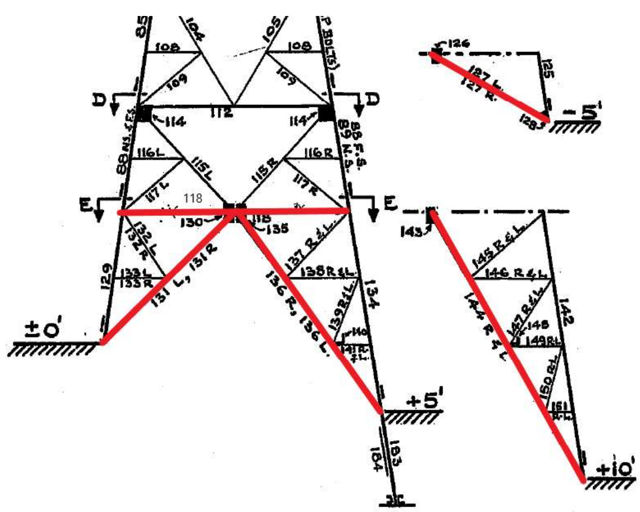
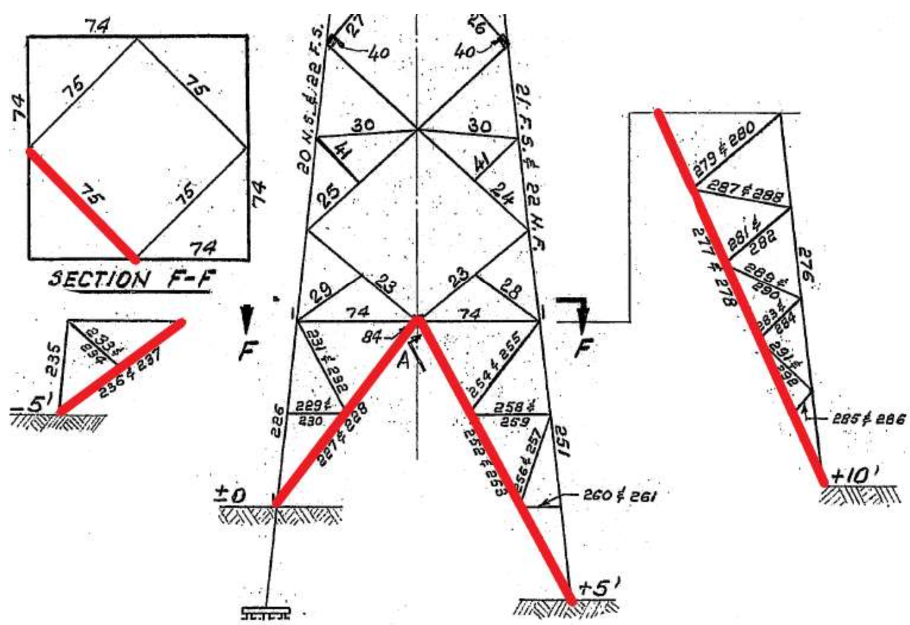


Table 8 provides the same breakdown as Table 7 but for line L24, with Figure 2 depicting the members.

Table 8 – Bent Members on Line L24 (by % of occurences)

Member ID	Description	Tower Type	Frequency
75	Plan brace in horizontal diaphragm	BB	27%
227 / 228	Main leg diagonal bracing (0ft leg extension)	BB	30%
236 / 237	Main leg diagonal bracing (-5ft leg extension)	BB	18%
252 / 253	Main leg diagonal bracing (5ft leg extension)	BB	13%
277 / 278	Main leg diagonal bracing (10ft leg extension)	BB	12%

Figure 2 – Predominant Deficient Members, L24 Type BB Tower



Some trends could also be observed within the results for broken members and missing members, though these trends are not as significant due to the lower number of occurrences of broken members.

- L23 – of the broken members, 71% were member #131 in the Type S tower.
  - #131 = main inside leg diagonal (0ft leg extension), same as in Table 7.

- L24 – of the missing members, 97% were member #75 in the Type BB tower.
    - #75 = inside member of diaphragm (where legs connect to body), same as in Table 8.
    - Some of these members flagged as missing were missing, but others were just deficient.

For all other specific instances of deficiencies observed throughout towers on lines L23 and L24, please see the full CAUS inspection report in Appendix A.

5 Analysis Criteria and Approach

5.1 Assumptions and Methodology

The following assumptions and remarks reflect how Stantec completed tower structure analysis and modelling on this project:

- Validating of available tower models was done in the context of the relevant standards they were modelled to, and assumptions made to accurately reflect the original design. For modelling of deficiencies and, where required, structural remedies, the same guiding principles were followed. Similar material, member sizes, connection style/properties, and structural system geometry were followed.

  Tower Member Check Criteria:

Slenderness Ratio	• If the member capacity, as determined by ASCE Standard, without limitation to the L/r ranges, meets or exceeds the new member force, then it may not be necessary to change or modify the member to meet the slenderness ratio recommendations in ASCE. • Any new or replacement members added to the existing tower shall meet the requirements of the ASCE standard.
Man-Load/Climbing Check	• Climbing check of members will not be completed considering alternate maintenance procedures (step bolts).
Minimum Distances	• Minimum end and edge distances will not be checked for the existing tower members. • Replacement or reinforcement members should meet the end distances, center-to-center bolt hole spacing, and edge distance criteria recommendations in the ASCE standard.
Member Usage Ratios	• Reinforcement will be designed for members whose loads exceed the calculated design capacity (e.g. > 100%). Reinforcement may include addition of members and bolts or complete replacement. This criterion may be adjusted on a case-by-case basis depending on how critical NLH deems a member.

- Available tower models for L23 utilize G40.4 and G40.6 tower steel, while L24 models utilize G40.4 and G40.8 steel in accordance with the original tower detail drawings. Any new steel members specified as part of the developed work methods shall be of equivalent grade. The properties of these materials are as follows:

Assumed Tower Material Properties

	G40.4 ASTM A7-52T	G40.6 ASTM A94	G40.8	Bolts
Yield Stress:	230	310	275.79	5/8" – ASTM A394 Type 0
Ultimate Stress:	410	550	448.158	Hole Dia: 19.05mm Shear Capacity: 49.60kN

New Reinforcement Material Properties

- All the new steel for proposed reinforcement shall be as per CSA G40.20-13/G40.21-13 Grade 350W for structural steel. New bolts shall be as per ASTM A394 Type T1. Member connection detailing was not considered when the available tower models were created. As such, member connections such as number of bolts and shear planes, will be modelled and checked as part of this project scope. However, minimum end and edge distances and connection rupture checking will not be completed as part of the tower analysis.
- Member checking shall primarily be completed for compression capacity (buckling) and tension capacity (net section) using PLS TOWER in accordance with methodology from ASCE 10 code built into the PLS-TOWER. No climbing load check will be completed.
- All redundant members are modelled and will be included in Finite Element Analysis (FEA). Redundant members are checked based on the actual force in redundant members.
- Deficiencies shall be simulated using specific approaches on a case-by-case basis at each tower location, depending on the exact deficiencies observed. This may include artificial reduction in member properties, steel material strength, basic connection strength, or complete elimination of a member from a tower model. The following are deficiency modelling techniques:

Type of Deficiency	Model Alteration
Rusted Members	Reduction in the thickness of the steel section (in case of severe corrosion)
Bent or Buckled Members	Member to be modelled as Tension-Only (severe), or member compression capacity to be reduced (mild)
Broken Members	Member to be removed from the tower model
Broken Connections	Member to be removed from the tower model, or rotational restraint to be modified

- Per findings in the Manitoba Hydro report, tower lean was not found to significantly impact analysis of the towers modelled. As tower lean is primarily a foundation issue and even the PLS TOWER manual (v18.00) states the "the ability to specify rotations is really not applicable to latticed towers for which there is no good way to account for the effects of foundation rotations" and that "the feature is included because the sable is shared with [the] PLS-POLE program for poles and frames", the impact of tower leans is not being considered during assessment work.
- PLS-CADD structure analysis shall be completed with SAPS level L3.

5.2 Structure Loads

The Manitoba Hydro report from 2020 is based on a very comprehensive, in-depth investigation of the original loading criteria applicable to the lines from Churchill Falls to Wabush, specific to each of the four segments (L23, L24, L23A, L24A). The report concludes that original climatic line loading criteria was difficult to back-calculate due to the limited amount of information in the tower detail drawings. As reliability-based loading calculations and analysis was not yet common practice at the time these lines were designed, Manitoba Hydro concluded that CSA C22.3 No. 1-15 deterministic loads were most suitable to apply for analysis of these towers at the time of the project. Additionally, Manitoba Hydro did not find any evidence of security load cases considered in the tower design either.

Based on Stantec's interpretation of Manitoba Hydro's approach as well as separate investigation and observation of the available project information, the ambiguity in what original structure loads are included on the tower detail drawings suggests that Manitoba Hydro's conclusions were reasonable. As reliability-based climatic loading criteria is unrealistic to apply on structures designed around 60 years ago, the basic deterministic CSA 22.3 No. 1-20 (newer standard than available at the time of Manitoba Hydro's report) criteria is deemed appropriate for minimum climatic loading. In conjunction with the climatic loading, typical security loading cases specific to each tower type shall be considered as well.

The following are the structural analysis load cases Stantec believes would be appropriate to apply for the purpose of analyzing towers on this project without deficiencies, with deficiencies, and after remedy:

For <u>climatic</u> loading per CSA C22.3 No. 1-20, the following shall be applied:

- CSA Medium B loading area:
  - 12.5mm radial ice, -20°C, 300 Pa wind on wire, 960 Pa wind on tower,

- Grade 2 construction load factors for steel structures:
  - Vertical – 1.15
  - Transverse – 1.10
  - Longitudinal (dead-end) – 1.10
  - Longitudinal (tangent/suspension) – 1.00

For <u>security</u> loading (to utilize CSA Medium B loading and Grade 2 load factors per above):

- Tangent/suspension structures *(L23 – Type S and L24 – Types BB, B)*
  - Unbalanced Ice (single wire)
    - All wires on structure loaded, except any one wire on one side of structure.
- Semi-anchor structures *(L23 – Type T and L24 – Type EE)*
  - Unbalanced Ice (single wire)
    - All wires on structure loaded, except any one wire on one side of structure.
  - Broken Wire (single wire)
    - All wires on structure loaded, any one wire broken on one side of structure.
- Dead-end structures *(L23 – Type C and L24 – Types HH, H)*
  - Unbalanced Ice (Full Span)

    - All wires on structure loaded on one side of structure, unloaded on opposite side.
  - Broken Wire (single wire)
    - All wires on structure loaded, any one wire broken on one side of structure.

All analysis cases shall utilize strength reduction factors of 1.0 for all structure components since the load cases are based on deterministic loads and already consider overload factors.

For <u>safety</u> loading, a Construction and Maintenance case will be considered:

- C&M load case, bare conductor, -20°C, 50 Pa wind on wire, 160 Pa wind on tower

The Construction and Maintenance loading case is recommended to be considered in the tower analysis to evaluate safe works method during tower repair. The subject members to be repaired will be removed from the tower model to check the stability of the structure. In case the tower cannot withstand the C&M loads after member removal with <u>overload factor of 2.0,</u> temporary support or reinforcement should be considered as part of the repair work method.

Development of suitable temporary support methods should be investigated in the detailed design stage as part of reinforcement/repair design. No tower types shall be treated and analyzed as full anti-cascading structures (i.e. no load cases considering full dead end or "broken span" conditions shall be checked). It is assumed that no structures on this line were designed for those conditions and the results that such an analysis would produce would not be meaningful given the project scope.

6 Structural Assessment

Structural assessment for scope locations was completed on the proofed (trued up) tower models (i.e. received tower models that were updated for better completion and to better reflect detailing in their drawing sets). Site-specific loads were applied per the assumed weather conditions and criteria on each individual structure based on the PLS-CADD line models received from NLH.

The following analysis outputs were documented for each tower:

- Maximum tower structure usage
- Governing member under maximum structure usage
- Maximum usage of deficient members
- Controlling member behaviour for deficient members (compression or tension)
- KL/R (slenderness ratio) for deficient members
- Combined loading (axial + bending) member checks (hand calculation)
    - Completed for main tower legs to evaluate impact of utilizing "Tension-Only" member definition for diagonal bracing in the post-deficiency analysis.

One round of analysis was completed on proofed tower models prior to simulation of deficiencies. A second round of analysis was completed after the deficiency simulation approach was determined for each deficiency and the same outputs listed above were documented.

The deficiency simulation was completed by applying one of the following member or member property override cases in each tower model:

1) Deficient member compression capacity set to 0% (i.e. member changed to tension-only).
2) Deficient member compression capacity reduced (e.g. to 25%, 50%).
3) Deficient member removed from tower model.

The full set of detailed results for pre-deficiency and post-deficiency tower analysis can be found in Appendix B.

6.1 Results – L23

The L23 analysis scope consisted of 45 structures in total, of which 42 (93%) were Type S suspension/tangent type (no ground wire). As such, the majority of L23 analysis and results pertain to the Type S tower.

For 2 of 42 Type S structures (#196 and #532), no supporting evidence was found during inspection of any deficiencies. This is partly due to overgrown vegetation obstructing the bases of the tower legs. However, even re-capturing of inspection data for these structures did not reveal any deficiencies.

For the remaining 40 Type S structures, the following tables summarize assessment the results under pre-deficiency and post-deficiency conditions.

Per Table 9, L23 Type S structure usages are all within a safe and reasonable range (optimal utilization) for the load cases defined and checked prior to simulation of observed deficiencies.

Table 9 – Max Structure Usages, L23 Type S (pre-deficiency)

Max Usage Range (%)	Quantity
0 – 60	0
60 – 70	3
70 - 80	16
80 - 90	14
90 - 100	7

For the 40 Type S structures on which deficiencies were simulated:

- 28 structures experienced increased maximum usage (expected).
- 1 structure experienced no change in maximum usage.
- 11 structures experienced reductions in maximum usage.

NOTE: *In specific deficiency simulation cases where buckling members were changed to Tension-Only type, overall structure usage is reduced in post-deficiency conditions. Use of Tension-Only members is not recommended for new tower structure design; it is only considered as a method to model members with large slenderness ratios that were designed prior to ASCE "Guide for Design of Steel Transmission Towers" in 1971. Utilizing Tension-Only members will redistribute stresses into other members such as main legs and horizontals.*

The Type S usage increases due to simulation of deficiencies are summarized in Table 10. All but one of the increases can be considered minor, or at most, moderate (< 15% usage increase).

Table 10 – Max Structure Usage Increases, L23 Type S (post-deficiency)

Increase Range (%)	Quantity
< 5	13
5 – 10	8
10 – 15	6
15 – 30	0
30 – 35	1

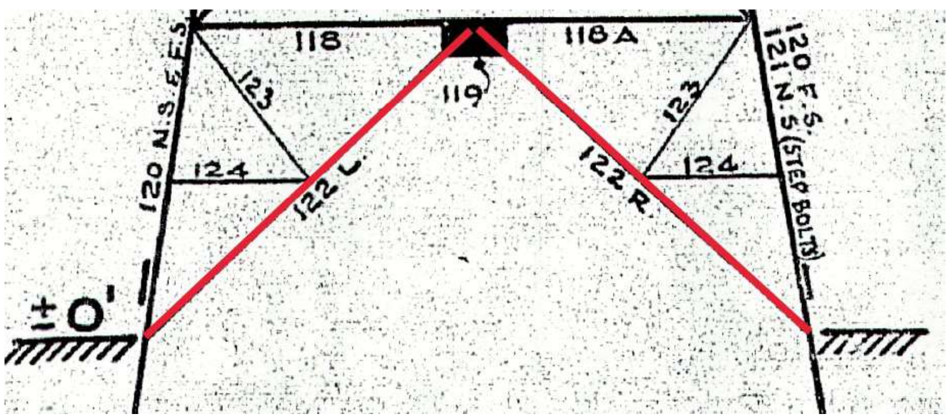
There are a total of 3 structures on line L23 that are not Type S. Structures #278 and #488 are Type T (semi-anchor, no ground wire) and structure #492 is Type C (heavy anchor, with ground wire). Analysis results for these 3 structures are presented in Table 11.

Table 11 – Analysis Results, L23 Types T and C

Structure	Type	Max Pre-Deficiency Usage (%)	Max Post-Deficiency Usage (%)	Usage Change (%)
278	T	146	146	0
488	T	124	128	4
492	C	94	192	98

Therefore, a very large jump in usage due to deficiency is observed at structure #492. This is a heavy anchor structure with ground wire, so the loading conditions (security loads) are more stringent than for suspension or semi-anchor structure as outlined in section 5.2. The deficiency simulation impact is emphasized greatly at this structure so special attention must be given to the remedy work plan.

Figure 3 – Deficient Member (122) on Structure #492 (Type C)



After L23 structures analysis, the following conclusions were drawn regarding governing members producing maximum structure usage across all structure types:

- 20% of cases had the exact same governing member pre-deficiency compared to post-deficiency.
- 73% of cases had a similar governing member (same member ID but different face) pre-deficiency compared to post-deficiency.
- 7% of cases had a different governing member (different member ID) pre-deficiency compared to post-deficiency. Examples of these include:
    - Structure #282 (Type S), in which the governing member changed from the main inside leg diagonal to a supporting member beneath the bridge where conductors are attached.
    - Structure #491 (Type S), in which the governing member changed from the main inside leg diagonal to the main outside leg diagonal.
    - Structure #492 (Type C), in which the governing member changed from an outer member of the waist diaphragm to an inside diagonal of the waist diaphragm.

6.2 Results – L24

The L24 analysis scope consisted of 122 structures in total, of which 114 (93%) were Type BB suspension/tangent type (no ground wire). As such, the majority of L24 results pertain to the Type BB tower.

For 1 of 114 Type BB structures (#539), no supporting evidence was found during inspection of any deficiencies. For the remaining 113 Type BB structures, the following tables summarize assessment results under pre-deficiency and post-deficiency conditions.

Per Table 12, L24 Type BB structure usages are all within a safe and reasonable range (optimal utilization) for the load cases defined and checked prior to simulation of observed deficiencies.

Table 12 – Max Structure Usages, L24 Type BB (pre-deficiency)

Max Usage Range (%)	Quantity
0 – 40	0
40 – 60	23
60 - 80	89
80 - 100	1
> 100	0

For the 113 Type BB structures on which deficiencies were simulated:

- 76 structures experienced increased maximum usage (expected).
- 11 structures experienced no change in maximum usage.
- 26 structures experienced reductions in maximum usage.
    - See note regarding Tension-Only members in L23 results Section 6.1 of this report.

The Type BB usage increases upon simulation of deficiencies are summarized in Table 13. The majority of increases (roughly 75% of locations) were minor (up to 5%) but the remainder experienced substantial jumps in usage (> 20%). These jumps in usage are indicative of which locations are deficiency-critical and are used as a metric to help define the suggested remedial repair priorities.

Table 13 – Max Structure Usage Increases, L24 Type BB (post-deficiency)

Increase Range (%)	Quantity
< 5	56
5 – 10	1
10 – 15	5
15 – 20	1
20 – 40	7
40 – 60	4
60 – 80	1
80 – 140	0
140 – 150	1

There are a total of 8 structures on line L24 that are not Type BB. See Table 2 for a description of each structure type. Table 14 summarizes analysis results for these structures. One key observation would be that aside from structure #5 which is a suspension/tangent structure type (with ground wire), all other structures are either semi-anchor or heavy-anchor (dead-end) structure types with very high pre-deficiency usage.

Table 14 – Analysis Results, L24 Types B, EE, HH, H

Structure	Type	Max Pre-Deficiency Usage (%)	Max Post-Deficiency Usage (%)	Usage Change (%)
5	B	76	76	0
111	EE	95	98	3
322	EE	96	97	1
369	EE	97	103	6
482	HH	94	94	0
490	HH	98	98	0
503	HH	98	175	77
568	H	180	212	32

Figure 4 – Deficient Members (20/23/24/62) on Structure #503 (Type HH)

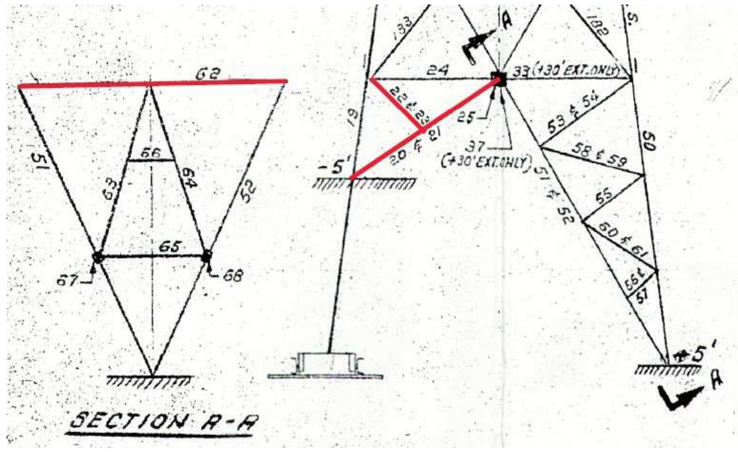
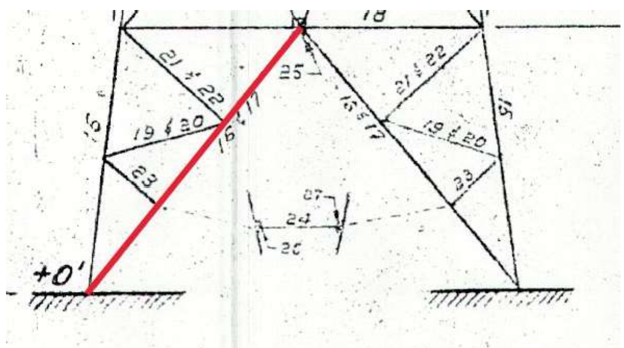


Figure 5 – Deficient Member (16/54) on Structure #568 (Type H)



After L24 structures analysis, the following conclusions were drawn regarding governing members producing maximum structure usage across all structure types:

- 69% of cases had the exact same governing member pre-deficiency compared to post-deficiency.
- 11% of cases had a similar governing member (same member ID but different face) pre-deficiency compared to post-deficiency.
- 20% of cases had a different governing member (different member ID) pre-deficiency compared to post-deficiency. Examples of these include:
    - Governing member is #103 (diagonal in tower section above waist line, immediately above the waist line) on all but one Type BB structure in this subset of cases in pre-deficiency analysis. In post-deficiency analysis, the governing member for these structures changes either to member #26 (diagonal below waist line) or main outside leg diagonals (e.g. member #235 for -5ft extension and member # 226 for 0ft extension).

7 Proposed Remedies and Repairs

7.1 Interpretation of Results

Based on the post-deficiency tower analysis results, the first suggested step for remedy and repair planning is to develop a priority designation system. This system should be based on the performance of towers in their idealized existing state as well as their sensitivity to their deficiencies under their site-specific conditions.

Table 15 outlines the classification system developed for structure usage jumps. Table 16 summarizes the priority system developed and summarizes the distribution of structure behaviours for each line. Note that maximum structure usage refers to the maximum of pre-deficiency and post-deficiency usages. See Appendix C for the full detailed list of priorities for each scope structure.

Table 15 – Structure Usage Jump Categories (post-deficiency)

Category	Usage Increase Range (%)	# of Structures	
		L23	L24
J0	0	11	20
J1	0 – 5	16	73
J2	5 – 10	8	2
J3	10 – 15	6	5
J4	15 – 20	0	1
J5	> 20	2	20

Table 16 – Remedy and Repair Priorities

Category	Description	# of Structures	
		L23	L24
P1	Max structure usage > 100%	8	37
P2	> 20% jump in max usage (J5), or 95-100% max usage	7	13
P3	15-20% jump in max usage (J4), or 90-95% max usage	0	12
P4	10-15% jump in max usage (J3)	2	0
P5	5-10% jump in max usage (J2)	3	0
P6	0-5% jump in max usage (J1)	12	42
P7	0% increase in max usage (J0)	11	17

On both lines L23 and L24, <u>all</u> the semi-anchor and heavy-anchor (dead-end) structure types in the scope (3 in total on L23, 7 in total on L24) were assigned priority level P1 for remedy and repair. This is due to the criteria developed but also because they are higher importance structures within the lines as they support conductor terminations.

7.2 Work Plan Development

The deficiency simulation results are now classified for each line and structure type, with a priority index developed to help determine a strategic order of operations for remedy and repair work. The final step in engineering analysis is to investigate and prescribe work plans to rectify the deficiencies identified in the project scope. It is understood that the preference would be to utilize work methods that minimizes outage duration (if any) and carry out the repair/replacement within safe working zones while the lines are energized.

Table 17 summarizes the remedy/repair methods deemed to be appropriate to rectify the spectrum of deficiencies observed throughout the L23 and L24 lines. For structures where either pre-deficiency or post-deficiency usages were found to exceed 100%, further analysis was completed to ensure that if deficient members were removed from a tower one at a time, structure usages did not exceed 100% at the Construction and Maintenance load case only (see Section 5.2 of this document). This analysis was also completed on several other priority P1 and P2 structures even when usage did not exceed 100%.

Table 17 – Remedy/Repair Method Breakdown

Category	Description	# of Member Instances	
		L23	L24
R1	Complete replacement of deficient member	147	74
R2	Addition of new member along existing deficient member to create double angle member	0	6
R3	Installation of additional redundant members	0	0

In all cases possible, it is recommended to rectify deficient members by complete replacement. There are particular instances where member replacement is not very feasible, such as where the members are part of a horizontal diaphragm/hip bracing system. For these locations, it's recommended to lay an additional member alongside the existing deficient member to reinforce the structure. There are no scenarios in which it's recommended to leave deficient members in place while only adding additional redundants.

For towers where the C&M load case simulating removal of an individual member during construction yielded failing structure analysis results, it was determined that the work plan for those structures must include some form of temporary structural support during construction.

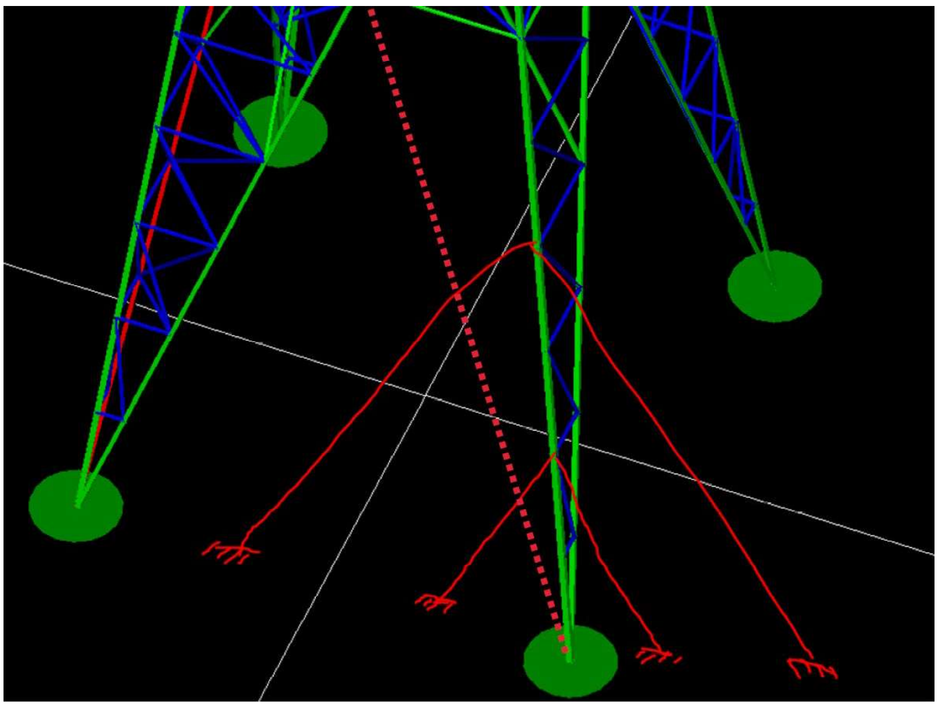
- For line L23, none of the work methods prescribed were found to require temporary support.
- For line L24, a total of 8 structure locations were found to require temporary support so the necessary remedy/repair methods can be applied to the structure to rectify all deficiencies.

See Appendix D for the full work plan summary covering the entire project scope. This appendix outlines the remedy/repair method prescribed for each structure as well as temporary support recommendations for critical structures where construction cannot be done on the existing towers without pre-emptive reinforcement to alleviate and redistribute forces to avoid any members being overloaded.

As the majority of deficient members across all structure types on both lines are primary, secondary, or redundant members in the tower legs, the predominant recommended solution to allow for prescribed remedy/repair works is to provide additional support to the tower legs on which work is being done. This additional support should be provided as close to redundant connection points as possible.

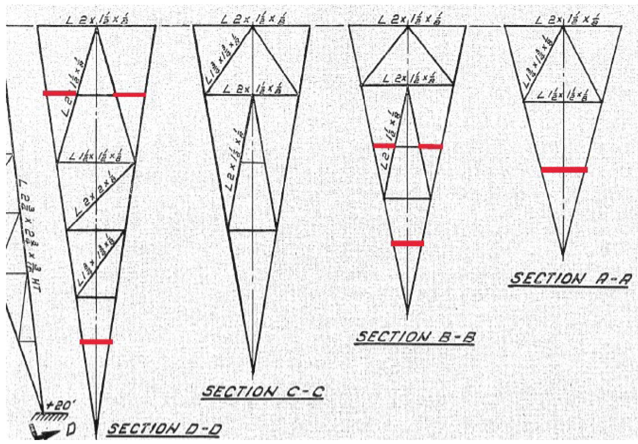
Figure 6 depicts a possible temporary support solution to reinforce legs via temporary cable ties. Another option would be to support the tower with a crane at proper location or unloading (temporarily lifting conductors). This particular option provides increased member stability if cables are installed at the leg joints but would increase compressive load in the supported member. Feasibility can only be determined from detailed analysis.

Figure 6 – Potential Cable Tie Support Solution, L24 Type BB



A secondary solution is to provide additional hip bracing (oblique bracing) redundant members to connect and strengthen diagonal leg elements together. Figure 7 outlines one possible temporary support solution to reinforce legs via hip bracing. The red lines indicate additional bracing members that could be installed.

Figure 7 – Potential Hip/Oblique Bracing Solution, L24 Type BB



Investigation and detailed design of temporary support mechanisms is not part of the current project scope. The high-level example information provided is for reference only.

8 Discussions and Recommendations

8.1 Historical Precedent

For transmission lattice towers design completed in the 1950s and 1960s, manufacturers completing the design utilized their own specific compression formulas. It was only in 1971 when first edition of "Guide for Design of Steel Transmission Towers" was published by ASCE (Manual 52) that standard formulas for calculation of effective length, slenderness ratio (KL/r) and compression curves were introduced. These calculations were supported by verification through testing. The older formulations and member design principles did not typically utilize an adjustment factor (K) to modify the allowable compression stresses. Older towers often contain members that have a larger calculated capacities based on the original curves in higher L/r ranges. This is specifically the case for diagonal bracing members, which are eccentric at both ends because of the addition of the K factor. The majority of deficiencies observed in lines L23 and L24 are diagonal bracing members and this is not by coincidence. In other words, present day or more historically recent ASCE-recommended calculations for diagonal bracing member capacities will yield lower capacities than the original design calculations would have produced back in the day. It is for this reason that bracing members in older tower structures are commonly found to be undersized.

8.2 Loading Scenarios

As discussed in Section 5.2, the deterministic load case of CSA Medium B per CSA C22.3 No 1 along with Grade 2 construction load factors and unity (1.0) strength reduction factors were used for all structure analysis and assessment. While these loading definitions were found to be the best representation of the original tower design loads and specifications, these loads are optimistic and may not represent recently adopted reliability weather and structure loading conditions outlined in CSA C22.3 No. 60826-19. However, these lines and structures have been in service for about 60 years and the successful history of operation with minimal known structure failures shows the original design load specifications has resulted in overall satisfactory outcome. Statistically, the probability of weather events producing radial wire ice accretions and wind speeds exceeding the original design loads of the L23 and L24 towers should be considered becoming higher in any given year and as the time passes..

8.3 Recommended Action

Considering the topics in Sections 8.1 and 8.2 of this report, it is strongly recommended that all critical and undersized diagonal bracings identified are replaced with members having structural capacity that exceeds the compression forces in compliance with KL/r limitations specified in ASCE 10. The recommended remedy and repair priorities and work methods discussed in Section 7 of this report should be followed. Temporary structural support solutions are recommended to ensure safe replacement of main leg diagonal bracings at specific critical tower locations and for specific leg extensions.

It is recommended that angle profiles with longer web width and higher thickness to be utilized for repair/replacement work to increase buckling and bending capacities of brace members. Connection details of the members should be checked to verify if any of the members (new or existing) will require cuts to fit. Below table shows recommended sizes for new angle members without any detailed analysis.

Table 18 – Recommended Angle Sizes for Replaced Members

Existing Member Angle Size	New Member Angle Size
1.75 x 1.75 x 1/8	2 x 2 x 3/16
2 x 1.5 x 1/8	2.5 x 2.5 x 3/16
2 x 2 x 1/8	2.5 x 2.5 x 3/16
2.5 x 2 x 1/8	3 x 3 x 3/16
2.5 x 2.5 x 1/8	3 x 3 x 3/16

Detailed engineering of the recommended engineering solution will be required beyond this project scope. While the project scope only considered specific structures on lines L23 and L24 based on inspection results summarized by NLH, it is recommended that action plans are developed for the remaining L23 and L24 line structures while the same exercises are carried out for adjoining line segments L23A and L24A.

APPENDICES

Appendix A – CAUS Inspection Report

line_number	structure_identifier	image_file	feature	id	defect	severity	leg	side
L23	L23_10	DJI_20230621211135_0066_Z.JPG	Member	131	['bent']	low	2	left
L23	L23_10	DJI_20230621211216_0076_Z.JPG	Member	131	['bent']	low	1	right
L23	L23_10	DJI_20230621211216_0076_Z.JPG	Member	131	['bent']	low	4	right
L23	L23_16	DJI_20230621222516_0141_Z.JPG	Member	131	['bent']	low	3	left
L23	L23_16	DJI_20230621222628_0157_Z.JPG	Member	131	['bent']	medium	3	right
L23	L23_16	DJI_20230621222628_0157_Z.JPG	Member	131	['bent']	low	2	left
L23	L23_16	DJI_20230621222628_0157_Z.JPG	Member	131	['bent']	low	1	left
L23	L23_19	DJI_20230621221725_0035_Z.JPG	Member	136	['bent']	low	2	left
L23	L23_19	DJI_20230621221731_0036_Z.JPG	Member	136	['bent']	low	4	right
L23	L23_107	DJI_20230616064738_0148_Z.JPG	Member	127	['bent']	low	2	right
L23	L23_107	DJI_20230616064738_0148_Z.JPG	Member	127	['bent']	low	1	left
L23	L23_107	DJI_20230616064738_0148_Z.JPG	Member	127	['bent']	low	1	right
L23	L23_107	DJI_20230616064738_0148_Z.JPG	Member	127	['bent']	low	4	left
L23	L23_107	DJI_20230616064808_0155_W.JPG	Structure		['leaning']	high		
L23	L23_139	DJI_20230618012427_0059_Z.JPG	Member	136	['bent']	low	2	right
L23	L23_139	DJI_20230618012638_0082_Z.JPG	Member	136	['bent']	low	3	right
L23	L23_139	DJI_20230701012438_0002_Z.JPG	Member	136	['broken']	low	3	right
L23	L23_145	DJI_20230621022706_0157_Z.JPG	Member	131	['bent']	low	4	left
L23	L23_152	DJI_20230622222637_0104_Z.JPG	Member	127	['bent']	low	4	right
L23	L23_152	DJI_20230622222637_0104_Z.JPG	Footings		['fill too high']	low		
L23	L23_152	DJI_20230622222637_0104_Z.JPG	Footings		['fill too high']	low		
L23	L23_152	DJI_20230622222637_0104_Z.JPG	Footings		['fill too high']	low		
L23	L23_152	DJI_20230622222637_0104_Z.JPG	Footings		['overgrown']	low		
L23	L23_153	DJI_20230622222945_0133_Z.JPG	Footings		['overgrown']	low		
L23	L23_153	DJI_20230622223029_0142_Z.JPG	Member	127	['bent']	low	1	right
L23	L23_153	DJI_20230622223057_0147_Z.JPG	Member	118	['bent']	low	2	left
L23	L23_167	DJI_20230623003950_0138_Z.JPG	Footings		['overgrown']	low		
L23	L23_167	DJI_20230623003953_0140_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_167	DJI_20230623004132_0159_Z.JPG	Member	131	['bent']	low	3	right
L23	L23_170	DJI_20230623020350_0022_Z.JPG	Member	131	['bent']	low	2	right
L23	L23_170	DJI_20230623020350_0022_Z.JPG	Member	131	['bent']	low	1	left
L23	L23_178	DJI_20230623023905_0044_Z.JPG	Member	136	['bent']	low	2	right
L23	L23_179	DJI_20230623024034_0057_Z.JPG	Footings		['overgrown']	low		
L23	L23_179	DJI_20230623024034_0057_Z.JPG	Footings		['overgrown']	low		
L23	L23_179	DJI_20230623024034_0057_Z.JPG	Footings		['overgrown']	low		
L23	L23_179	DJI_20230623024125_0072_Z.JPG	Member	131	['bent']	low	4	left
L23	L23_179	DJI_20230623024147_0079_Z.JPG	Member	131	['broken']	medium	1	left
L23	L23_189	DJI_20230624214224_0141_Z.JPG	Member	127	['bent']	low	1	right
L23	L23_189	DJI_20230624214224_0141_Z.JPG	Member	127	['broken']	low	4	left
L23	L23_189	DJI_20230624214300_0153_Z.JPG	Member	127	['bent']	low	3	right
L23	L23_189	DJI_20230624214300_0153_Z.JPG	Member	127	['bent']	low	2	left
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L23	L23_190	DJI_20230624214349_0158_Z.JPG	Footings		['overgrown']	low		
L23	L23_190	DJI_20230624214349_0158_Z.JPG	Footings		['overgrown']	low		
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L23	L23_190	DJI_20230624214429_0172_Z.JPG	Member	118	['bent']	low	1	right
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L23	L23_196	DJI_20230624215913_0094_Z.JPG	Member	127	['overgrown']	low		
L23	L23_196	DJI_20230624215913_0094_Z.JPG	Member	127	['overgrown']	low		
L23	L23_196	DJI_20230624215913_0094_Z.JPG	Member	127	['overgrown']	low		
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L23	L23_205	DJI_20230624235937_0208_Z.JPG	Member	131	['bent']	low	1	right
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L23	L23_205	DJI_20230625000053_0228_Z.JPG	Footings		['overgrown']	low		
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L23	L23_206	DJI_20230625000312_0257_Z.JPG	Member	136	['bent']	low	3	right
L23	L23_222	DJI_20230625010812_0196_Z.JPG	Member	131	['bent']	low	1	right
L23	L23_222	DJI_20230625010812_0196_Z.JPG	Member	131	['bent']	low	3	left

line_number	structure_identifier	image_file	feature	id	defect	severity	leg	side
L23	L23_222	DJI_20230625010832_0203_Z.JPG	Member	131	['bent']	low	4	left
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L23	L23_262	DJI_20230625235821_0042_Z.JPG	Member	144	['bent']	low	4	right
L23	L23_263	DJI_20230626000056_0073_Z.JPG	Member	136	['bent']	low	1	right
L23	L23_263	DJI_20230626000149_0082_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_263	DJI_20230626000205_0085_Z.JPG	Member	136	['bent']	low	3	right
L23	L23_269	DJI_20230626001543_0040_Z.JPG	Member	127	['bent']	low	3	left
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L23	L23_269	DJI_20230626001543_0040_Z.JPG	Footings		['fill too high']	low		
L23	L23_269	DJI_20230626001543_0040_Z.JPG	Footings		['fill too high']	low		
L23	L23_269	DJI_20230626001543_0040_Z.JPG	Footings		['fill too high']	low		
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L23	L23_272	DJI_20230626002210_0122_Z.JPG	Footings		['overgrown']	low		
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L23	L23_272	DJI_20230626002210_0122_Z.JPG	Footings		['overgrown']	low		
L23	L23_272	DJI_20230626002215_0124_Z.JPG	Environmental		['raptor nest']	low		
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L23	L23_274	DJI_20230626002621_0175_Z.JPG	Member	127	['bent']	low	4	left
L23	L23_274	DJI_20230626002624_0177_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_278	DJI_20230626021850_0046_Z.JPG	Member	124	['bent']	low	2	right
L23	L23_278	DJI_20230626021850_0046_Z.JPG	Member	124	['bent']	low	1	right
L23	L23_278	DJI_20230626021850_0046_Z.JPG	Member	124	['bent']	low	1	left
L23	L23_278	DJI_20230626021850_0046_Z.JPG	Member	124	['bent']	low	4	left
L23	L23_278	DJI_20230626021850_0046_Z.JPG	Member	119	['bent']	low	4	right
L23	L23_279	DJI_20230626022032_0068_Z.JPG	Member	127	['bent']	low	1	right
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L23	L23_279	DJI_20230626022105_0079_Z.JPG	Footings		['overgrown']	low		
L23	L23_279	DJI_20230626022105_0079_Z.JPG	Footings		['overgrown']	low		
L23	L23_279	DJI_20230626022105_0079_Z.JPG	Footings		['overgrown']	low		
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L23	L23_282	DJI_20230626022659_0162_Z.JPG	Member	131	['bent']	low	2	left
L23	L23_282	DJI_20230626022659_0162_Z.JPG	Member	131	['bent']	low	2	right
L23	L23_282	DJI_20230626022659_0162_Z.JPG	Member	131	['broken']	low	1	left
L23	L23_282	DJI_20230626022659_0162_Z.JPG	Member	131	['bent']	low	1	right
L23	L23_282	DJI_20230626022659_0162_Z.JPG	Member	131	['bent']	low	4	left
L23	L23_282	DJI_20230626022659_0162_Z.JPG	Member	131	['bent']	low	3	right
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L23	L23_286	DJI_20230626023909_0003_Z.JPG	Footings		['overgrown']	low		
L23	L23_286	DJI_20230626023934_0012_Z.JPG	Member	127	['bent']	low	4	left
L23	L23_287	DJI_20230626024220_0058_Z.JPG	Member	127	['bent']	low	1	right
L23	L23_287	DJI_20230626024220_0058_Z.JPG	Member	127	['bent']	low	1	right
L23	L23_287	DJI_20230626024220_0058_Z.JPG	Member	127	['bent']	low	1	right
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L23	L23_455	DJI_20230623223357_0128_Z.JPG	Member	131	['bent']	low	4	right
L23	L23_455	DJI_20230623223357_0128_Z.JPG	Member	131	['bent']	low	3	left
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L23	L23_466	DJI_20230624003513_0175_Z.JPG	Member	131	['overgrown']	low		
L23	L23_466	DJI_20230624003550_0184_Z.JPG	Member	131	['bent']	low	3	left
L23	L23_466	DJI_20230624003647_0195_Z.JPG	Member	131	['bent']	low	1	left
L23	L23_470	DJI_20230630011349_0103_Z.JPG	Footings		['overgrown']	low		
L23	L23_470	DJI_20230630011425_0113_Z.JPG	Member	131	['bent']	low	2	right
L23	L23_470	DJI_20230630011425_0113_Z.JPG	Member	131	['bent']	low	1	left
L23	L23_488	DJI_20230630200730_0003_Z.JPG	Member	124	['bent']	low	2	left
L23	L23_488	DJI_20230630200730_0003_Z.JPG	Member	125	['bent']	low	2	left
L23	L23_488	DJI_20230630200730_0003_Z.JPG	Member	126	['bent']	low	2	left
L23	L23_488	DJI_20230630200819_0018_Z.JPG	Member	124	['bent']	low	2	right
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L23	L23_491	DJI_20230630201409_0088_Z.JPG	Member	131	['bent']	low	2	left
L23	L23_491	DJI_20230630201409_0088_Z.JPG	Member	131	['bent']	low	4	right
L23	L23_491	DJI_20230630201454_0098_Z.JPG	Member	131	['broken']	medium	1	right
L23	L23_491	DJI_20230630201525_0108_Z.JPG	Member	131	['broken']	low	1	left
L23	L23_492	DJI_20230630201623_0115_Z.JPG	Member	122	['bent']	low	2	left

line_number	structure_identifier	image_file	feature	id	defect	severity	leg	side
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L23	L23_502	DJI_20230630215941_0163_Z.JPG	Member	131	['broken']	medium	3	left
L23	L23_502	DJI_20230630220024_0177_Z.JPG	Member	131	['bent']	low	4	left
L23	L23_507	DJI_20230630221141_0079_Z.JPG	Footings		['overgrown']	low		
L23	L23_507	DJI_20230630221212_0088_Z.JPG	Member	127	['bent']	low	4	left
L23	L23_507	DJI_20230630221212_0088_Z.JPG	Member	127	['altered member']	low	4	right
L23	L23_521	DJI_20230614043659_0159_Z.JPG	Member	127	['bent']	low	4	right
L23	L23_521	DJI_20230614043817_0169_Z.JPG	Member	127	['bent']	low	3	left
L23	L23_521	DJI_20230614043915_0177_Z.JPG	Member	127	['bent']	low	4	left
L23	L23_521	DJI_20230614044020_0190_Z.JPG	Member	127	['bent']	low	1	left
L23	L23_530	DJI_20230614030012_0175_Z.JPG	Member	118	['bent']	low	3	right
L23	L23_530	DJI_20230614030012_0175_Z.JPG	Member	127	['altered member']	low	2	left
L23	L23_530	DJI_20230614030030_0180_Z.JPG	Member	127	['altered member']	low	4	left
L23	L23_530	DJI_20230614030030_0180_Z.JPG	Member	118	['bent']	low	4	right
L23	L23_530	DJI_20230614030030_0180_Z.JPG	Member	127	['altered member']	low	3	left
L23	L23_530	DJI_20230614030232_0209_Z.JPG	Member	118	['bent']	low	2	left
L23	L23_530	DJI_20230614030232_0209_Z.JPG	Member	118	['bent']	low	2	right
L23	L23_530	DJI_20230614030232_0209_Z.JPG	Member	118	['bent']	low	1	left
L23	L23_532	DJI_20230614025535_0118_Z.JPG	Footings		['overgrown']	low		
L23	L23_534	DJI_20230614024632_0014_Z.JPG	Member	127	['bent']	low	2	left
L23	L23_534	DJI_20230614024653_0019_Z.JPG	Member	118	['bent']	low	4	right
L23	L23_534	DJI_20230614024747_0031_Z.JPG	Member	118	['bent']	low	4	left
L23	L23_534	DJI_20230614024747_0031_Z.JPG	Member	127	['bent']	low	1	right
L23	L23_538	DJI_20230614022358_0028_Z.JPG	Member	131	['bent']	low	1	right
L23	L23_538	DJI_20230614022658_0055_Z.JPG	Member	131	['bent']	low	3	right
L23	L23_538	DJI_20230614022700_0056_Z.JPG	Member	131	['bent']	low	2	left
L23	L23_538	DJI_20230614022702_0057_Z.JPG	Member	131	['bent']	low	1	left
L23	L23_556	DJI_20230613052638_0015_Z.JPG	Member	118	['bent']	low	4	right
L23	L23_556	DJI_20230613052729_0028_Z.JPG	Member	118	['bent']	low	3	left
L23	L23_556	DJI_20230613052729_0028_Z.JPG	Member	118	['bent']	low	4	right
L23	L23_556	DJI_20230613052930_0046_Z.JPG	Member	127	['altered member']	low	1	left
L23	L23_556	DJI_20230613052930_0046_Z.JPG	Member	127	['bent']	low	1	right
L23	L23_556	DJI_20230613052930_0046_Z.JPG	Member	118	['bent']	low	1	right
L23	L23_556	DJI_20230613052930_0046_Z.JPG	Member	127	['bent']	low	2	right
L23	L23_556	DJI_20230613052930_0046_Z.JPG	Member	127	['bent']	low	4	left
L23	L23_556	DJI_20230613052930_0046_Z.JPG	Member	118	['bent']	low	4	left
L23	L23_563	DJI_20230613024853_0121_Z.JPG	Member	127	['bent']	low	4	left
L23	L23_563	DJI_20230613025044_0139_Z.JPG	Member	127	['bent']	low	2	left
L23	L23_567	DJI_20230613014523_0086_Z.JPG	Member	127	['broken']	low	2	left
L23	L23_567	DJI_20230613014758_0114_Z.JPG	Member	127	['bent']	low	4	left
L23	L23_567	DJI_20230613014758_0114_Z.JPG	Member	127	['bent']	low	1	right
L24	L24_5	DJI_20230620063916_0035_Z.JPG	Member	22	['bent']	low	4	center
L24	L24_5	DJI_20230620063916_0035_Z.JPG	Member	30	['bent']	low	4	right
L24	L24_5	DJI_20230620063916_0035_Z.JPG	Member	21	['bent']	low	2	left
L24	L24_5	DJI_20230620063939_0042_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_9	DJI_20230621204732_0012_Z.JPG	Member	75	['bent']	low	4	center
L24	L24_9	DJI_20230621204732_0012_Z.JPG	Member	228	['bent']	low	1	right
L24	L24_9	DJI_20230621204732_0012_Z.JPG	Member	227	['bent']	low	3	left
L24	L24_9	DJI_20230621204732_0012_Z.JPG	Member	228	['bent']	low	2	right
L24	L24_9	DJI_20230621204732_0012_Z.JPG	Member	227	['bent']	low	2	left
L24	L24_9	DJI_20230621204917_0031_Z.JPG	Member	228	['bent']	low	1	left
L24	L24_9	DJI_20230621204917_0031_Z.JPG	Member	227	['bent']	low	1	right
L24	L24_9	DJI_20230621204917_0031_Z.JPG	Member	230	['bent']	low	1	left
L24	L24_9	DJI_20230621204922_0032_Z.JPG	Member	227	['broken']	medium	1	left
L24	L24_11	DJI_20230621205533_0094_Z.JPG	Member	252	['bent']	low	3	right
L24	L24_11	DJI_20230621205533_0094_Z.JPG	Member	252	['bent']	low	1	right
L24	L24_11	DJI_20230621205533_0094_Z.JPG	Member	252	['bent']	low	1	left
L24	L24_11	DJI_20230621205533_0094_Z.JPG	Member	261	['bent']	low	3	left
L24	L24_13	DJI_20230621225900_0219_Z.JPG	Member	227	['bent']	low	3	right
L24	L24_13	DJI_20230621225900_0219_Z.JPG	Member	228	['bent']	low	1	right
L24	L24_16	DJI_20230621225118_0125_Z.JPG	Member	252	['bent']	low	2	left

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L24	L24_16	DJI_20230621225118_0125_Z.JPG	Member	252	['bent']	low	3	left
L24	L24_16	DJI_20230621225118_0125_Z.JPG	Member	253	['bent']	low	3	right
L24	L24_16	DJI_20230621225118_0125_Z.JPG	Member	251	['bent']	low	4	center
L24	L24_16	DJI_20230621225205_0138_Z.JPG	Member	253	['bent']	low	1	right
L24	L24_16	DJI_20230621225227_0145_Z.JPG	Member	252	['bent']	low	2	right
L24	L24_16	DJI_20230621225227_0145_Z.JPG	Member	252	['bent']	low	4	left
L24	L24_17	DJI_20230621224855_0097_Z.JPG	Member	252	['bent']	low	2	left
L24	L24_17	DJI_20230621224915_0102_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_17	DJI_20230621224922_0104_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_17	DJI_20230621224941_0107_Z.JPG	Member	252	['bent']	low	3	left
L24	L24_17	DJI_20230621225003_0114_Z.JPG	Member	252	['bent']	low	1	left
L24	L24_17	DJI_20230621225024_0119_Z.JPG	Member	252	['bent']	low	1	left
L24	L24_17	DJI_20230621225024_0119_Z.JPG	Member	253	['bent']	low	1	right
L24	L24_18	DJI_20230621224744_0088_Z.JPG	Member	252	['bent']	low	4	left
L24	L24_18	DJI_20230621224744_0088_Z.JPG	Member	253	['bent']	low	4	left
L24	L24_18	DJI_20230621224744_0088_Z.JPG	Member	252	['bent']	low	4	left
L24	L24_18	DJI_20230621224744_0088_Z.JPG	Member	253	['bent']	low	4	left
L24	L24_18	DJI_20230621224744_0088_Z.JPG	Member	253	['bent']	low	4	left
L24	L24_18	DJI_20230621224744_0088_Z.JPG	Member	252	['bent']	low	4	left
L24	L24_19	DJI_20230621224433_0045_Z.JPG	Member	253	['bent']	low	1	right
L24	L24_19	DJI_20230621224433_0045_Z.JPG	Member	253	['bent']	low	4	right
L24	L24_19	DJI_20230621224433_0045_Z.JPG	Member	252	['bent']	low	3	left
L24	L24_19	DJI_20230621224433_0045_Z.JPG	Member	253	['bent']	low	2	right
L24	L24_19	DJI_20230621224433_0045_Z.JPG	Member	252	['bent']	low	2	left
L24	L24_20	DJI_20230621224212_0020_Z.JPG	Member	228	['bent']	low	2	right
L24	L24_20	DJI_20230621224236_0026_Z.JPG	Member	29	['bent']	low	3	center
L24	L24_21	DJI_20230620015416_0003_Z.JPG	Member	237	['bent']	low	4	right
L24	L24_21	DJI_20230620015541_0020_Z.JPG	Member	237	['bent']	low	4	left
L24	L24_21	DJI_20230620015541_0020_Z.JPG	Member	236	['bent']	low	1	right
L24	L24_23	DJI_20230620020702_0123_Z.JPG	Member	227	['bent']	low	1	left
L24	L24_23	DJI_20230620020702_0123_Z.JPG	Member	228	['bent']	low	1	right
L24	L24_31	DJI_20230620210756_0017_Z.JPG	Member	227	['bent']	low	4	left
L24	L24_31	DJI_20230620210838_0027_Z.JPG	Member	227	['bent']	low	1	left
L24	L24_37	DJI_20230622035302_0135_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_37	DJI_20230622035432_0155_Z.JPG	Footings		['fill too high']	low		
L24	L24_37	DJI_20230622035432_0155_Z.JPG	Footings		['fill too high']	low		
L24	L24_37	DJI_20230622035432_0155_Z.JPG	Footings		['fill too high']	low		
L24	L24_37	DJI_20230622035432_0155_Z.JPG	Footings		['fill too high']	low		
L24	L24_37	DJI_20230622035432_0155_Z.JPG	Member	75	['bent']	low	4	center
L24	L24_49	DJI_20230622021054_0004_Z.JPG	Member	75	['bent']	low	3	center
L24	L24_49	DJI_20230622021205_0018_Z.JPG	Footings		['fill too high']	low		
L24	L24_49	DJI_20230622021205_0018_Z.JPG	Footings		['fill too high']	low		
L24	L24_49	DJI_20230622021205_0018_Z.JPG	Footings		['fill too high']	low		
L24	L24_49	DJI_20230622021205_0018_Z.JPG	Footings		['fill too high']	low		
L24	L24_49	DJI_20230622021241_0026_Z.JPG	Member	75	['bent']	low	4	center
L24	L24_58	DJI_20230620215651_0126_Z.JPG	Member	236	['bent']	low	1	left
L24	L24_58	DJI_20230620215651_0126_Z.JPG	Member	237	['bent']	low	2	right
L24	L24_58	DJI_20230620215651_0126_Z.JPG	Member	237	['bent']	low	1	right
L24	L24_58	DJI_20230620215651_0126_Z.JPG	Member	236	['bent']	low	4	left
L24	L24_58	DJI_20230620215651_0126_Z.JPG	Member	75	['bent']	low	1	center
L24	L24_58	DJI_20230620215651_0126_Z.JPG	Member	75	['bent']	low	3	left
L24	L24_58	DJI_20230620215651_0126_Z.JPG	Member	237	['bent']	low	3	right
L24	L24_58	DJI_20230620215651_0126_Z.JPG	Member	234	['bent']	low	4	right
L24	L24_58	DJI_20230620215651_0126_Z.JPG	Member	75	['bent']	low	4	center
L24	L24_58	DJI_20230620215700_0129_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_58	DJI_20230620215708_0131_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_61	DJI_20230620214940_0049_Z.JPG	Member	75	['bent']	low	4	center
L24	L24_61	DJI_20230620214940_0049_Z.JPG	Member	75	['bent']	low	3	center
L24	L24_61	DJI_20230620214940_0049_Z.JPG	Member	75	['bent']	low	2	center
L24	L24_61	DJI_20230620214940_0049_Z.JPG	Member	75	['bent']	low	1	center
L24	L24_61	DJI_20230620214943_0050_Z.JPG	Footings		['overgrown']	low		
L24	L24_61	DJI_20230620214943_0050_Z.JPG	Footings		['overgrown']	low		
L24	L24_61	DJI_20230620214943_0050_Z.JPG	Footings		['overgrown']	low		

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L24	L24_61	DJI_20230620214943_0050_Z.JPG	Footings		['overgrown']	low		
L24	L24_72	DJI_20230621002245_0076_Z.JPG	Footings		['fill too high']	low		
L24	L24_72	DJI_20230621002245_0076_Z.JPG	Footings		['fill too high']	low		
L24	L24_72	DJI_20230621002245_0076_Z.JPG	Footings		['fill too high']	low		
L24	L24_72	DJI_20230621002245_0076_Z.JPG	Footings		['fill too high']	low		
L24	L24_72	DJI_20230621002245_0076_Z.JPG	Member	75	['bent']	low	3	center
L24	L24_72	DJI_20230621002245_0076_Z.JPG	Member	75	['bent']	low	1	center
L24	L24_72	DJI_20230621002403_0097_Z.JPG	Member	75	['bent']	low	2	center
L24	L24_89	DJI_20230615234911_0031_Z.JPG	Member	227	['bent']	low	1	left
L24	L24_91	DJI_20230616001358_0024_Z.JPG	Member	237	['bent']	low	4	left
L24	L24_91	DJI_20230616001358_0024_Z.JPG	Member	237	['bent']	low	2	right
L24	L24_91	DJI_20230616001358_0024_Z.JPG	Member	237	['bent']	low	2	left
L24	L24_91	DJI_20230616001451_0035_Z.JPG	Member	237	['bent']	low	3	left
L24	L24_91	DJI_20230616001451_0035_Z.JPG	Member	237	['bent']	low	1	left
L24	L24_91	DJI_20230616001451_0035_Z.JPG	Member	237	['bent']	low	1	right
L24	L24_91	DJI_20230616001451_0035_Z.JPG	Member	237	['bent']	low	3	right
L24	L24_92	DJI_20230616001607_0043_Z.JPG	Member	75	['bent']	low	4	center
L24	L24_92	DJI_20230616001607_0043_Z.JPG	Member	75	['bent']	low	3	center
L24	L24_92	DJI_20230616001607_0043_Z.JPG	Member	75	['bent']	low	2	center
L24	L24_92	DJI_20230616001607_0043_Z.JPG	Member	75	['bent']	low	1	center
L24	L24_92	DJI_20230616001816_0067_Z.JPG	Footings		['fill too high']	low		
L24	L24_92	DJI_20230616001816_0067_Z.JPG	Footings		['fill too high']	low		
L24	L24_92	DJI_20230616001816_0067_Z.JPG	Footings		['fill too high']	low		
L24	L24_92	DJI_20230616001816_0067_Z.JPG	Footings		['fill too high']	low		
L24	L24_108	DJI_20230617064843_0025_Z.JPG	Member	228	['bent']	low	1	right
L24	L24_108	DJI_20230617064843_0025_Z.JPG	Member	228	['bent']	low	3	left
L24	L24_111	DJI_20230617065920_0105_Z.JPG	Member	175	['bent']	low	2	center
L24	L24_111	DJI_20230617065945_0111_Z.JPG	Insulator		['porcelain']	low		
L24	L24_119	DJI_20230617200711_0219_Z.JPG	Member	75	['bent']	low	2	center
L24	L24_119	DJI_20230617200711_0219_Z.JPG	Member	75	['bent']	low	4	center
L24	L24_119	DJI_20230617200733_0224_Z.JPG	Member	75	['bent']	low	1	center
L24	L24_119	DJI_20230617200733_0224_Z.JPG	Member	75	['bent']	low	3	center
L24	L24_142	DJI_20230621024730_0073_Z.JPG	Member	278	['bent']	low	1	right
L24	L24_142	DJI_20230621024832_0089_Z.JPG	Member	278	['bent']	low	3	right
L24	L24_142	DJI_20230621024832_0089_Z.JPG	Member	277	['bent']	low	2	left
L24	L24_142	DJI_20230621024832_0089_Z.JPG	Member	277	['bent']	low	1	left
L24	L24_142	DJI_20230621024832_0089_Z.JPG	Member	277	['bent']	low	4	right
L24	L24_143	DJI_20230621025019_0105_Z.JPG	Member	277	['bent']	low	2	right
L24	L24_143	DJI_20230621025019_0105_Z.JPG	Member	278	['bent']	low	2	right
L24	L24_145	DJI_20230621025458_0158_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_145	DJI_20230621025505_0160_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_145	DJI_20230621025634_0174_Z.JPG	Member	75	['bent']	low	4	center
L24	L24_145	DJI_20230621025634_0174_Z.JPG	Footings		['overgrown']	low		
L24	L24_145	DJI_20230621025634_0174_Z.JPG	Footings		['overgrown']	low		
L24	L24_146	DJI_20230621025758_0184_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_146	DJI_20230621025805_0186_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_146	DJI_20230621025834_0194_Z.JPG	Member	252	['bent']	low	3	right
L24	L24_146	DJI_20230621025856_0200_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_146	DJI_20230621025907_0203_Z.JPG	Footings		['overgrown']	low		
L24	L24_146	DJI_20230621025907_0203_Z.JPG	Footings		['overgrown']	low		
L24	L24_146	DJI_20230621025907_0203_Z.JPG	Footings		['overgrown']	low		
L24	L24_146	DJI_20230621025907_0203_Z.JPG	Footings		['overgrown']	low		
L24	L24_146	DJI_20230621025907_0203_Z.JPG	Member	75	['bent']	low	2	center
L24	L24_148	DJI_20230622223723_0021_Z.JPG	Member	253	['bent']	low	2	right
L24	L24_148	DJI_20230622223723_0021_Z.JPG	Member	252	['bent']	low	3	right
L24	L24_148	DJI_20230622223723_0021_Z.JPG	Member	252	['bent']	low	3	left
L24	L24_150	DJI_20230622224141_0054_Z.JPG	Member	278	['bent']	low	4	right
L24	L24_150	DJI_20230622224221_0064_Z.JPG	Member	277	['bent']	low	4	left
L24	L24_153	DJI_20230622225019_0137_Z.JPG	Footings		['overgrown']	low		
L24	L24_153	DJI_20230622225019_0137_Z.JPG	Footings		['overgrown']	low		
L24	L24_153	DJI_20230622225019_0137_Z.JPG	Footings		['overgrown']	low		
L24	L24_153	DJI_20230622225019_0137_Z.JPG	Footings		['overgrown']	low		
L24	L24_153	DJI_20230622225129_0152_Z.JPG	Member	253	['bent']	low	4	left

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L24	L24_155	DJI_20230622231921_0039_Z.JPG	Member	228	['bent']	low	4	left
L24	L24_155	DJI_20230622231921_0039_Z.JPG	Member	227	['bent']	low	3	left
L24	L24_155	DJI_20230622231921_0039_Z.JPG	Member	228	['bent']	low	2	left
L24	L24_155	DJI_20230622231921_0039_Z.JPG	Member	227	['bent']	low	2	right
L24	L24_155	DJI_20230622231921_0039_Z.JPG	Footings		['overgrown']	low		
L24	L24_155	DJI_20230622231921_0039_Z.JPG	Member	75	['bent']	low	4	center
L24	L24_168	DJI_20230623011853_0187_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_168	DJI_20230623011950_0202_Z.JPG	Member	228	['bent']	low	3	right
L24	L24_170	DJI_20230623014019_0020_Z.JPG	Footings		['fill too low']	low		
L24	L24_170	DJI_20230623014105_0030_Z.JPG	Member	253	['bent']	low	3	right
L24	L24_170	DJI_20230623014105_0030_Z.JPG	Member	252	['bent']	low	1	left
L24	L24_170	DJI_20230623014105_0030_Z.JPG	Member	253	['bent']	low	4	right
L24	L24_170	DJI_20230623014105_0030_Z.JPG	Member	252	['bent']	low	4	left
L24	L24_172	DJI_20230623014419_0062_Z.JPG	Member	237	['bent']	low	3	right
L24	L24_172	DJI_20230623014419_0062_Z.JPG	Member	237	['bent']	low	4	right
L24	L24_172	DJI_20230623014513_0074_Z.JPG	Member	75	['bent']	low	4	center
L24	L24_172	DJI_20230623014608_0087_Z.JPG	Member	236	['bent']	low	3	right
L24	L24_172	DJI_20230623014608_0087_Z.JPG	Member	236	['bent']	low	1	left
L24	L24_173	DJI_20230623014900_0111_Z.JPG	Member	228	['bent']	low	2	right
L24	L24_173	DJI_20230623014900_0111_Z.JPG	Member	227	['bent']	low	4	left
L24	L24_173	DJI_20230623014953_0119_Z.JPG	Member	230	['installed incorrectly']	low	2	left
L24	L24_173	DJI_20230623014953_0119_Z.JPG	Member	230	['installed incorrectly']	low	2	right
L24	L24_173	DJI_20230623014953_0119_Z.JPG	Member	228	['bent']	low	3	right
L24	L24_174	DJI_20230623015059_0127_Z.JPG	Member	277	['bent']	low	1	left
L24	L24_174	DJI_20230623015059_0127_Z.JPG	Member	278	['bent']	low	1	right
L24	L24_174	DJI_20230623015059_0127_Z.JPG	Member	277	['bent']	low	4	left
L24	L24_174	DJI_20230623015059_0127_Z.JPG	Member	278	['bent']	low	2	right
L24	L24_174	DJI_20230623015059_0127_Z.JPG	Member	278	['bent']	low	3	right
L24	L24_174	DJI_20230623015107_0130_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_175	DJI_20230623015322_0153_Z.JPG	Member	237	['broken']	medium	4	right
L24	L24_175	DJI_20230623015403_0163_Z.JPG	Member	23	['bent']	low	4	left
L24	L24_175	DJI_20230623015500_0174_Z.JPG	Member	75	['bent']	low	4	center
L24	L24_175	DJI_20230623015500_0174_Z.JPG	Member	236	['bent']	low	1	left
L24	L24_175	DJI_20230623015500_0174_Z.JPG	Footings		['overgrown']	low		
L24	L24_175	DJI_20230623015500_0174_Z.JPG	Footings		['overgrown']	low		
L24	L24_175	DJI_20230623015500_0174_Z.JPG	Footings		['overgrown']	low		
L24	L24_175	DJI_20230623015500_0174_Z.JPG	Footings		['overgrown']	low		
L24	L24_177	DJI_20230623025613_0015_Z.JPG	Member	233	['bent']	low	4	left
L24	L24_177	DJI_20230623025633_0021_Z.JPG	Member	75	['bent']	low	2	center
L24	L24_177	DJI_20230623025633_0021_Z.JPG	Member	237	['bent']	low	2	right
L24	L24_177	DJI_20230623025633_0021_Z.JPG	Member	233	['bent']	low	4	left
L24	L24_177	DJI_20230623025702_0029_Z.JPG	Member	234	['bent']	low	2	right
L24	L24_177	DJI_20230623025702_0029_Z.JPG	Member	75	['bent']	low	2	center
L24	L24_177	DJI_20230623025702_0029_Z.JPG	Member	236	['bent']	low	2	left
L24	L24_177	DJI_20230623025702_0029_Z.JPG	Member	74	['bent']	low	2	left
L24	L24_177	DJI_20230623025702_0029_Z.JPG	Member	75	['bent']	low	3	center
L24	L24_177	DJI_20230623025702_0029_Z.JPG	Member	75	['bent']	low	4	center
L24	L24_177	DJI_20230623025702_0029_Z.JPG	Member	28	['missing bolt']	low	2	center
L24	L24_178	DJI_20230623025806_0035_Z.JPG	Member	277	['bent']	low	1	left
L24	L24_178	DJI_20230623025929_0062_Z.JPG	Member	278	['bent']	low	4	right
L24	L24_178	DJI_20230623025929_0062_Z.JPG	Member	277	['bent', 'missing']	low	4	left
L24	L24_178	DJI_20230623025929_0062_Z.JPG	Member	278	['bent']	low	1	right
L24	L24_178	DJI_20230623025929_0062_Z.JPG	Member	277	['bent']	low	1	left
L24	L24_178	DJI_20230623025929_0062_Z.JPG	Member	278	['bent']	low	3	right
L24	L24_178	DJI_20230623025929_0062_Z.JPG	Member	278	['bent']	low	2	right
L24	L24_178	DJI_20230623025929_0062_Z.JPG	Member	277	['bent']	low	2	left
L24	L24_179	DJI_20230623030047_0071_Z.JPG	Member	75	['bent']	low	2	center
L24	L24_179	DJI_20230623030047_0071_Z.JPG	Member	226	['bent']	low	2	center
L24	L24_179	DJI_20230623030120_0080_Z.JPG	Member	75	['bent']	low	3	left
L24	L24_179	DJI_20230623030120_0080_Z.JPG	Member	227	['bent']	low	3	left
L24	L24_179	DJI_20230623030157_0088_Z.JPG	Member	227	['bent']	low	2	right
L24	L24_179	DJI_20230623030218_0095_Z.JPG	Member	228	['bent']	low	1	left
L24	L24_179	DJI_20230623030218_0095_Z.JPG	Member	75	['bent']	low	4	center

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L24	L24_180	DJI_20230623030343_0109_W.JPG	Structure		['many broken members']	high		
L24	L24_180	DJI_20230623030345_0110_Z.JPG	Member	234	['bent']	low	2	right
L24	L24_180	DJI_20230623030345_0110_Z.JPG	Member	237	['broken']	medium	2	right
L24	L24_180	DJI_20230623030345_0110_Z.JPG	Member	233	['bent']	low	2	left
L24	L24_180	DJI_20230623030403_0118_Z.JPG	Environmental		['raptor nest']	low		
L24	L24_180	DJI_20230623030414_0121_Z.JPG	Member	236	['broken']	medium	3	left
L24	L24_180	DJI_20230623030414_0121_Z.JPG	Member	236	['broken']	medium	3	right
L24	L24_180	DJI_20230623030414_0121_Z.JPG	Member	236	['broken']	medium	1	left
L24	L24_180	DJI_20230623030414_0121_Z.JPG	Member	237	['broken']	medium	1	right
L24	L24_180	DJI_20230623030414_0121_Z.JPG	Member	236	['broken']	medium	4	left
L24	L24_180	DJI_20230623030414_0121_Z.JPG	Member	237	['broken']	medium	4	right
L24	L24_181	DJI_20230623030600_0147_Z.JPG	Member	26	['bent']	low	1	left
L24	L24_188	DJI_20230624221618_0121_Z.JPG	Member	75	['bent']	low	1	center
L24	L24_188	DJI_20230624221618_0121_Z.JPG	Member	75	['bent']	low	4	center
L24	L24_189	DJI_20230624221828_0147_Z.JPG	Member	237	['bent']	low	1	right
L24	L24_189	DJI_20230624221828_0147_Z.JPG	Member	236	['bent']	low	4	left
L24	L24_189	DJI_20230624221828_0147_Z.JPG	Member	236	['bent']	low	3	left
L24	L24_189	DJI_20230624221922_0160_Z.JPG	Member	237	['bent']	low	3	right
L24	L24_189	DJI_20230624221922_0160_Z.JPG	Member	236	['bent']	low	1	left
L24	L24_189	DJI_20230624221922_0160_Z.JPG	Member	75	['bent']	low	2	center
L24	L24_189	DJI_20230624221922_0160_Z.JPG	Member	75	['bent', 'broken']	low	4	center
L24	L24_190	DJI_20230624222046_0175_Z.JPG	Member	228	['bent']	low	1	right
L24	L24_190	DJI_20230624222125_0187_Z.JPG	Member	227	['bent']	low	2	left
L24	L24_190	DJI_20230624222130_0189_Z.JPG	Member	227	['bent']	low	3	left
L24	L24_190	DJI_20230624222130_0189_Z.JPG	Member	228	['bent']	low	3	right
L24	L24_190	DJI_20230624222130_0189_Z.JPG	Member	228	['bent']	low	2	right
L24	L24_190	DJI_20230624222130_0189_Z.JPG	Member	227	['bent']	low	1	left
L24	L24_191	DJI_20230624222219_0197_Z.JPG	Member	236	['bent']	low	2	left
L24	L24_191	DJI_20230624222232_0200_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_191	DJI_20230624222255_0205_Z.JPG	Member	237	['bent']	low	1	right
L24	L24_191	DJI_20230624222338_0220_Z.JPG	Member	237	['bent']	low	3	right
L24	L24_196	DJI_20230624223525_0083_Z.JPG	Member	237	['bent']	low	4	right
L24	L24_196	DJI_20230624223606_0096_Z.JPG	Member	74	['bent']	low	3	left
L24	L24_197	DJI_20230624223725_0109_Z.JPG	Footings		['overgrown']	low		
L24	L24_197	DJI_20230624223725_0109_Z.JPG	Footings		['overgrown']	low		
L24	L24_197	DJI_20230624223725_0109_Z.JPG	Footings		['overgrown']	low		
L24	L24_197	DJI_20230624223725_0109_Z.JPG	Footings		['overgrown']	low		
L24	L24_197	DJI_20230624223754_0119_Z.JPG	Member	75	['bent']	low	2	center
L24	L24_197	DJI_20230624223754_0119_Z.JPG	Member	75	['bent']	low	4	center
L24	L24_197	DJI_20230624223754_0119_Z.JPG	Member	75	['bent']	low	3	center
L24	L24_213	DJI_20230624233614_0160_Z.JPG	Member	75	['bent']	low	3	center
L24	L24_213	DJI_20230624233614_0160_Z.JPG	Member	75	['bent']	low	2	center
L24	L24_213	DJI_20230624233614_0160_Z.JPG	Member	236	['bent']	low	2	left
L24	L24_221	DJI_20230625014440_0039_Z.JPG	Member	75	['missing']	medium	4	center
L24	L24_221	DJI_20230625014440_0039_Z.JPG	Member	75	['missing']	medium	1	center
L24	L24_221	DJI_20230625014440_0039_Z.JPG	Member	75	['missing']	medium	3	center
L24	L24_221	DJI_20230625014440_0039_Z.JPG	Member	75	['missing']	medium	2	center
L24	L24_221	DJI_20230625014512_0049_Z.JPG	Member	233	['bent']	low	3	right
L24	L24_224	DJI_20230625015023_0100_Z.JPG	Member	237	['bent']	low	2	left
L24	L24_224	DJI_20230625015109_0109_Z.JPG	Footings		['overgrown']	low		
L24	L24_224	DJI_20230625015109_0109_Z.JPG	Footings		['overgrown']	low		
L24	L24_224	DJI_20230625015109_0109_Z.JPG	Footings		['overgrown']	low		
L24	L24_224	DJI_20230625015125_0114_Z.JPG	Member	236	['bent']	low	2	right
L24	L24_234	DJI_20230625022833_0130_Z.JPG	Footings		['fill too high']	low		
L24	L24_234	DJI_20230625022833_0130_Z.JPG	Footings		['fill too high']	low		
L24	L24_234	DJI_20230625022833_0130_Z.JPG	Footings		['fill too high']	low		
L24	L24_234	DJI_20230625022833_0130_Z.JPG	Footings		['fill too high']	low		
L24	L24_234	DJI_20230625022833_0130_Z.JPG	Member	75	['bent']	low	3	center
L24	L24_234	DJI_20230625022833_0130_Z.JPG	Member	75	['bent']	low	4	center
L24	L24_234	DJI_20230625022833_0130_Z.JPG	Member	75	['bent']	low	2	center
L24	L24_239	DJI_20230625214131_0078_Z.JPG	Member	75	['bent']	low	2	center
L24	L24_239	DJI_20230625214131_0078_Z.JPG	Footings		['fill too high']	low		
L24	L24_239	DJI_20230625214229_0091_Z.JPG	Footings		['fill too high']	low		

line_number	structure_identifier	image_file	feature	id	defect	severity	leg	side
L24	L24_239	DJI_20230625214229_0091_Z.JPG	Footings		['fill too high']	low		
L24	L24_239	DJI_20230625214229_0091_Z.JPG	Footings		['fill too high']	low		
L24	L24_239	DJI_20230625214229_0091_Z.JPG	Member	75	['bent']	low	2	center
L24	L24_239	DJI_20230625214229_0091_Z.JPG	Member	75	['bent']	low	1	center
L24	L24_239	DJI_20230625214229_0091_Z.JPG	Member	75	['bent']	low	4	center
L24	L24_245	DJI_20230625221638_0032_Z.JPG	Member	228	['bent']	low	4	right
L24	L24_245	DJI_20230625221657_0038_Z.JPG	Member	227	['bent']	low	3	left
L24	L24_245	DJI_20230625221729_0046_Z.JPG	Member	227	['bent']	low	1	left
L24	L24_249	DJI_20230625222336_0130_Z.JPG	Member	236	['bent']	low	1	right
L24	L24_249	DJI_20230625222336_0130_Z.JPG	Member	237	['bent']	low	1	left
L24	L24_249	DJI_20230625222407_0140_Z.JPG	Member	236	['bent']	low	1	right
L24	L24_249	DJI_20230625222407_0140_Z.JPG	Member	234	['bent']	low	4	left
L24	L24_249	DJI_20230625222407_0140_Z.JPG	Member	233	['bent']	low	4	right
L24	L24_249	DJI_20230625222407_0140_Z.JPG	Member	75	['bent']	low	1	center
L24	L24_249	DJI_20230625222513_0156_Z.JPG	Member	237	['bent']	low	1	left
L24	L24_249	DJI_20230625222513_0156_Z.JPG	Member	75	['bent']	low	3	center
L24	L24_249	DJI_20230625222513_0156_Z.JPG	Member	75	['bent']	low	4	center
L24	L24_253	DJI_20230625223613_0019_Z.JPG	Member	75	['bent']	low	1	center
L24	L24_253	DJI_20230625223613_0019_Z.JPG	Member	75	['bent']	low	3	center
L24	L24_253	DJI_20230625223613_0019_Z.JPG	Member	75	['bent']	low	4	center
L24	L24_253	DJI_20230625223613_0019_Z.JPG	Footings		['fill too high']	low		
L24	L24_253	DJI_20230625223613_0019_Z.JPG	Footings		['fill too high']	low		
L24	L24_253	DJI_20230625223613_0019_Z.JPG	Footings		['fill too high']	low		
L24	L24_253	DJI_20230625223613_0019_Z.JPG	Footings		['fill too high']	low		
L24	L24_254	DJI_20230625223815_0046_Z.JPG	Member	252	['bent']	low	3	left
L24	L24_254	DJI_20230625223832_0052_Z.JPG	Member	253	['bent']	low	2	right
L24	L24_254	DJI_20230625223832_0052_Z.JPG	Member	252	['bent']	low	1	left
L24	L24_254	DJI_20230625223832_0052_Z.JPG	Member	253	['bent']	low	1	right
L24	L24_256	DJI_20230625224232_0113_Z.JPG	Member	237	['bent']	low	3	right
L24	L24_256	DJI_20230625224232_0113_Z.JPG	Member	236	['bent']	low	3	left
L24	L24_256	DJI_20230625224232_0113_Z.JPG	Member	237	['bent']	low	4	right
L24	L24_256	DJI_20230625224232_0113_Z.JPG	Member	236	['bent']	low	4	left
L24	L24_256	DJI_20230625224232_0113_Z.JPG	Member	237	['bent']	low	2	right
L24	L24_256	DJI_20230625224232_0113_Z.JPG	Member	236	['bent']	low	2	left
L24	L24_256	DJI_20230625224232_0113_Z.JPG	Member	236	['bent']	low	1	left
L24	L24_256	DJI_20230625224232_0113_Z.JPG	Member	237	['bent']	low	1	right
L24	L24_262	DJI_20230626004448_0080_Z.JPG	Member	75	['bent']	low	3	center
L24	L24_262	DJI_20230626004448_0080_Z.JPG	Member	75	['bent']	low	2	center
L24	L24_262	DJI_20230626004448_0080_Z.JPG	Member	75	['bent']	low	1	center
L24	L24_262	DJI_20230626004500_0085_Z.JPG	Hardware		['worn hardware']	medium		
L24	L24_262	DJI_20230626004548_0098_Z.JPG	Member	75	['bent']	low	4	center
L24	L24_270	DJI_20230626010359_0093_Z.JPG	Member	237	['bent']	low	1	right
L24	L24_270	DJI_20230626010359_0093_Z.JPG	Member	233	['bent']	low	4	left
L24	L24_270	DJI_20230626010359_0093_Z.JPG	Member	234	['bent']	low	4	right
L24	L24_270	DJI_20230626010359_0093_Z.JPG	Member	235	['bent']	medium	3	center
L24	L24_270	DJI_20230626010359_0093_Z.JPG	Member	75	['bent']	low	2	center
L24	L24_270	DJI_20230626010359_0093_Z.JPG	Footings		['fill too high']	medium		
L24	L24_270	DJI_20230626010359_0093_Z.JPG	Footings		['fill too high']	medium		
L24	L24_270	DJI_20230626010359_0093_Z.JPG	Footings		['fill too high']	medium		
L24	L24_270	DJI_20230626010359_0093_Z.JPG	Footings		['fill too high']	medium		
L24	L24_273	DJI_20230626010900_0157_Z.JPG	Member	233	['bent']	low	4	left
L24	L24_273	DJI_20230626010942_0169_Z.JPG	Member	237	['bent', 'damaged']	low	2	right
L24	L24_273	DJI_20230626010942_0169_Z.JPG	Footings		['fill too high']	low		
L24	L24_273	DJI_20230626010942_0169_Z.JPG	Footings		['fill too high']	low		
L24	L24_273	DJI_20230626010942_0169_Z.JPG	Footings		['fill too high']	low		
L24	L24_273	DJI_20230626010942_0169_Z.JPG	Footings		['fill too high']	low		
L24	L24_280	DJI_20230626014816_0163_Z.JPG	Member	236	['bent']	low	1	left
L24	L24_280	DJI_20230626014816_0163_Z.JPG	Member	233	['bent']	low	1	left
L24	L24_280	DJI_20230626014816_0163_Z.JPG	Member	74	['bent']	low	1	left
L24	L24_280	DJI_20230626014816_0163_Z.JPG	Member	75	['missing']	medium	4	center
L24	L24_280	DJI_20230626014816_0163_Z.JPG	Member	75	['missing']	medium	3	center
L24	L24_280	DJI_20230626014816_0163_Z.JPG	Member	75	['missing']	medium	2	center
L24	L24_280	DJI_20230626014816_0163_Z.JPG	Member	75	['missing']	medium	1	center

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L24	L24_280	DJI_20230626014816_0163_Z.JPG	Member	236	['bent']	low	4	left
L24	L24_280	DJI_20230626014816_0163_Z.JPG	Member	237	['bent']	low	4	right
L24	L24_280	DJI_20230626014816_0163_Z.JPG	Member	236	['bent']	low	3	left
L24	L24_280	DJI_20230626014816_0163_Z.JPG	Member	237	['bent']	low	1	right
L24	L24_282	DJI_20230626015053_0198_Z.JPG	Member	237	['bent']	low	4	right
L24	L24_282	DJI_20230626015053_0198_Z.JPG	Member	236	['bent']	low	3	left
L24	L24_282	DJI_20230626015053_0198_Z.JPG	Member	237	['bent']	medium	3	right
L24	L24_282	DJI_20230626015053_0198_Z.JPG	Member	75	['missing']	medium	1	center
L24	L24_282	DJI_20230626015053_0198_Z.JPG	Member	75	['missing']	medium	2	center
L24	L24_282	DJI_20230626015053_0198_Z.JPG	Member	75	['missing']	medium	4	center
L24	L24_282	DJI_20230626015053_0198_Z.JPG	Member	75	['missing']	medium	3	center
L24	L24_282	DJI_20230626015140_0212_Z.JPG	Member	233	['bent']	low	1	left
L24	L24_282	DJI_20230626015140_0212_Z.JPG	Member	234	['bent']	low	1	right
L24	L24_282	DJI_20230626015154_0217_Z.JPG	Member	233	['bent']	low	2	left
L24	L24_282	DJI_20230626015154_0217_Z.JPG	Member	234	['bent']	low	2	right
L24	L24_289	DJI_20230626214405_0003_Z.JPG	Footings		['fill too high']	low		
L24	L24_289	DJI_20230626214405_0003_Z.JPG	Footings		['fill too high']	low		
L24	L24_289	DJI_20230626214405_0003_Z.JPG	Footings		['fill too high']	low		
L24	L24_289	DJI_20230626214405_0003_Z.JPG	Footings		['fill too high']	low		
L24	L24_289	DJI_20230626214559_0024_Z.JPG	Member	75	['bent']	low	2	center
L24	L24_301	DJI_20230626221559_0199_Z.JPG	Member	237	['bent']	low	2	right
L24	L24_301	DJI_20230626221559_0199_Z.JPG	Member	75	['missing']	medium	4	center
L24	L24_301	DJI_20230626221559_0199_Z.JPG	Member	75	['missing']	medium	3	center
L24	L24_301	DJI_20230626221559_0199_Z.JPG	Member	75	['missing']	medium	2	center
L24	L24_301	DJI_20230626221559_0199_Z.JPG	Member	75	['missing']	medium	1	center
L24	L24_301	DJI_20230626221623_0205_Z.JPG	Member	74	['bent']	low	1	right
L24	L24_301	DJI_20230626221623_0205_Z.JPG	Member	237	['bent']	low	1	right
L24	L24_301	DJI_20230626221626_0206_Z.JPG	Member	74	['bent']	low	4	left
L24	L24_308	DJI_20230626225205_0130_Z.JPG	Member	75	['bent']	low	2	center
L24	L24_308	DJI_20230626225205_0130_Z.JPG	Member	75	['bent']	low	3	center
L24	L24_308	DJI_20230626225205_0130_Z.JPG	Member	75	['bent']	low	1	center
L24	L24_308	DJI_20230626225326_0150_Z.JPG	Member	75	['bent']	low	3	center
L24	L24_308	DJI_20230626225340_0155_Z.JPG	Footings		['fill too high']	low		
L24	L24_308	DJI_20230626225340_0155_Z.JPG	Footings		['fill too high']	low		
L24	L24_308	DJI_20230626225340_0155_Z.JPG	Footings		['fill too high']	low		
L24	L24_308	DJI_20230626225340_0155_Z.JPG	Footings		['fill too high']	low		
L24	L24_311	DJI_20230626225756_0212_Z.JPG	Member	234	['bent']	low	4	right
L24	L24_311	DJI_20230626225810_0213_Z.JPG	Member	74	['bent']	low	3	left
L24	L24_311	DJI_20230626225918_0228_Z.JPG	Member	237	['bent']	low	2	right
L24	L24_311	DJI_20230626225918_0228_Z.JPG	Member	236	['bent']	low	4	left
L24	L24_311	DJI_20230626225933_0231_Z.JPG	Member	237	['bent']	low	2	right
L24	L24_311	DJI_20230626225933_0231_Z.JPG	Member	236	['bent']	low	4	left
L24	L24_311	DJI_20230626225933_0231_Z.JPG	Member	236	['bent']	low	3	right
L24	L24_311	DJI_20230626225933_0231_Z.JPG	Member	74	['bent']	low	2	right
L24	L24_311	DJI_20230626225949_0236_Z.JPG	Member	237	['bent']	low	3	right
L24	L24_311	DJI_20230626225949_0236_Z.JPG	Member	236	['bent']	low	2	left
L24	L24_311	DJI_20230626225949_0236_Z.JPG	Member	74	['bent']	low	3	left
L24	L24_313	DJI_20230626230602_0036_Z.JPG	Member	75	['bent']	low	1	center
L24	L24_313	DJI_20230626230648_0050_Z.JPG	Footings		['overgrown']	low		
L24	L24_313	DJI_20230626230648_0050_Z.JPG	Footings		['overgrown']	low		
L24	L24_313	DJI_20230626230648_0050_Z.JPG	Footings		['overgrown']	low		
L24	L24_313	DJI_20230626230648_0050_Z.JPG	Footings		['overgrown']	low		
L24	L24_314	DJI_20230626230803_0062_W.JPG	Structure		['leaning']	low		
L24	L24_314	DJI_20230626230830_0072_Z.JPG	Footings		['overgrown']	low		
L24	L24_314	DJI_20230626230842_0077_Z.JPG	Member	75	['bent']	low	3	center
L24	L24_314	DJI_20230626230842_0077_Z.JPG	Member	75	['bent']	low	2	center
L24	L24_316	DJI_20230626231233_0115_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_316	DJI_20230626231240_0117_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_316	DJI_20230626231343_0134_Z.JPG	Member	52	['bent']	low	2	left
L24	L24_316	DJI_20230626231343_0134_Z.JPG	Member	52	['bent']	low	1	left
L24	L24_318	DJI_20230626231834_0180_Z.JPG	Member	227	['bent']	low	3	left
L24	L24_318	DJI_20230626231911_0183_Z.JPG	Member	228	['bent']	low	4	right
L24	L24_318	DJI_20230626232021_0195_Z.JPG	Member	228	['bent']	low	3	right

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L24	L24_318	DJI_20230626232021_0195_Z.JPG	Member	227	['bent']	low	1	left
L24	L24_318	DJI_20230626232021_0195_Z.JPG	Member	227	['bent']	low	4	left
L24	L24_322	DJI_20230627012727_0089_Z.JPG	Member	175	['bent']	low	4	center
L24	L24_327	DJI_20230627013602_0207_Z.JPG	Member	75	['bent']	low	1	center
L24	L24_327	DJI_20230627013616_0212_Z.JPG	Member	75	['bent']	low	3	center
L24	L24_327	DJI_20230627013616_0212_Z.JPG	Member	75	['bent']	low	4	center
L24	L24_327	DJI_20230627013616_0212_Z.JPG	Member	75	['bent']	low	2	center
L24	L24_331	DJI_20230627014659_0091_Z.JPG	Member	75	['bent']	low	2	center
L24	L24_331	DJI_20230627014813_0112_Z.JPG	Footings		['overgrown']	low		
L24	L24_342	DJI_20230627222518_0041_Z.JPG	Member	237	['bent']	low	4	right
L24	L24_342	DJI_20230627222518_0041_Z.JPG	Member	236	['bent']	low	3	left
L24	L24_342	DJI_20230627222533_0046_Z.JPG	Member	237	['bent']	low	2	right
L24	L24_342	DJI_20230627222548_0051_Z.JPG	Member	75	['bent']	low	2	center
L24	L24_345	DJI_20230627223017_0110_Z.JPG	Member	74	['bent']	low	4	right
L24	L24_345	DJI_20230627223023_0113_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_348	DJI_20230627223619_0199_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_348	DJI_20230627223632_0202_Z.JPG	Member	253	['bent']	low	1	right
L24	L24_348	DJI_20230627223632_0202_Z.JPG	Member	252	['bent']	low	3	left
L24	L24_348	DJI_20230627223726_0217_Z.JPG	Member	253	['bent']	low	3	right
L24	L24_348	DJI_20230627223726_0217_Z.JPG	Member	252	['bent']	low	2	left
L24	L24_348	DJI_20230627223726_0217_Z.JPG	Member	253	['bent']	low	2	right
L24	L24_361	DJI_20230627230453_0148_Z.JPG	Member	228	['bent']	low	2	right
L24	L24_361	DJI_20230627230453_0148_Z.JPG	Member	227	['bent']	low	4	left
L24	L24_361	DJI_20230627230453_0148_Z.JPG	Member	230	['bent']	low	2	right
L24	L24_361	DJI_20230627230453_0148_Z.JPG	Member	231	['bent']	low	2	left
L24	L24_361	DJI_20230627230453_0148_Z.JPG	Member	228	['bent']	low	3	right
L24	L24_361	DJI_20230627230453_0148_Z.JPG	Member	227	['bent']	low	3	left
L24	L24_365	DJI_20230627231807_0030_Z.JPG	Member	227	['bent']	low	4	left
L24	L24_365	DJI_20230627231807_0030_Z.JPG	Member	228	['bent']	low	1	right
L24	L24_365	DJI_20230627231807_0030_Z.JPG	Member	228	['bent']	low	3	right
L24	L24_365	DJI_20230627231807_0030_Z.JPG	Member	227	['bent']	low	3	left
L24	L24_365	DJI_20230627231807_0030_Z.JPG	Member	227	['bent']	low	2	left
L24	L24_365	DJI_20230627231807_0030_Z.JPG	Member	75	['bent']	low	2	center
L24	L24_366	DJI_20230627231906_0039_Z.JPG	Member	75	['bent']	low	2	center
L24	L24_366	DJI_20230627231958_0055_Z.JPG	Member	75	['bent']	low	3	center
L24	L24_369	DJI_20230627232604_0143_Z.JPG	Member	175	['bent']	low	1	center
L24	L24_397	DJI_20230628225641_0033_Z.JPG	Member	252	['bent']	low	4	left
L24	L24_397	DJI_20230628225641_0033_Z.JPG	Member	253	['bent']	low	4	right
L24	L24_397	DJI_20230628225641_0033_Z.JPG	Member	252	['bent']	low	2	left
L24	L24_397	DJI_20230628225708_0041_Z.JPG	Member	253	['bent']	low	1	right
L24	L24_397	DJI_20230628225810_0058_Z.JPG	Member	253	['bent']	low	3	right
L24	L24_397	DJI_20230628225810_0058_Z.JPG	Member	252	['bent']	low	1	left
L24	L24_397	DJI_20230628225810_0058_Z.JPG	Member	252	['bent']	low	3	left
L24	L24_400	DJI_20230628013950_0045_Z.JPG	Member	277	['bent']	low	3	left
L24	L24_400	DJI_20230628014019_0055_Z.JPG	Member	227	['bent']	low	3	right
L24	L24_400	DJI_20230628014019_0055_Z.JPG	Member	228	['bent']	low	2	left
L24	L24_400	DJI_20230628014019_0055_Z.JPG	Member	227	['bent']	low	2	right
L24	L24_400	DJI_20230628014019_0055_Z.JPG	Member	228	['bent']	low	1	left
L24	L24_400	DJI_20230628014019_0055_Z.JPG	Member	227	['bent']	low	1	right
L24	L24_400	DJI_20230628014019_0055_Z.JPG	Member	227	['bent']	low	4	right
L24	L24_434	DJI_20230629220854_0105_Z.JPG	Member	228	['bent']	low	4	right
L24	L24_434	DJI_20230629220854_0105_Z.JPG	Member	227	['bent']	low	2	left
L24	L24_434	DJI_20230629221004_0124_Z.JPG	Member	228	['bent']	low	2	right
L24	L24_434	DJI_20230629221004_0124_Z.JPG	Member	227	['bent']	low	1	left
L24	L24_434	DJI_20230629221004_0124_Z.JPG	Member	228	['bent']	low	1	right
L24	L24_434	DJI_20230629221004_0124_Z.JPG	Member	227	['bent']	low	4	left
L24	L24_440	DJI_20230629222419_0119_Z.JPG	Member	232	['bent']	low	3	right
L24	L24_440	DJI_20230629222419_0119_Z.JPG	Member	228	['bent']	low	4	right
L24	L24_440	DJI_20230629222419_0119_Z.JPG	Member	75	['bent']	low	2	center
L24	L24_440	DJI_20230629222529_0137_Z.JPG	Footings		['overgrown']	low		
L24	L24_440	DJI_20230629222529_0137_Z.JPG	Footings		['fill too high']	low		
L24	L24_440	DJI_20230629222529_0137_Z.JPG	Footings		['fill too high']	low		
L24	L24_440	DJI_20230629222529_0137_Z.JPG	Footings		['overgrown']	low		

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L24	L24_442	DJI_20230629222911_0182_Z.JPG	Member	277	['bent']	low	3	left
L24	L24_444	DJI_20230629224435_0017_Z.JPG	Member	227	['bent']	low	2	right
L24	L24_444	DJI_20230629224457_0023_Z.JPG	Footings		['fill too high']	low		
L24	L24_444	DJI_20230629224457_0023_Z.JPG	Footings		['fill too high']	low		
L24	L24_444	DJI_20230629224457_0023_Z.JPG	Footings		['fill too high']	low		
L24	L24_444	DJI_20230629224457_0023_Z.JPG	Footings		['fill too high']	low		
L24	L24_445	DJI_20230629224648_0045_Z.JPG	Member	74	['bent']	low	4	center
L24	L24_448	DJI_20230630001122_0029_Z.JPG	Member	23	['bent']	low	3	left
L24	L24_448	DJI_20230630001226_0041_Z.JPG	Member	233	['bent']	low	1	left
L24	L24_448	DJI_20230630001226_0041_Z.JPG	Member	74	['bent']	low	1	left
L24	L24_448	DJI_20230630001226_0041_Z.JPG	Member	75	['missing']	medium	2	center
L24	L24_448	DJI_20230630001226_0041_Z.JPG	Member	75	['missing']	medium	3	center
L24	L24_448	DJI_20230630001226_0041_Z.JPG	Member	75	['missing']	medium	4	center
L24	L24_448	DJI_20230630001226_0041_Z.JPG	Member	75	['missing']	medium	1	center
L24	L24_448	DJI_20230630001226_0041_Z.JPG	Footings		['fill too high']	low		
L24	L24_448	DJI_20230630001226_0041_Z.JPG	Footings		['fill too high']	low		
L24	L24_448	DJI_20230630001226_0041_Z.JPG	Footings		['fill too high']	low		
L24	L24_448	DJI_20230630001226_0041_Z.JPG	Footings		['fill too high']	low		
L24	L24_448	DJI_20230630001226_0041_Z.JPG	Member	74	['broken']	medium	4	right
L24	L24_448	DJI_20230630001226_0041_Z.JPG	Member	74	['broken']	medium	2	left
L24	L24_456	DJI_20230623221541_0206_Z.JPG	Member	75	['bent']	low	1	center
L24	L24_456	DJI_20230623221559_0213_Z.JPG	Member	75	['bent']	low	3	center
L24	L24_456	DJI_20230623221559_0213_Z.JPG	Member	75	['bent']	low	4	center
L24	L24_456	DJI_20230623221559_0213_Z.JPG	Member	75	['bent']	low	2	center
L24	L24_464	DJI_20230624005854_0176_Z.JPG	Member	75	['bent']	low	2	center
L24	L24_464	DJI_20230624005854_0176_Z.JPG	Member	75	['bent']	low	4	center
L24	L24_464	DJI_20230624005854_0176_Z.JPG	Member	237	['overgrown']	low		
L24	L24_464	DJI_20230624005854_0176_Z.JPG	Member	237	['overgrown']	low		
L24	L24_464	DJI_20230624010016_0189_Z.JPG	Member	236	['bent']	low	1	left
L24	L24_464	DJI_20230624010016_0189_Z.JPG	Member	237	['vegetation overgrown']	low	2	right
L24	L24_464	DJI_20230624010016_0189_Z.JPG	Member	237	['overgrown']	low		
L24	L24_464	DJI_20230624010016_0189_Z.JPG	Member	237	['overgrown']	low		
L24	L24_466	DJI_20230630003104_0032_Z.JPG	Member	75	['bent']	low	2	center
L24	L24_466	DJI_20230630003214_0051_Z.JPG	Footings		['overgrown']	low		
L24	L24_466	DJI_20230630003214_0051_Z.JPG	Footings		['overgrown']	low		
L24	L24_466	DJI_20230630003214_0051_Z.JPG	Footings		['overgrown']	low		
L24	L24_466	DJI_20230630003214_0051_Z.JPG	Footings		['overgrown']	low		
L24	L24_468	DJI_20230630003537_0095_Z.JPG	Member	75	['bent']	low	4	center
L24	L24_468	DJI_20230630003537_0095_Z.JPG	Footings		['overgrown']	low		
L24	L24_468	DJI_20230630003537_0095_Z.JPG	Footings		['overgrown']	low		
L24	L24_468	DJI_20230630003537_0095_Z.JPG	Footings		['overgrown']	low		
L24	L24_468	DJI_20230630003537_0095_Z.JPG	Footings		['overgrown']	low		
L24	L24_471	DJI_20230630004116_0159_Z.JPG	Member	75	['bent']	low	3	center
L24	L24_471	DJI_20230630004218_0178_Z.JPG	Footings		['fill too high']	low		
L24	L24_471	DJI_20230630004218_0178_Z.JPG	Footings		['fill too high']	low		
L24	L24_471	DJI_20230630004218_0178_Z.JPG	Footings		['fill too high']	low		
L24	L24_471	DJI_20230630004218_0178_Z.JPG	Footings		['fill too high']	low		
L24	L24_472	DJI_20230630004403_0197_Z.JPG	Member	75	['missing']	medium	1	center
L24	L24_472	DJI_20230630004403_0197_Z.JPG	Member	75	['missing']	medium	2	center
L24	L24_472	DJI_20230630004403_0197_Z.JPG	Member	75	['missing']	medium	3	center
L24	L24_472	DJI_20230630004403_0197_Z.JPG	Member	75	['missing']	medium	4	center
L24	L24_472	DJI_20230630004403_0197_Z.JPG	Member	235	['bent']	low	2	center
L24	L24_472	DJI_20230630004403_0197_Z.JPG	Footings		['overgrown']	low		
L24	L24_472	DJI_20230630004403_0197_Z.JPG	Footings		['overgrown']	low		
L24	L24_472	DJI_20230630004403_0197_Z.JPG	Footings		['overgrown']	low		
L24	L24_472	DJI_20230630004403_0197_Z.JPG	Footings		['overgrown']	low		
L24	L24_473	DJI_20230630005036_0022_Z.JPG	Footings		['overgrown']	low		
L24	L24_473	DJI_20230630005036_0022_Z.JPG	Footings		['overgrown']	low		
L24	L24_473	DJI_20230630005036_0022_Z.JPG	Footings		['overgrown']	low		
L24	L24_473	DJI_20230630005036_0022_Z.JPG	Footings		['overgrown']	low		
L24	L24_473	DJI_20230630005051_0027_Z.JPG	Member	75	['bent']	low	2	center
L24	L24_473	DJI_20230630005051_0027_Z.JPG	Member	75	['bent']	low	3	center
L24	L24_473	DJI_20230630005051_0027_Z.JPG	Member	75	['bent']	low	4	center

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L24	L24_482	DJI_20230630022902_0106_Z.JPG	Member	62	['bent']	low	1	center
L24	L24_482	DJI_20230630022930_0114_Z.JPG	Footings		['fill too high']	low		
L24	L24_482	DJI_20230630022930_0114_Z.JPG	Footings		['fill too high']	low		
L24	L24_482	DJI_20230630022930_0114_Z.JPG	Footings		['fill too high']	low		
L24	L24_482	DJI_20230630022930_0114_Z.JPG	Footings		['fill too high']	low		
L24	L24_484	DJI_20230630023356_0157_Z.JPG	Member	253	['bent']	low	3	right
L24	L24_484	DJI_20230630023408_0162_Z.JPG	Insulator		['broken']	low		
L24	L24_489	DJI_20230630024714_0083_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_489	DJI_20230630024727_0085_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_489	DJI_20230630024742_0088_Z.JPG	Member	252	['bent']	low	3	left
L24	L24_489	DJI_20230630024742_0088_Z.JPG	Member	253	['bent']	low	4	right
L24	L24_489	DJI_20230630024801_0093_Z.JPG	Member	252	['bent']	low	4	left
L24	L24_489	DJI_20230630024824_0099_Z.JPG	Member	253	['bent']	low	3	right
L24	L24_489	DJI_20230630024824_0099_Z.JPG	Member	253	['bent']	low	2	right
L24	L24_489	DJI_20230630024824_0099_Z.JPG	Member	252	['bent']	low	2	left
L24	L24_490	DJI_20230630024908_0105_Z.JPG	Member	24	['bent']	low	4	right
L24	L24_490	DJI_20230630025002_0118_Z.JPG	Member	24	['bent']	low	1	left
L24	L24_490	DJI_20230630025031_0126_Z.JPG	Member	22	['bent']	low	2	left
L24	L24_490	DJI_20230630025031_0126_Z.JPG	Member	23	['bent']	low	3	right
L24	L24_491	DJI_20230630203024_0012_Z.JPG	Member	227	['bent']	low	3	left
L24	L24_491	DJI_20230630203104_0024_Z.JPG	Member	226	['bent']	low	3	center
L24	L24_492	DJI_20230630203313_0042_Z.JPG	Member	227	['bent']	low	3	left
L24	L24_492	DJI_20230630203313_0042_Z.JPG	Member	228	['bent']	low	1	right
L24	L24_492	DJI_20230630203404_0055_Z.JPG	Member	227	['bent']	low	2	left
L24	L24_492	DJI_20230630203404_0055_Z.JPG	Member	227	['bent']	low	1	left
L24	L24_495	DJI_20230630205945_0044_Z.JPG	Footings		['fill too high']	low		
L24	L24_495	DJI_20230630205945_0044_Z.JPG	Footings		['fill too high']	low		
L24	L24_495	DJI_20230630205945_0044_Z.JPG	Footings		['fill too high']	low		
L24	L24_495	DJI_20230630205945_0044_Z.JPG	Footings		['fill too high']	low		
L24	L24_495	DJI_20230630210014_0053_Z.JPG	Member	75	['bent']	low	4	center
L24	L24_495	DJI_20230630210014_0053_Z.JPG	Member	75	['bent']	low	1	center
L24	L24_495	DJI_20230630210014_0053_Z.JPG	Member	75	['bent']	low	2	center
L24	L24_496	DJI_20230630210202_0070_Z.JPG	Member	237	['bent']	low	1	left
L24	L24_496	DJI_20230630210236_0080_Z.JPG	Member	236	['bent']	low	2	left
L24	L24_496	DJI_20230630210236_0080_Z.JPG	Footings		['fill too high']	low		
L24	L24_496	DJI_20230630210236_0080_Z.JPG	Footings		['fill too high']	low		
L24	L24_496	DJI_20230630210236_0080_Z.JPG	Footings		['fill too high']	low		
L24	L24_496	DJI_20230630210236_0080_Z.JPG	Footings		['fill too high']	low		
L24	L24_497	DJI_20230630210425_0100_Z.JPG	Member	230	['bent']	low	4	right
L24	L24_497	DJI_20230630210508_0106_Z.JPG	Footings		['fill too high']	low		
L24	L24_497	DJI_20230630210508_0106_Z.JPG	Footings		['fill too high']	low		
L24	L24_497	DJI_20230630210508_0106_Z.JPG	Footings		['fill too high']	low		
L24	L24_497	DJI_20230630210508_0106_Z.JPG	Footings		['fill too high']	low		
L24	L24_498	DJI_20230630210734_0129_Z.JPG	Member	253	['bent']	low	2	right
L24	L24_498	DJI_20230630210734_0129_Z.JPG	Member	252	['bent']	low	1	left
L24	L24_499	DJI_20230630210856_0141_Z.JPG	Member	236	['bent']	low	4	left
L24	L24_499	DJI_20230630210856_0141_Z.JPG	Member	75	['missing']	medium	1	center
L24	L24_499	DJI_20230630210856_0141_Z.JPG	Member	75	['missing']	medium	4	center
L24	L24_499	DJI_20230630210856_0141_Z.JPG	Member	75	['missing']	medium	3	center
L24	L24_499	DJI_20230630210856_0141_Z.JPG	Member	75	['missing']	medium	2	center
L24	L24_499	DJI_20230630211006_0156_Z.JPG	Member	237	['bent']	low	2	right
L24	L24_499	DJI_20230630211024_0161_Z.JPG	Footings		['fill too high']	low		
L24	L24_499	DJI_20230630211024_0161_Z.JPG	Footings		['fill too high']	low		
L24	L24_499	DJI_20230630211024_0161_Z.JPG	Footings		['fill too high']	low		
L24	L24_499	DJI_20230630211024_0161_Z.JPG	Footings		['fill too high']	low		
L24	L24_500	DJI_20230630211109_0167_Z.JPG	Footings		['overgrown']	low		
L24	L24_500	DJI_20230630211109_0167_Z.JPG	Footings		['overgrown']	low		
L24	L24_500	DJI_20230630211140_0175_Z.JPG	Member	234	['altered member']	low	1	right
L24	L24_502	DJI_20230630212033_0059_Z.JPG	Member	277	['bent']	low	2	left
L24	L24_502	DJI_20230630212033_0059_Z.JPG	Member	278	['bent']	low	1	left
L24	L24_502	DJI_20230630212033_0059_Z.JPG	Member	278	['bent']	low	3	right
L24	L24_503	DJI_20230630212227_0079_Z.JPG	Member	62	['bent']	low	3	center
L24	L24_503	DJI_20230630212227_0079_Z.JPG	Member	24	['bent']	low	1	left

line_number	structure_identifier	image_file	feature	id	defect	severity	leg	side
L24	L24_503	DJI_20230630212227_0079_Z.JPG	Member	23	['broken']	low	4	right
L24	L24_503	DJI_20230630212227_0079_Z.JPG	Member	20	['bent']	low	4	left
L24	L24_503	DJI_20230630212246_0084_Z.JPG	Footings		['overgrown']	low		
L24	L24_505	DJI_20230630212628_0129_Z.JPG	Member	75	['missing']	medium	4	center
L24	L24_505	DJI_20230630212628_0129_Z.JPG	Member	75	['missing']	medium	1	center
L24	L24_505	DJI_20230630212628_0129_Z.JPG	Member	75	['missing']	medium	3	center
L24	L24_505	DJI_20230630212628_0129_Z.JPG	Member	75	['missing']	medium	2	center
L24	L24_519	DJI_20230614054628_0154_Z.JPG	Member	236	['bent']	low	1	right
L24	L24_519	DJI_20230614054648_0159_Z.JPG	Member	236	['bent']	low	3	right
L24	L24_519	DJI_20230614054648_0159_Z.JPG	Member	237	['bent']	low	3	left
L24	L24_519	DJI_20230614054720_0167_Z.JPG	Member	235	['bent']	high	2	center
L24	L24_519	DJI_20230614054720_0167_Z.JPG	Member	236	['bent']	low	2	left
L24	L24_519	DJI_20230614054750_0173_Z.JPG	Member	236	['bent']	low	3	left
L24	L24_521	DJI_20230614053707_0068_Z.JPG	Member	253	['bent']	low	1	right
L24	L24_521	DJI_20230614053844_0085_Z.JPG	Member	252	['bent']	low	1	left
L24	L24_532	DJI_20230614015133_0043_Z.JPG	Member	75	['bent']	low	2	center
L24	L24_532	DJI_20230614015133_0043_Z.JPG	Member	75	['bent']	low	1	center
L24	L24_532	DJI_20230614015133_0043_Z.JPG	Member	75	['bent']	low	4	center
L24	L24_532	DJI_20230614015133_0043_Z.JPG	Member	75	['bent']	low	3	center
L24	L24_532	DJI_20230614015154_0049_Z.JPG	Member	236	['bent']	low	1	right
L24	L24_532	DJI_20230614015158_0050_Z.JPG	Member	236	['bent']	low	3	left
L24	L24_536	DJI_20230614012121_0005_Z.JPG	Member	75	['bent']	low	3	center
L24	L24_536	DJI_20230614012121_0005_Z.JPG	Member	75	['bent']	low	1	center
L24	L24_536	DJI_20230614012121_0005_Z.JPG	Member	75	['bent']	low	4	center
L24	L24_536	DJI_20230614012121_0005_Z.JPG	Member	75	['bent']	low	2	center
L24	L24_536	DJI_20230614012155_0010_Z.JPG	Member	236	['bent']	low	2	center
L24	L24_536	DJI_20230614012449_0038_Z.JPG	Member	237	['bent']	low	4	right
L24	L24_542	DJI_20230613213516_0094_Z.JPG	Member	75	['bent']	low	2	center
L24	L24_542	DJI_20230613213516_0094_Z.JPG	Member	75	['bent']	low	1	center
L24	L24_542	DJI_20230613213516_0094_Z.JPG	Member	75	['bent']	low	4	center
L24	L24_542	DJI_20230613213516_0094_Z.JPG	Member	75	['bent']	low	3	center
L24	L24_542	DJI_20230613213903_0126_Z.JPG	Footings		['fill too high']	high		
L24	L24_542	DJI_20230613213903_0126_Z.JPG	Footings		['fill too high']	high		
L24	L24_542	DJI_20230613213903_0126_Z.JPG	Footings		['fill too high']	high		
L24	L24_542	DJI_20230613213903_0126_Z.JPG	Footings		['fill too high']	high		
L24	L24_543	DJI_20230613213029_0051_Z.JPG	Member	277	['bent']	low	4	right
L24	L24_543	DJI_20230613213221_0069_Z.JPG	Member	277	['bent']	low	1	right
L24	L24_546	DJI_20230613210757_0061_Z.JPG	Member	75	['bent']	low	4	center
L24	L24_546	DJI_20230613210803_0062_Z.JPG	Member	227	['bent']	low	2	left
L24	L24_546	DJI_20230613210803_0062_Z.JPG	Member	226	['bent']	medium	2	center
L24	L24_546	DJI_20230613210920_0075_Z.JPG	Member	227	['bent']	low	1	left
L24	L24_546	DJI_20230613211027_0088_Z.JPG	Member	228	['bent']	low	2	right
L24	L24_546	DJI_20230613211119_0096_Z.JPG	Member	Dirty	[]	medium		
L24	L24_546	DJI_20230613211132_0100_Z.JPG	Member	227	['bent']	low	1	left
L24	L24_555	DJI_20230613062127_0037_Z.JPG	Footings		['fill too high']	low		
L24	L24_555	DJI_20230613062127_0037_Z.JPG	Footings		['fill too high']	low		
L24	L24_555	DJI_20230613062127_0037_Z.JPG	Footings		['fill too high']	low		
L24	L24_555	DJI_20230613062146_0039_Z.JPG	Footings		['fill too high']	low		
L24	L24_555	DJI_20230613062149_0040_Z.JPG	Member	75	['bent']	low	1	left
L24	L24_555	DJI_20230613062249_0051_Z.JPG	Member	75	['bent']	low	2	left
L24	L24_561	DJI_20230613031155_0055_Z.JPG	Insulator		['broken']	low		
L24	L24_561	DJI_20230613031201_0057_Z.JPG	Footings		['fill too high']	low		
L24	L24_561	DJI_20230613031201_0057_Z.JPG	Member	21	['bent']	medium	1	center
L24	L24_561	DJI_20230613031201_0057_Z.JPG	Footings		['fill too high']	low		
L24	L24_561	DJI_20230613031201_0057_Z.JPG	Footings		['fill too high']	low		
L24	L24_561	DJI_20230613031201_0057_Z.JPG	Footings		['fill too high']	low		
L24	L24_568	DJI_20230612230559_0136_Z.JPG	Member	54	['bent']	low	2	center
L24	L24_568	DJI_20230612230733_0156_Z.JPG	Member	16	['bent']	low	1	left
L24	L24_568	DJI_20230612231100_0183_Z.JPG	Footings		['fill too high']	low		
L24	L24_568	DJI_20230612231100_0183_Z.JPG	Footings		['fill too high']	low		
L24	L24_568	DJI_20230612231100_0183_Z.JPG	Footings		['fill too high']	low		
L24	L24_568	DJI_20230612231100_0183_Z.JPG	Footings		['fill too high']	low		

Appendix B – Structural Assessment Results

L23	General Details						Analysis Results (before deficiency simulation)					Analysis Results (after deficiency simulation)				
Str. #	Tower Type & Extension	Deficient Member ID #	Leg	Side	Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed Incorrectly D5: Missing Bolts D6: Altered Member	Defeciency Scope (Original or Additional)	Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage	Maximum Usage of Deficient Member (%)	Controlling Mode of Deficient Member	Deficient Member KL/R	Deficiency Simulation Mode: M1: set to T-only (C=0%) M2: remove member	Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage	Maximum Usage of Deficient Member (%)	Additional Remarks (notes, assumptions, discrepancies)
10	S_+0+0+0+0	131	2	left	D1	Original	77.5	LY_131-T1P (131)	77.5	Comp.	236.6	M1	82.4	LY_131-T1P (131)	7.2	
		131	4	right	D1	Original						M1				
		131	1	right	D1	Original						M1				
16	S_+0+0+0+0	131	3	left	D1	Original	81.8	LX_131-T1P (131)	81.8	Comp.	236.6	M1	66.6	131-T1P (131)	12.9	
		131	3	right	D1	Original						M1				
		131	2	left	D1	Original						M1				
		131	1	left	D1	Original						M1				
19	S_+5+5+5+5	136	2	left	D1	Original	92.7	Fg143X (136)	92.7	Comp.	240.0	M1	105.2	Fg143-1P (131)	7.5	
		136	4	right	D1	Original						M1				
107	S_-5-5-5-5	127	2	right	D1	Original	85.4	g143XY (127)	85.4	Comp.	267.6	M1	86.8	g143-4P (127)	9.8	
		127	1	left	D1	Original						M1				
		127	1	right	D1	Original						M1				
		127	4	left	D1	Original						M1				
139	S_+5+5+5+5	136	2	left	D1	Original	87.6	Fg143XY (136)	87.6	Comp.	240.0	M1	119.0	Fg143-1P (131)	8.0	Leg 02 - left considered
		136	3	right	D1	Original						M1				Same member *
		136	3	right	D2	Original						M2			N/A	
145	S_+0+0+0+0	131	4	left	D1	Original	75.9	LY_131-T1P (131)	75.9	Comp.	236.6	M1	86.4	LY_131-T1P (131)	4.3	
152	S_-5-5-5-5	127	4	right	D1	Original	89.5	g143XY (127)	89.5	Comp.	267.6	M1	88.7	g143-2P (127)	5.7	
153	S_-5-5-5-5	127	1	right	D1	Original	85.6	g143XY (127)	85.6	Comp.	267.6	M1	88.9	g143-2P (127)	3.4	
		118	3	left	D1	Original			4.0	Comp.	162.3	M1			0.3	Leg 03 - left considered
167	S_+0+0+0+0	131	3	right	D1	Original	76.2	LY_131-T1P (131)	76.2	Comp.	236.6	M1	85.4	131-T1P (131)	4.5	
170	S_+0+0+0+0	131	2	right	D1	Original	85.2	LY_131-T1P (131)	85.2	Comp.	236.6	M1	85.2	LY_131-T1P (131)	7.7	
		131	1	left	D1	Original						M1				
178	S_+5+5+5+5	136	2	right	D1	Original	95.5	Fg143XY (136)	95.5	Comp.	240.0	M2	97.7	Fg142-1P (136)	N/A	Connected redundants are also removed *
179	S_+0+0+0+0	131	4	left	D1	Original	80.9	131-T1P (131)	80.9	Comp.	236.6	M1	92.1	LY_131-T1P (131)	3.5	
		131	1	left	D2	Original						M2			N/A	
189	S_-5-5-5-5	127	1	right	D1	Original	93.0	g143P (127)	93.0	Comp.	267.6	M1	99.5	g143-3P (127)	9.1	
		127	4	left	D2	Original						M2				Connected redundants are also removed *
		127	3	right	D1	Original						M1				
		127	2	left	D1	Original						M1				
		127	2	right	D1	Original						M1				
190	S_-5-5-5-5	127	3	right	D1	Original	83.5	g143X (127)	83.5	Comp.	267.6	M1	85.5	g143-3P (127)	3.6	
		127	2	right	D2	Original						M1			N/A	
		127	4	left	D2	Original						M1			N/A	
		118	1	right	D1	Additional			4.0	Comp.	162.3	M1			0.9	
196	S_-5-5-5-5	No supporting evidence of deficiency found.														
205	S_+0+0+0+0	131	1	right	D1	Original	72.2	LY_131-T1P (131)	72.2	Comp.	236.6	M1	79.4	LXY_131-T1P (131)	10.6	
		131	3	left	D1	Original						M1				
		131	4	left	D1	Original						M1				
206	S_+5+5+5+5	136	3	left	D2	Original	87.3	Fg143X (136)	87.3	Comp.	240.0	M2	94.4	Fg142-4P (136)	N/A	Connected redundants are also removed *
		136	1	left	D1	Original						M1			11.1	
		136	3	right	D1	Original						M1				
222	S_+0+0+0+0	131	1	right	D1	Original	85.4	LY_131-T1P (131)	85.4	Comp.	236.6	M1	95.5	LXY_131-T1P (131)	13.4	
		131	3	left	D1	Original						M1				
		131	4	left	D1	Original						M1				
262	S_+10+10+10+10	144	4	right	D1	Original	64.3	115-T2P (115)	42.9	Comp.	195.1	M1	61.2	115-T2X (115)	5.3	
263	S_+5+5+5+5	136	1	right	D1	Original	88.6	Fg143X (136)	88.6	Comp.	240.0	M1	102.0	Fg143-2P (136)	5.2	
		136	3	right	D1	Original						M1				
269	S_-5-5-5-5	127	3	left	D1	Original	95.1	g143XY (127)	95.1	Comp.	267.6	M1	94.4	g143-2P (127)	7.0	
272	S_-5-5-5-5	127	1	left	D1	Original	93.0	g143X (127)	93.0	Comp.	267.6	M1	100.0	g142-2P (127)	7.5	
		127	2	left	D2	Original	93.0	g143X (127)	93.0	Comp.	267.6	M1				
		127	3	left	D2	Original	93.0	g143X (127)	93.0	Comp.	267.6	M1				
		127	3	right	D2	Original	93.0	g143X (127)	93.0	Comp.	267.6	M1				
274	S_-5-5-5-5	127	2	left	D1	Original	78.2	g143XY (127)	78.2	Comp.	267.6	M1	82.1	g143-1P (127)	3.8	
		127	4	left	D1	Original						M1				

L23	General Details							Analysis Results (before deficiency simulation)					Analysis Results (after deficiency simulation)				
Str. #	Tower Type & Extension	Deficient Member ID #		Leg	Side	Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed Incorrectly D5: Missing Bolts D6: Altered Member	Defeciency Scope (Original or Additional)	Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage	Maximum Usage of Deficient Member (%)	Controlling Mode of Deficient Member	Deficient Member KL/R	Deficiency Simulation Mode: M1: set to T-only (C=0%) M2: remove member	Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage	Maximum Usage of Deficient Member (%)	Additional Remarks (notes, assumptions, discrepancies)
278	T_+0+0+0+0	with 2 guy wires	124	2	right	D1	Original	145.5	g136P (63)	99.0	Comp.	287.6	M1	145.5	g136P (63)	59.1	In pre-deficiency model, #124 is modelled as "T-Only Beam" element. During the post-deficiency analysis, make % of compression capacity as 0
			124	1	right	D1	Original						M1				
			124	1	left	D1	Original						M1				
			124	4	left	D1	Original						M1				
			119	4	right	D1	Additional			10.5	Comp.	216.2	M1			1.5	
		with 1 guy wire	124	2	right	D1	Original	145.5	g136P (63)	97.0	Comp.	287.6	M1	145.5	g136P (63)	58.2	In pre-deficiency model, #124 is modelled as "T-Only Beam" element. During the post-deficiency analysis, make % of compression capacity as 0
			124	1	right	D1	Original						M1				
			124	1	left	D1	Original						M1				
			124	4	left	D1	Original						M1				
			119	4	right	D1	Additional			10.4	Comp.	216.2	M1			1.5	
		with 0 guy wires	124	2	right	D1	Original	145.4	g136P (63)	98.2	Comp.	287.6	M1	145.4	g136P (63)	57.5	In pre-deficiency model, #124 is modelled as "T-Only Beam" element. During the post-deficiency analysis, make % of compression capacity as 0
			124	1	right	D1	Original						M1				
			124	1	left	D1	Original						M1				
			124	4	left	D1	Original						M1				
			119	4	right	D1	Additional			10.4	Comp.	216.2	M1			1.5	
279	S_-5-5-5-5	127		1	right	D1	Original	68.5	g143X (127)	68.5	Comp.	267.6	M1	72.8	g143-2P (127)	1.4	
		118		4	left	D1	Additional			3.9	Comp.	162.3	M1			0.9	
282	S_+0+0+0+0	131		2	left	D1	Original	78.3	LY_131-T1P (131)	78.3	Comp.	236.6	M1	51.2	48-1X (48)	15.1	
		131		3	left	D1	Original						M1				
		131		2	right	D1	Original						M1				
		131		1	left	D2	Original						M2				Connected redundants are also removed *
		131		1	right	D1	Original						M1				
		131		4	left	D1	Original						M1				
		131		3	right	D1	Original						M1				
		131		3	left	D1	Original						M1				
286	S_-5-5-5-5	127		4	left	D1	Original	79.6	g143X (127)	79.6	Comp.	267.6	M1	85.8	g143-3P (127)	3.4	
287	S_-5-5-5-5	127		1	right	D1	Original	89.2	g143XY (127)	89.2	Comp.	267.6	M1	97.9	g143-4P (127)	10.4	Leg 1 - right considered
		127		3	right	D1	Original						M1				Leg 3 - right considered
		127		2	left	D1	Original						M1				Leg 2 - left considered
		127		1	left	D1	Original						M1				Leg 1 - left considered
455	S_+0+0+0+0	131		4	right	D1	Additional	77.3	LY_131-T1P (131)	77.3	Comp.	236.6	M1	76.4	LXY_131-T1P (131)	7.8	
		131		3	left	D1	Original						M1				
		131		3	right	D1	Original						M1				
466	S_+0+0+0+0	131		2	left	D2	Original	79.1	131-T1P (131)	79.1	Comp.	236.6	M2	69.4	LXY_131-L1P (131)	N/A	Connected redundants are also removed *
		131		3	left	D1	Original						M1			7.5	
		131		1	left	D1	Original						M1				
470	S_+0+0+0+0	131		2	right	D1	Original	79.5	131-T1P (131)	79.5	Comp.	236.6	M1	81.7	LXY_131-L1P (131)	N/A	
		131		1	left	D2	Original						M1			N/A	
		131		1	right	D2	Original						M1			16.3	
		131		4	left	D1	Original						M1				
		131		4	right	D1	Original						M1				
		131		3	left	D1	Original						M1				
		131		3	right	D2	Original						M1			N/A	
488	T_+0+0+0+0	124		2	left	D1	Additional	123.8	g136P (63)	99.2	Comp.	287.6	M1	127.7	g136P (63)	49.6	
		124		2	right	D1	Additional						M1				
		126		2	left	D1	Original			31.1	Comp.	209.3	M1			10.2	
		126		2	right	D1	Original						M1				
		125		2	left	D1	Original			18.0	Comp.	215.8	M1			0.5	
491	S_+0+0+0+0	131		2	left	D1	Original	71.8	131-T1P (131)	71.8	Comp.	236.6	M1	71.7	LX-129-2P (Leg 1)	5.2	
		131		4	right	D1	Original						M1				
		131		1	right	D2	Original						M2				Connected redundants are also removed *
		131		1	left	D2	Original						M2				Connected redundants are also removed *
492	C_+0+0+0+0	122		2	left	D1	Original	93.4	g7X (118)	64.9	Comp.	189.4	M1	192.0	g37P (98)	26.0	
		122		4	left	D1	Original						M1				
500	S_+0+0+0+0	131		4	right	D1	Original	76.3	131-T1P (131)	76.3	Comp.	236.6	M1	75.4	LXY_131-T1P (131)	7.0	
502	S_+0+0+0+0	131		3	left	D2	Original	72.1	131-T1P (131)	72.1	Comp.	236.6	M2	74.3	LX_131-T1P (131)	5.1	
		131		4	left	D1	Original						M1				

L23	General Details						Analysis Results (before deficiency simulation)					Analysis Results (after deficiency simulation)				
Str. #	Tower Type & Extension	Deficient Member ID #	Deficient Member Leg	Deficient Member Side	Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed Incorrectly D5: Missing Bolts D6: Altered Member	Defeciency Scope (Original or Additional)	Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage	Maximum Usage of Deficient Member (%)	Controlling Mode of Deficient Member	Deficient Member KL/R	Deficiency Simulation Mode: M1: set to T-only (C=0%) M2: remove member	Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage	Maximum Usage of Deficient Member (%)	Additional Remarks (notes, assumptions, discrepancies)
507	S_-5-5-5-5	127	4	left	D1	Original	82.4	g143X (127)	82.4	Comp.	267.6	M1	83.5	g143-2P (127)	2.6	
		127	4	right	D6	Original						M2				Altered member. Removed during the simulation *
521	S_-5-5-5-5	127	4	right	D1	Original	93.2	g143P (127)	93.2	Comp.	267.6	M1	70.6	g142-3P (127)	7.6	
		127	3	left	D1	Original						M1				
		127	4	left	D1	Original						M1				
		127	1	left	D1	Original						M1				
530	S_-5-5-5-5	127	2	left	D6	Original	78.9	g143X (127)	78.9	Comp.	267.6	M2	62.4	g143-1P (127)	N/A	
		127	4	left	D6	Original						M2				
		127	3	left	D6	Original						M2				
		118	3	right	D1	Original			4.0	Comp.	162.3	M1			2.1	
		118	4	right	D1	Original						M1				
		118	2	left	D1	Original						M1				
		118	2	right	D1	Original						M1				
		118	1	left	D1	Original						M1				
532	S_-5-5-5-5	No supporting evidence of deficiency found.														
534	S_-5-5-5-5	118	4	right	D1	Original	89.0	g143X (127)	4.0	Comp.	162.3	M1	94.3	g143-1P (127)	1.1	
		118	4	left	D1	Original						M1				
		127	1	right	D1	Additional						M1			3.7	
		127	2	left	D1	Additional						M1				
538	S_+0+0+0+0	131	1	right	D1	Original	75.3	LXY_131-T1P (131)	75.3	Comp.	236.6	M1	85.6	131-T1P (131)	11.9	
		131	3	right	D1	Original						M1				
		131	2	left	D1	Original						M1				
		131	1	left	D1	Original						M1				
556	S_-5-5-5-5	118	4	left	D1	Original	77.5	g143Y (127)	3.9	Comp.	162.3	M1	79.9	g143-3P (127)	6.9	Leg 4 - left considered
		118	3	left	D1	Original						M1				Leg 3 - left considered
		118	4	right	D1	Original						M1				Leg 4 - right considered
		118	1	right	D1	Original						M1				Leg 1 - right considered
		127	4	left	D6	Original			77.5	Comp.	267.6	M2			N/A	Leg 4 - left considered
		127	1	left	D6	Original						M2				Leg 1 - left considered
		127	4	left	D1	Original						M1 (Removed above)			6.5	Leg 4 - left considered
		127	2	right	D1	Original						M1				Leg 2 - right considered
		127	1	right	D1	Original						M1				Leg 1 - right considered
563	S_-5-5-5-5	127	3	left	D1	Original	91.2	g143XY (127)	91.2	Comp.	267.6	M1	95.7	g143-1P (127)	5.8	
		127	2	left	D1	Original						M1				
567	S_-5-5-5-5	127	2	left	D2	Original	69.1	g143Y (127)	69.1	Comp.	267.6	M2	72.6	g143-1P (127)	N/A	
		127	4	left	D1	Original						M1			6.0	
		127	1	right	D1	Original						M1				

L24	General Details						Analysis Results (before deficiency simulation)					Analysis Results (after deficiency simulation)				
Str. #	Tower Type & Extension	Deficient Member ID #	Leg	Side	Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed Incorrectly D5: Missing Bolts D6: Altered Member	Defeciency Scope (Original or Additional)	Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage	Maximum Usage of Deficient Member (%)	Controlling Mode of Deficient Member	Deficient Member KL/R	Deficiency Simulation Mode: M1: set to T-only (C=0%) M2: remove member	Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage	Maximum Usage of Deficient Member (%)	Additional Remarks (notes, assumptions, discrepancies)
5	B_+5+5+5+5	30	4	right	D1	Original	76.3	216-3X	2.7	Comp	216.7	M1	76.2	216-3X	1.0	
		22	4	right	D1	Original			40.4	Comp	173.5	M1			18.7	
		21	2	left	D1	Original			29.2	Comp	173.5	M1			17.4	
9	BB_+0+0+0+0	75	4	center	D1	Original	63.6	103P	2.9	Comp	170.7	M1	96.0	g135P (Leg 1)	3.7	
		230	1	left	D1	Additional			3.0	Comp	230.9	M2			N/A	
		227	1	left	D2	Original			26.2	Comp	175.0	M2			18.9	
		228	1	right	D1	Original						M1				
		227	3	left	D1	Original						M1				
		228	2	right	D1	Original						M1				
		227	2	left	D1	Original						M1				
		228	1	left	D1	Original						M2				
		227	1	right	D1	Original						M1				
11	BB_+5+5+5+5	252	3	right	D1	Original	64.2	103P	31.4	Comp	160.8	M1	64.9	103Y	17.8	
		252	1	right	D1	Original						M1				
		252	1	left	D1	Original						M1				
		261	3	left	D1	Additional			1.2	Comp	107.8	M1			1.2	
13	BB_+0+0+0+0	227	3	right	D1	Original	53.7	103P	25.1	Comp	175.0	M1	53.6	103Y	20.7	
		228	1	right	D1	Original						M1				
16	BB_+5+5+5+5	251	4	center	D1	Original	74.1	103P	56.4	Comp		Override compression capacity to 50%	143.3	251-4	143.3	
		252	2	right	D1	Original			33.8	Comp	160.8	M1			27.6	
		252	4	left	D1	Original						M1				
		252	2	left	D1	Original						M1				
		252	3	left	D1	Original						M1				
		253	3	right	D1	Original						M1				
		253	1	right	D1	Original						M1				
17	BB_+5+5+5+5	252	2	left	D1	Original	70.3	103P	32.6	Comp	160.8	M1	82.1	26-L2Y	17.7	
		252	3	left	D1	Original						M1				
		252	1	left	D1	Original						M1				
		252	1	left	D1	Original						M1				
		253	1	right	D1	Original						M1				
18	BB_+5+5+5+5	252	1	right	D1	Original	75.2	103P	34.9	Comp	160.8	M1	87.7	26-L2Y	30.9	Leg 1 -right considered
		253	2	left	D1	Original						M1				Leg 2 - left considered
		252	2	right	D1	Original						M1				Leg 2 - right considered
		253	1	left	D1	Original						M1				Leg 1 - left considered
		252	3	left	D1	Original						M1				Leg 3 -left considered
		253	3	right	D1	Original			1.4	Comp	107.8	M1				Leg 3 - right considered
19	BB_+5+5+5+5	253	1	right	D1	Original	71.7	103P	34.5	Comp	160.8	M1	81.2	26_L2P	18.6	
		253	4	right	D1	Original						M1				
		252	3	left	D1	Original						M1				
		253	2	right	D1	Original						M1				
		252	2	left	D1	Original						M1				
20	BB_+0+0+0+0	228	2	right	D1	Additional	71.8	103Y	33.5	Comp	175.0	M1	71.7	103y	14.2	
		29	3	right	D1	Original			3.3	Comp	230.9	M1			0.8	Leg 3 - left considered
21	BB_-5-5-5-5	237	4	right	D1	Original	74.3	103Y	30.1	Comp	161.4	M1	73.9	103Y	22.8	
		237	4	left	D1	Original						M1				
		236	1	right	D1	Original						M1				
23	BB_+0+0+0+0	227	1	left	D1	Original	63.0	103Y	30.3	Comp	175.0	M1	63.0	103Y	18.9	
		228	1	right	D1	Original						M1				
31	BB_+0+0+0+0	227	4	left	D1	Original	65.7	103XY	31.7	Comp	175.0	M1	66.7	103P	17.1	
		227	1	left	D1	Original						M1				
37	BB_-5-5-5-5	75	4	center	D1	Original	61.6	103Y	2.5	Comp	170.7	M1	61.6	103Y	0.8	
49	BB_+0+0+0+0	75	3	center	D1	Original	71.4	103Y	3.5	Comp	170.7	M1	71.4	103Y	0.6	
		75	4	center	D1	Original						M1				

L24	General Details						Analysis Results (before deficiency simulation)					Analysis Results (after deficiency simulation)				
Str. #	Tower Type & Extension	Deficient Member ID #	Leg	Side	Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed Incorrectly D5: Missing Bolts D6: Altered Member	Defeciency Scope (Original or Additional)	Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage	Maximum Usage of Deficient Member (%)	Controlling Mode of Deficient Member	Deficient Member KL/R	Deficiency Simulation Mode: M1: set to T-only (C=0%) M2: remove member	Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage	Maximum Usage of Deficient Member (%)	Additional Remarks (notes, assumptions, discrepancies)
58	BB_-5-5-5-5	236	1	left	D1	Additional	61.7	103Y	24.4	Comp	161.4	M1	63.4	103Y	26.2	
		236	4	left	D1	Additional						M1				
		237	2	right	D1	Additional						M1				
		237	1	right	D1	Additional						M1				
		237	3	right	D1	Additional						M1				
		234	4	right	D1	Additional			0.2	Tens	172.2	M1			0.2	
		75	1	center	D1	Original			2.6	Comp	170.7	M1			0.8	
		75	3	left	D1	Original						M1				
		75	4	center	D1	Original						M1				
61	BB_-5-5-5-5	75	4	center	D1	Original	61.2	103P	2.5	Comp	170.7	M1	61.2	103P	0.7	
		75	3	center	D1	Original						M1				
		75	2	center	D1	Original						M1				
		75	1	center	D1	Original						M1				
72	BB_-5-5-5-5	75	3	center	D1	Original	64.1	103P	2.7	Comp	170.7	M1	64.1	103P	1.5	
		75	1	center	D1	Original						M1				
		75	2	center	D1	Original						M1				
89	BB_+0+0+0+0	227	1	left	D1	Original	65.6	103P	29.3	Comp	175.0	M1	65.6	103P	9.7	
91	BB_-5-5-5-5	237	4	left	D1	Original	66.3	103Y	26.1	Comp	161.4	M1	67.2	103Y	28.5	
		237	2	right	D1	Original						M1				
		237	2	left	D1	Original						M1				
		237	3	left	D1	Original						M1				
		237	1	left	D1	Original						M1				
		237	1	right	D1	Original						M1				
		237	3	right	D1	Original						M1				
92	BB_-5-5-5-5	75	4	center	D1	Original	62.6	103Y	2.5	Comp	170.7	M1	62.5	103P	0.7	
		75	3	center	D1	Original						M1				
		75	2	center	D1	Original						M1				
		75	1	center	D1	Original						M1				
108	BB_+0+0+0+0	228	1	right	D1	Original	60.2	103P	27.0	Comp	175.0	M1	60.1	103p	21.7	
		228	3	right	D1	Original						M1				Leg 3 - right considered
111	EE_-5-5-5-5	175	2	center	D1	Original	95.0	76Y	16.5	Comp	177.7	M1	97.9	76Y	8.2	
119	BB_-5-5-5-5	75	2	center	D1	Original	56.1	103P	2.2	Comp	170.7	M1	56.1	103p	0.7	
		75	4	center	D1	Original						M1				
		75	1	center	D1	Original						M1				
		75	3	center	D1	Original						M1				
142	BB_+10+10+10+10	278	1	right	D1	Original	69.8	103P	33.6	Comp	128.5	M1	95.4	26-L2Y	40.9	
		278	3	right	D1	Original						M1				
		277	2	left	D1	Original						M1				
		277	1	left	D1	Original						M1				
		277	4	left	D1	Original						M1				Leg 4 - left considered
143	BB_+10+10+10+10	277	2	right	D1	Original	62.7	103X	33.5	Comp	128.5	M1	63.1	103P	27.3	Leg 2 -right considered
		278	4	left	D1	Original						M1				Leg 4 - left considered
145	BB_+0+0+0+0	75	4	center	D1	Original	64.5	103P	3.3	Comp	170.7	M1	64.5	103P	1.1	
146	BB_+5+5+5+5	252	2	right	D1	Original	47.5	103P	26.8	Comp	160.8	M1	47.9	103P	5.6	Leg 2 -right considered
		75	2	center	D1	Original			4.0	Comp	170.7	M1			1.2	
148	BB_+5+5+5+5	252	1	right	D1	Original	75.0	103X	36.5	Comp	160.8	M1	86.1	26-L2P	16.1	Leg 1 - right considered
		252	2	left	D1	Original						M1				Leg 2 - left considered
		253	2	right	D1	Original						M1				Leg 2 - right considered
150	BB_+10+10+10+10	278	4	right	D1	Original	63.5	103Y	33.0	Comp	128.5	M1	63.2	103Y	5.2	
		277	3	left	D1	Original						M1				Leg 1 - left considered
153	BB_+5+5+5+5	253	4	left	D1	Original	61.9	103Y	31.0	Comp	160.8	M1	61.8	103Y	12.5	
155	BB_+0+0+0+0	228	4	left	D1	Original	66.8	103X	32.6	Comp	175.0	M1	64.5	103X	32.9	
		228	2	left	D1	Original						M1				
		227	3	right	D1	Original						M1				Leg 3 - right considered
		227	2	right	D1	Original						M1				
		75	4	center	D1	Original			3.4	Comp	170.7	M1			3.7	
168	BB_+0+0+0+0	228	3	right	D1	Original	58.0	103P	27.1	Comp	175.0	M1	57.9	103P	16.3	

L24	General Details						Analysis Results (before deficiency simulation)					Analysis Results (after deficiency simulation)				
Str. #	Tower Type & Extension	Deficient Member			Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed Incorrectly D5: Missing Bolts D6: Altered Member	Defeciency Scope (Original or Additional)	Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage	Maximum Usage of Deficient Member (%)	Controlling Mode of Deficient Member	Deficient Member KL/R	Deficiency Simulation Mode: M1: set to T-only (C=0%) M2: remove member	Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage	Maximum Usage of Deficient Member (%)	Additional Remarks (notes, assumptions, discrepancies)
		ID #	Leg	Side												
170	BB_+5+5+5+5	253	3	right	D1	Original	77.0	103P	36.2	Comp	160.8	M1	79.4	103P	19.5	
		252	1	left	D1	Original						M1				
		253	4	right	D1	Original						M1				
		252	4	left	D1	Original						M1				
172	BB_-5-5-5-5	237	3	right	D1	Additional	71.9	103Y	28.1	Comp	161.4	M1	72.9	103Y	20.2	
		237	4	right	D1	Additional						M1				
		236	1	left	D1	Additional						M1				
		236	3	right	D1	Additional						M1				Repeated *
		75	4	center	D1	Original			2.8	Comp	170.7	M1			6.7	
173	BB_+0+0+0+0	228	2	right	D1	Additional	69.3	103P	31.2	Comp	175.0	M1	70.6	103P	24.2	
		227	4	left	D1	Additional						M1				
		228	3	right	D1	Additional						M1				
		230	2	left	D4	Original			3.3	Comp	230.9	M2 (To check whether it is safe to remove & intall again			N/A	
		230	2	right	D4	Original										
174	BB_+10+10+10+10	277	3	left	D1	Original	71.6	103P	35.4	Comp	128.5	M1	97.9	26-L2X	42.8	Leg 3 -left side considered
		278	1	right	D1	Original						M1				
		277	4	left	D1	Original						M1				
		278	2	right	D1	Original						M1				
		278	3	right	D1	Original						M1				
175	BB_-5-5-5-5	237	4	right	D3	Original	63.1	103P	24.8	Comp	161.4	M2	65.6	103X	N/A	Connected redundants are also removed *
		236	1	left	D1	Original						M1			9.2	
		23	4	left	D1	Additional			15.9	Comp	140.3	M1			11.4	
		75	4	center	D1	Original			2.6	Comp	170.7	M1			7.0	
177	BB_-5-5-5-5	233	4	left	D1	Original	61.6	103P	0.2	Tens	172.2	M1	61.8	103P	0.5	
		233	4	left	D1	Original						M1				Repeated *
		234	2	right	D1	Original						M1				
		237	2	right	D1	Original			23.6	Comp	161.4	M1			11.8	
		236	2	left	D1	Original						M1				
		75	2	center	D1	Original			2.5	Comp	170.7	M1			0.7	Repeated *
		75	2	center	D1	Original						M1				
		75	4	center	D1	Original						M1				
		75	3	center	D1	Original						M1				
		74	2	left	D1	Original			3.5	Comp	223.0	M1			0.7	
		28	2	left	D5	Additional			1.6	Comp	191.6	M2			N/A	Not connected (Missing bolt) *
178	BB_+10+10+10+10	277	1	left	D1	Original	78.3	103Y	38.3	Comp	128.5	M1	105.8	26-L2P	46.1	
		278	4	right	D1	Original						M1				
		277	4	left	D1	Original						M1				Member avialble, but bent *
		278	1	right	D1	Original						M1				
		277	1	left	D1	Original						M1				Repeated *
		278	3	right	D1	Original						M1				
		278	2	right	D1	Original						M1				
		277	2	left	D1	Original						M1				
179	BB_+0+0+0+0	226	2	center	D1	Original	67.9	103P	54.0	Comp	112.6	Override compression capacity to 50%	110.0	g141P (226)	110.0	
		227	3	left	D1	Original			30.8	Comp	175.0	M1			16.3	
		227	2	right	D1	Original						M1				
		228	1	left	D1	Original						M1				
		75	2	center	D1	Original			3.4	Comp	170.7	M1			1.4	
		75	3	left	D1	Original						M1				
		75	4	center	D1	Original						M1				

L24	General Details						Analysis Results (before deficiency simulation)					Analysis Results (after deficiency simulation)				
Str. #	Tower Type & Extension	Deficient Member			Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed Incorrectly D5: Missing Bolts D6: Altered Member	Defeciency Scope (Original or Additional)	Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage	Maximum Usage of Deficient Member (%)	Controlling Mode of Deficient Member	Deficient Member KL/R	Deficiency Simulation Mode: M1: set to T-only (C=0%) M2: remove member	Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage	Maximum Usage of Deficient Member (%)	Additional Remarks (notes, assumptions, discrepancies)
		ID #	Leg	Side												
180	BB_-5-5-5-5	234	2	right	D1	Original	72.3	103Y	0.2	Tens	172.2	M2	73.4	103Y	N/A	
		233	2	left	D1	Original						M1			0.2	
		237	2	right	D2	Original			28.7	Comp	161.4	M2			N/A	Connected redundants are also removed *
		236	3	left	D2	Original						M2			N/A	Connected redundants are also removed *
		236	3	right	D2	Original						M2			N/A	Connected redundants are also removed *
		236	1	left	D2	Original						M2			N/A	Connected redundants are also removed *
		237	1	right	D2	Original						M2			N/A	Connected redundants are also removed *
		236	4	left	D2	Original						M2			N/A	Connected redundants are also removed *
		237	4	right	D2	Original						M2			N/A	Connected redundants are also removed *
181	BB_+5+5+5+5	26	1	left	D1	Original	69.7	103Y	32.6	Comp	115.6	M1	69.7	103Y	26.5	
188	BB_-5-5-5-5	75	1	center	D1	Original	53.5	103P	2.0	Comp	170.7	M1	53.5	103P	0.4	
		75	4	center	D1	Original						M1				
189	BB_-5-5-5-5	237	1	right	D1	Original	70.2	103P	26.1	Comp	161.4	M1	71.2	103P	26.1	
		236	4	left	D1	Original						M1				
		236	3	left	D1	Original						M1				
		237	3	right	D1	Original						M1				
		236	1	left	D1	Original						M1				
		75	2	center	D1	Original			2.7	Comp	170.7	M1			1.6	
		75	4	center	D2	Original						M2			N/A	
190	BB_+0+0+0+0	228	1	right	D1	Original	64.9	103P	30.3	Comp	175.0	M1	64.5	103P	39.2	
		227	2	left	D1	Original						M1				
		227	3	left	D1	Original						M1				
		228	3	right	D1	Original						M1				
		228	2	right	D1	Original						M1				
		227	1	left	D1	Original						M1				
191	BB_-5-5-5-5	236	2	left	D1	Additional	57.8	103Y	23.2	Comp	161.4	M1	58.5	103Y	17.4	
		237	1	right	D1	Additional						M1				
		237	3	right	D1	Additional						M1				
196	BB_-5-5-5-5	237	4	right	D1	Original	66.7	103P	25.7	Comp	161.4	M1	66.7	103P	11.3	
		74	3	left	D1	Original			3.6	Comp	223.0	M1			0.9	
197	BB_-5-5-5-5	75	2	center	D1	Original	73.9	103Y	3.0	Comp	170.7	M1	75.2	103Y	0.8	
		75	4	center	D1	Original						M1				
		75	4	center	D1	Original						M1				
		237/238	all	both	D1	Original						M1			31.4	
213	BB_-5-5-5-5	75	3	center	D1	Original	53.1	103X	2.5	Comp	170.7	M1	53.1	103X	12.5	
		75	2	center	D1	Original						M1				
		236	2	left	D1	Additional			22.9	Comp	161.4	M1			0.7	
221	BB_-5-5-5-5	75	4	center	D3	Additional	81.5	103P	3.2	Comp	170.7	M2	81.5	103X	N/A	
		75	1	center	D3	Additional						M2				
		75	3	center	D3	Additional						M2				
		75	2	center	D3	Additional						M2				
		233	3	right	D1	Original			0.2	Tens	172.2	M1			0.2	
224	BB_-5-5-5-5	237	2	left	D1	Original	64.2	103P	26.1	Comp	170.7	M1	64.2	103P	14.6	
		236	2	right	D1	Original						M1				
234	BB_-5-5-5-5	75	3	center	D1	Original	69.6	103Y	2.9	Comp	170.7	M1	69.6	103Y	2.6	
		75	4	center	D1	Original						M1				
		75	2	center	D1	Original						M1				
239	BB_-5-5-5-5	75	2	center	D1	Original	63.3	103P	2.6	Comp	170.7	M1	63.3	103P	1.5	Repeated *
		75	2	center	D1	Original						M1				
		75	1	center	D1	Original						M1				
		75	4	center	D1	Original						M1				

L24	General Details						Analysis Results (before deficiency simulation)					Analysis Results (after deficiency simulation)				
Str. #	Tower Type & Extension	Deficient Member			Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed Incorrectly D5: Missing Bolts D6: Altered Member	Defeciency Scope (Original or Additional)	Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage	Maximum Usage of Deficient Member (%)	Controlling Mode of Deficient Member	Deficient Member KL/R	Deficiency Simulation Mode: M1: set to T-only (C=0%) M2: remove member	Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage	Maximum Usage of Deficient Member (%)	Additional Remarks (notes, assumptions, discrepancies)
		ID #	Leg	Side												
245	BB_+0+0+0+0	228	4	right	D1	Original	71.9	103P	32.5	Comp	175.0	M1	71.5	103P	16.9	
		227	3	left	D1	Original						M1				
		227	1	left	D1	Original						M1				
249	BB_-5-5-5-5	75	1	center	D1	Original	60.6	103P	2.4	Comp	170.7	M1	60.5	103P	0.7	
		75	3	center	D1	Original						M1				
		75	4	center	D1	Original						M1				
		236	1	right	D1	Original			23.1	Comp	161.4	M1			11.0	Repeated *
		237	1	left	D1	Original						M1				Repeated *
		236	1	right	D1	Original						M1				
		237	1	left	D1	Original						M1				
		234	4	left	D1	Additional			0.2	Comp	172.2	M1			0.2	
		233	4	right	D1	Additional						M1				
253	BB_-5-5-5-5	75	1	center	D1	Original	78.2	103Y	3.0	Comp	170.7	M1	78.3	103Y	0.7	
		75	3	center	D1	Original						M1				
		75	4	center	D1	Original						M1				
254	BB_+5+5+5+5	252	3	left	D1	Original	67.2	103Y	32.3	Comp	160.8	M1	67.3	26-L2P	20.5	
		253	2	right	D1	Original						M1				
		252	1	left	D1	Original						M1				
		253	1	right	D1	Original						M1				
256	BB_-5-5-5-5	237	3	right	D1	Original	60.8	103Y	24.5	Comp	161.4	M1	61.7	103Y	27.2	
		236	3	left	D1	Original						M1				
		237	4	right	D1	Original						M1				
		236	4	left	D1	Original						M1				
		237	2	right	D1	Original						M1				
		236	2	left	D1	Original						M1				
		236	1	left	D1	Original						M1				
		237	1	right	D1	Original						M1				
262	BB_-5-5-5-5	75	3	center	D1	Original	60.2	103Y	2.5	Comp	170.7	M2	60.2	103Y	N/A	
		75	2	center	D1	Original						M2				
		75	1	center	D1	Original						M2				
		75	4	center	D1	Original						M2				
270	BB_-5-5-5-5	75	2	center	D1	Original	68.8	103P	2.6	Comp	170.7	M2	210.8	LY_235	N/A	
		233	4	left	D1	Original			0.2	Tens	172.2	M1			0.2	
		234	4	right	D1	Original						M1				overfilled up to about half of the height of -5' panel *
		235	3	center	D1	Additional			55.0	Comp	112.6	Override compression capacity to 25%			211.2	
		237	1	right	D1	Additional			25.4	Comp	161.4	M1			13.8	
273	BB_-5-5-5-5	233	4	left	D1	Original	74.4	103Y	0.2	Tens	172.2	M1	74.4	103Y	11.3	
		237	2	right	D2	Original			27.3	Comp	161.4	M2			N/A	Connected redundants are also removed *
280	BB_-5-5-5-5	74	1	left	D1	Original	67.3	103P	3.5	Comp	223.0	M1	68.5	103P	0.3	
		75	4	center	D3	Additional			2.6	Comp	170.7	M2			N/A	
		75	3	center	D3	Additional						M2				
		75	2	center	D3	Additional						M2				
		75	1	center	D3	Additional						M2				
		233	1	left	D1	Original			0.2	Tens	172.2	M1			0.2	
		236	1	left	D1	Original			26.2	Comp	161.4	M1			25.4	
		236	4	left	D1	Original						M1				
		237	4	right	D1	Original						M1				
		236	3	left	D1	Original						M1				
		237	1	right	D1	Original						M1				

L24	General Details						Analysis Results (before deficiency simulation)					Analysis Results (after deficiency simulation)				
Str. #	Tower Type & Extension	Deficient Member			Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed Incorrectly D5: Missing Bolts D6: Altered Member	Defeciency Scope (Original or Additional)	Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage	Maximum Usage of Deficient Member (%)	Controlling Mode of Deficient Member	Deficient Member KL/R	Deficiency Simulation Mode: M1: set to T-only (C=0%) M2: remove member	Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage	Maximum Usage of Deficient Member (%)	Additional Remarks (notes, assumptions, discrepancies)
		ID #	Leg	Side												
282	BB_-5-5-5-5	75	1	center	D3	Additional	64.7	103Y	2.5	Comp	170.7	M2	66.0	103Y	N/A	
		75	2	center	D3	Additional						M2				
		75	4	center	D3	Additional						M2				
		75	3	center	D3	Additional						M2				
		233	1	left	D1	Original			0.2	Tens	172.2	M1			0.2	
		234	1	right	D1	Original						M1				
		233	2	left	D1	Original						M1				
		234	2	right	D1	Original						M1				
		237	4	right	D1	Original			25.2	Comp	161.4	M1			11.2	
		236	3	left	D1	Original						M1				
		237	3	right	D1	Original						M1				
289	BB_-5-5-5-5	75	2	center	D1	Original	61.9	103P	2.4	Comp	170.7	M1	62.0	103P	1.3	
301	BB_-5-5-5-5	74	1	left	D1	Original	55.3	103Y	3.4	Comp	223.0	M1	55.7	103P	0.8	Considered as leg 4 -right
		74	2	right	D1	Original						M1				Considered as leg 3 -left
		75	4	center	D3	Additional			2.2	Comp	170.7	M2			N/A	
		75	3	center	D3	Additional						M2				
		75	2	center	D3	Additional						M2				
		75	1	center	D3	Additional						M2				
		237	2	right	D1	Additional			20.3	Comp	161.4	M1			7.6	Considered as both referred to same leg; leg 4 -right
		237	4	right	D1	Additional						M1				
308	BB_-5-5-5-5	75	2	center	D1	Original	54.6	103XY	2.6	Comp	170.7	M2	54.5	103XY	N/A	
		75	3	center	D1	Original						M2				
		75	1	center	D1	Original						M2				
		75	3	center	D1	Original										Repeated *
311	BB_-5-5-5-5	74	3	left	D1	Original	62.6	103Y	3.5	Comp	223.0	M1	63.4	103Y	0.7	
		74	2	right	D1	Original						M1				
		74	3	right	D1	Original						M1				Leg 3 - right considered
		234	4	right	D1	Additional			0.2	Tens	172.2	M1			0.2	
		236	2	right	D1	Original			23.8	Comp	161.4	M1			20.7	Repeated *
		237	4	left	D1	Original						M1				Repeated *
		237	2	right	D1	Original						M1				
		236	4	left	D1	Original						M1				
		236	3	right	D1	Original						M1				
		237	3	left	D1	Original						M1				Leg 3 -left considered
		236	2	left	D1	Original						M1				
313	BB_+0+0+0+0	75	1	center	D1	Original	48.5	103P	3.1	Comp	170.7	M1	48.4	103P	1.7	
314	BB_-5-5-5-5	75	3	center	D1	Original	52.1	103X	2.4	Comp	170.7	M1	52.2	103X	0.4	
		75	2	center	D1	Original						M1				
316	BB_+20+20+20+20	52	2	left	D1	Original	54.8	20-3Y	42.2	Comp	151.0	M1	102.2	26-L2Y	20.9	
		52	1	left	D1	Original						M1				
318	BB_+0+0+0+0	227	3	left	D1	Original	66.1	103P	29.3	Comp	175.0	M1	67.2	103P	22.4	
		228	4	right	D1	Original						M1				
		228	3	right	D1	Original						M1				
		227	1	left	D1	Original						M1				
		227	4	left	D1	Original						M1				
322	EE_-5-5-5-5	175	4	center	D1	Original	95.6	76X	16.2	Comp	177.7	M1	97.1	76X	7.3	
327	BB_-5-5-5-5	75	1	center	D1	Original	43.9	103Y	2.3	Comp	170.7	M1	43.9	103Y	0.7	
		75	3	center	D1	Original						M1				
		75	4	center	D1	Original						M1				
		75	2	center	D1	Original						M1				
331	BB_-5-5-5-5	75	2	center	D1	Original	61.0	103P	2.5	Comp	170.7	M1	61.1	103P	1.2	
342	BB_-5-5-5-5	237	4	right	D1	Original	66.0	103P	26.2	Comp	161.4	M1	65.7	103P	12.8	
		236	3	left	D1	Original						M1				
		237	2	right	D1	Original						M1				
		75	2	center	D1	Original			2.7	Comp	170.7	M1			5.1	
345	BB_-5-5-5-5	74	4	right	D1	Original	73.2	103P	3.5	Comp	223.0	M1	73.2	103P	1.0	

L24	General Details						Analysis Results (before deficiency simulation)					Analysis Results (after deficiency simulation)				
Str. #	Tower Type & Extension	Deficient Member ID #	Leg	Side	Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed Incorrectly D5: Missing Bolts D6: Altered Member	Defeciency Scope (Original or Additional)	Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage	Maximum Usage of Deficient Member (%)	Controlling Mode of Deficient Member	Deficient Member KL/R	Deficiency Simulation Mode: M1: set to T-only (C=0%) M2: remove member	Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage	Maximum Usage of Deficient Member (%)	Additional Remarks (notes, assumptions, discrepancies)
348	BB_+5+5+5+5	253	1	right	D1	Original	71.0	103Y	34.7	Comp	160.8	M1	84.9	26-L2P	20.9	
		252	3	left	D1	Original						M1				
		253	3	right	D1	Original						M1				
		252	2	left	D1	Original						M1				
		253	2	right	D1	Original						M1				
361	BB_+0+0+0+0	228	2	right	D1	Original	72.6	103Y	33.6	Comp	175.0	M1	74.3	103Y	26.8	
		227	4	left	D1	Original						M1				
		228	3	right	D1	Original						M1				
		227	3	left	D1	Original						M1				
		230	2	right	D1	Additional			1.5	Comp	143.3	M1			0.4	
		231	2	left	D1	Additional			3.4	Comp	230.9	M1			1.8	
365	BB_+0+0+0+0	227	4	left	D1	Additional	67.7	103P	30.9	Comp	175.0	M1	71.1	103P	42.0	
		228	1	right	D1	Additional						M1				
		228	3	right	D1	Additional						M1				
		227	3	left	D1	Additional						M1				
		227	2	left	D1	Additional						M1				
		75	2	center	D1	Original			3.4	Comp	170.7	M1			7.7	
366	BB_-5-5-5-5	75	2	center	D1	Original	73.9	103Y	2.9	Comp	170.7	M1	74.0	103P	0.4	
		75	3	center	D1	Original						M1				
369	EE_+5+5+5+5	175	1	center	D1	Original	96.7	LX_222-L2P	24.4	Comp	177.7	M1	102.9	LX_222-L2P	12.6	
397	BB_+5+5+5+5	252	4	left	D1	Original	67.7	103X	34.7	Comp	160.8	M1	80.9	20-L2XY	28.1	
		253	4	right	D1	Original						M1				
		252	2	left	D1	Original						M1				
		253	1	right	D1	Original						M1				
		253	3	right	D1	Original						M1				
		252	1	left	D1	Original						M1				
		252	3	left	D1	Original						M1				
400	BB_+0+0+0+0	228	3	left	D1	Original	74.4	103Y	35.1	Comp	175.0	M1	76.1	103Y	42.5	
		227	3	right	D1	Original						M1				
		228	2	left	D1	Original						M1				
		227	2	right	D1	Original						M1				
		228	1	left	D1	Original						M1				
		227	1	right	D1	Original						M1				
		227	4	right	D1	Original						M1				
434	BB_+0+0+0+0	228	4	right	D1	Original	68.7	103Y	30.9	Comp	175.0	M1	68.9	103P	42.2	
		227	2	left	D1	Original						M1				
		228	2	right	D1	Original						M1				
		227	1	left	D1	Original						M1				
		228	1	right	D1	Original						M1				
		227	4	left	D1	Original						M1				
440	BB_+0+0+0+0	226	1	center	D1	Original	54.4	103P	2.9	Comp	230.9	Override compression capacity to 50%	95.8	g135P	95.8	
		232	3	right	D1	Original			2.9	Comp	230.9	M1			0.7	
		228	4	right	D1	Original			24.7	Comp	175.0	M1			8.5	
		75	2	center	D1	Original			2.7	Comp	170.7	M1			1.2	
442	BB_+10+10+10+10	277	3	left	D1	Original	63.5	103P	32.4	Comp	128.5	M1	63.4	103X	11.5	
444	BB_+0+0+0+0	227	2	right	D1	Original	77.7	103P	35.2	Comp	175.0	M1	77.7	103P	16.2	
445	BB_+0+0+0+0	74	4	left	D1	Original	67.6	103Y	4.3	Comp	223.0	M1	67.6	103Y	0.8	Leg 4 -left considered

L24	General Details						Analysis Results (before deficiency simulation)					Analysis Results (after deficiency simulation)				
Str. #	Tower Type & Extension	Deficient Member ID #	Leg	Side	Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed Incorrectly D5: Missing Bolts D6: Altered Member	Defeciency Scope (Original or Additional)	Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage	Maximum Usage of Deficient Member (%)	Controlling Mode of Deficient Member	Deficient Member KL/R	Deficiency Simulation Mode: M1: set to T-only (C=0%) M2: remove member	Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage	Maximum Usage of Deficient Member (%)	Additional Remarks (notes, assumptions, discrepancies)
448	BB_-5-5-5-5	23	3	left	D1	Additional	65.5	103Y	16.6	Comp	140.3	M1	65.5	103Y	10.1	
		233	1	left	D1	Original			0.2	Tens	172.2	M1			0.1	
		74	1	left	D1	Original			3.5	Comp	223.0	M1			0.8	
		74	4	left	D2	Additional						M2			N/A	
		74	2	right	D2	Additional						M2			N/A	
		75	2	center	D3	Additional			2.7	Comp	170.7	M2			N/A	
		75	3	center	D3	Additional						M2				
		75	4	center	D3	Additional						M2				
		75	1	center	D3	Additional						M2				
456	BB_-5-5-5-5	75	1	center	D1	Original	65.4	103P	2.7	Comp	170.7	M1	65.5	103P	0.7	
		75	3	center	D1	Original						M1				
		75	4	center	D1	Original						M1				
		75	2	center	D1	Original						M1				
464	BB_-5-5-5-5	75	2	center	D1	Original	71.9	103P	3.0	Comp	170.7	M1	73.6	103P	2.4	
		75	4	center	D1	Original						M1				
		236	all	all	D1	Original			30.1	Comp	161.4	M1			32.5	
466	BB_-5-5-5-5	75	2	center	D1	Original	53.3	103Y	2.3	Comp	170.7	M1	53.3	103Y	1.2	
468	BB_-5-5-5-5	75	4	center	D1	Original	73.9	103XY	3.3	Comp	170.7	M1	73.9	103XY	0.8	
471	BB_-5-5-5-5	75	3	center	D1	Original	59.4	103P	2.2	Comp	170.7	M1	59.4	103P	0.6	
472	BB_-5-5-5-5	75	1	center	D3	Additional	56.7	103P	2.3	Comp	170.7	M2	93.2	LXY_235P	N/A	
		75	2	center	D3	Additional						M2				
		75	3	center	D3	Additional						M2				
		75	4	center	D3	Additional						M2				
		235	2	center	D1	Original			45.9	Comp	112.6	Override compression capacity to 50%			93.2	
473	BB_-5-5-5-5	75	2	center	D1	Original	48.8	103Y	1.9	Comp	170.7	M1	48.8	103Y	0.7	
		75	3	center	D1	Original						M1				
		75	4	center	D1	Original						M1				
482	HH_-5-5-5-5	62	1	center	D1	Original	94.1	232-2P	43.1	Comp	362.9	M1	94.1	232-2P	5.4	
484	BB_+5+5+5+5	253	3	right	D1	Original	50.7	103Y	25.4	Comp	160.8	M1	51.7	103Y	9.4	
489	BB_+5+5+5+5	252	3	left	D1	Original	65.3	103Y	27.8	Comp	160.8	M1	67.4	103Y	22.2	
		253	4	right	D1	Original						M1				
		252	4	left	D1	Original						M1				
		253	3	right	D1	Original						M1				
		253	2	right	D1	Original						M1				
		252	2	left	D1	Original						M1				
490	HH_-5-5-5-5	24	4	right	D1	Original	98.2	232-2P	14.4	Comp	214.5	M1	98.2	232-2P	4.1	
		24	1	left	D1	Original						M1				
		22	2	left	D1	Original			1.2	Comp	179.6	M1			0.8	
		23	3	right	D1	Original						M1				
491	BB_+0+0+0+0	227	3	left	D1	Original	63.6	103P	27.5	Comp	175.0	M1	97.8	g139P	9.6	
		226	3	center	D1	Original			48.9	Comp	112.6	Override compression capacity to 50%			97.8	
492	BB_+0+0+0+0	227	3	left	D1	Additional	68.4	103P	30.7	Comp	175.0	M1	68.1	103P	20.6	
		228	1	right	D1	Additional						M1				
		227	2	left	D1	Additional						M1				
		227	1	left	D1	Additional						M1				
495	BB_-5-5-5-5	75	4	center	D1	Original	68.9	103Y	2.8	Comp	170.7	M1	68.9	103Y	1.6	
		75	1	center	D1	Original						M1				
		75	2	center	D1	Original						M1				
496	BB_-5-5-5-5	237	1	right	D1	Original	63.7	103Y	25.5	Comp	161.4	M1	63.7	103Y	10.9	Leg 01 - right considered
		236	2	left	D1	Original						M1				
497	BB_+0+0+0+0	230	4	right	D1	Original	60.8	103P	1.3	Comp	230.9	M1	60.8	103P	0.6	
498	BB_+5+5+5+5	253	2	right	D1	Original	68.3	103P	32.5	Comp	160.8	M1	68.2	103P	7.7	
		252	1	left	D1	Original						M1				

L24	General Details						Analysis Results (before deficiency simulation)					Analysis Results (after deficiency simulation)				
Str. #	Tower Type & Extension	Deficient Member ID #	Leg	Side	Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed Incorrectly D5: Missing Bolts D6: Altered Member	Defeciency Scope (Original or Additional)	Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage	Maximum Usage of Deficient Member (%)	Controlling Mode of Deficient Member	Deficient Member KL/R	Deficiency Simulation Mode: M1: set to T-only (C=0%) M2: remove member	Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage	Maximum Usage of Deficient Member (%)	Additional Remarks (notes, assumptions, discrepancies)
499	BB_-5-5-5-5	236	2	left	D1	Original	61.4	103Y	24.0	Comp	161.4	M1	60.3	103P	13.4	Leg 4 - right considered
		237	2	right	D1	Original						M1				Leg 4 - left considered
		75	1	center	D3	Additional			2.4	Comp	170.7	M2			N/A	
		75	4	center	D3	Additional						M2				
		75	3	center	D3	Additional						M2				
		75	2	center	D3	Additional						M2				
500	BB_-5-5-5-5	234	1	right	D6	Original	60.3	103P	0.2	Tens	172.2	M2 (To check whether it is safe to remove & intall the correct member)	60.3	103P	0.2	
502	BB_+10+10+10+10	277	2	left	D1	Original	55.6	103Y	28.4	Comp	128.5	M1	57.1	LXY_276_4P (276)	22.1	
		278	1	left	D1	Original						M1				
		278	3	right	D1	Original						M1				
503	HH_-5-5-5-5	62	3	center	D1	Original	98.1	232-2XY	46.9	Comp	362.9	M1	174.8	62XY_P	21.5	
		24	1	left	D1	Original			11.8	Comp	214.5	M1			4.0	
		23	4	right	D2	Original			1.3	Comp	179.6	M2			N/A	
		20	4	left	D1	Original			62.9	Comp	134.5	M1			46.4	
505	BB_-5-5-5-5	75	4	center	D3	Original	56.2	103X	2.4	Comp	170.7	M2	56.2	103X	N/A	
		75	1	center	D3	Original						M2				
		75	3	center	D3	Original						M2				
		75	2	center	D3	Original						M2				
519	BB_-5-5-5-5	235	1	center	D1	Original	67.4	103P	52.9	Comp	112.6	M1	86.3	LXY_235P (235)	23.1	This leg member is heavily bent. Assumed 0% compression capacity *
		236	1	left	D1	Original			26.1	Comp	161.4	M1			36.8	Leg 1 - left is considered
		236	3	left	D1	Original						M1				
		236	1	right	D1	Original						M1				
		236	3	right	D1	Original						M1				
		237	3	left	D1	Original						M1				
521	BB_+5+5+5+5	253	1	right	D1	Original	73.5	103Y	35.8	Comp	160.8	M1	73.5	103Y	16.7	
		252	1	left	D1	Original						M1				
532	BB_-5-5-5-5	75	2	center	D1	Original	64.1	103P	2.6	Comp	170.7	M1	64.4	103Y	0.8	
		75	1	center	D1	Original						M1				
		75	4	center	D1	Original						M1				
		75	3	center	D1	Original						M1				
		236	1	right	D1	Original			24.7	Comp	161.4	M1			13.1	
		236	3	left	D1	Original						M1				
536	BB_-5-5-5-5	75	3	center	D1	Original	60.8	103P	2.5	Comp	170.7	M1	60.9	103P	0.9	
		75	1	center	D1	Original						M1				
		75	4	center	D1	Original						M1				
		75	2	center	D1	Original						M1				
		236	2	left	D1	Original			23.8	Comp	161.4	M1			12.5	Leg 2 -left considered
		237	2	right	D1	Original						M1				Leg 2 - right considered
539	BB_5+5+5+5	No supporting evidence of deficiency found.														
542	BB_-5-5-5-5	75	2	center	D1	Original	72.2	103P	2.9	Comp	170.7	M1	72.2	103P	0.7	
		75	1	center	D1	Original						M1				
		75	4	center	D1	Original						M1				
		75	3	center	D1	Original						M1				
543	BB_+10+10+10+10	277	4	left	D1	Original	69.2	103Y	33.3	Comp	128.5	M1	69.1	103Y	14.8	Leg 4 - left considered
		277	1	right	D1	Original						M1				
546	BB_+0+0+0+0	75	3	center	D1	Original	58.6	103Y	3.0	Comp	170.7	M1	158.9	g141P (226)	1.1	Leg 3 - center considered
		226	2	center	D1	Original			46.3	Comp	175.0	Override compression capacity to 50%			109.5	
		227	2	left	D2	Original			27.0	Comp	175.0	M2			15.5	Leg 1 - right considered
		227	1	right	D1	Original						M1				
		228	2	right	D1	Original						M1				
		227	1	left	D1	Original						M1				
555	BB_-5-5-5-5	75	1	left	D1	Original	65.8	103Y	2.6	Comp	170.7	M1	65.9	103Y	1.5	
		75	2	left	D1	Original						M1				
561	BB_-5-5-5-5	21	1	center	D1	Original	46.7	103P	38.5	Comp	112.6	Override compression capacity to 30%	82.9	4-1P (21)	82.9	
568	H_+0+0+0+0	54	2	center	D1	Original	179.4	198XY	62.7	Comp	364.9	M1	211.5	54Y_P	27.8	
		16	3	left	D1	Additional			73.1	Comp	132.5	M1			24.7	

Appendix C – Remedy/Repair Priorities

L23	Tower Type & Extension	Maximum Tower Structure Usage (%)		Maximum Tower Structure Usage Jump (%)	Maximum Combined Axial + Bending Member Usage (%)		Maximum Combined Axial + Bending Member Usage Jump (%)	Jump Index: J0: no increase J1: 0-5% increase J2: 5-10% increase J3: 10-15% increase J4: 15-20% increase J5: >20% increase	Priority Index: P1: max usage > 100% P2: max usage 95-100%, or J5 P3: max usage 90-95%, or J4 P4: J3 P5: J2 P6: J1 P7: J0
Str. #		(pre-deficiency)	(post-deficiency)		(pre-deficiency)	(post-deficiency)			
10	S_+0+0+0+0	77.5	82.4	5.0		72.2		J1	P6
16	S_+0+0+0+0	81.8	66.6		94.2	94.2	0.0	J0	P7
19	S_+5+5+5+5	92.7	105.2	12.5	83.0	83.0	0.0	J3	P1
107	S_-5-5-5-5	85.4	86.8	1.5		66.9		J1	P6
139	S_+5+5+5+5	87.6	119.0	31.4	72.3	72.3	0.0	J5	P1
145	S_+0+0+0+0	75.9	86.4	10.5		69.1		J3	P4
152	S_-5-5-5-5	89.5	88.7			71.9		J0	P7
153	S_-5-5-5-5	85.6	88.9	3.3		66.1		J1	P6
167	S_+0+0+0+0	76.2	85.4	9.2		67.5		J2	P5
170	S_+0+0+0+0	85.2	85.2	0.0		83.5		J1	P6
178	S_+5+5+5+5	95.5	97.7	2.2		80.8		J1	P2
179	S_+0+0+0+0	80.9	92.1	11.3		78.1		J3	P2
189	S_-5-5-5-5	93.0	99.5	6.5		73.2		J2	P1
190	S_-5-5-5-5	83.5	85.5	2.0		65.1		J1	P6
196	S_-5-5-5-5	No supporting evidence of deficiency found.							
205	S_+0+0+0+0	72.2	79.4	7.1		62.6		J2	P5
206	S_+5+5+5+5	87.3	94.4	7.1		75.9		J2	P2
222	S_+0+0+0+0	85.4	95.5	10.1	85.3	85.3	0.0	J3	P2
262	S_+10+10+10+10	64.3	61.2			63.0		J0	P7
263	S_+5+5+5+5	88.6	102.0	13.4		71.6		J3	P1
269	S_-5-5-5-5	95.1	94.4			76.0		J0	P7
272	S_-5-5-5-5	93.0	100.0	7.0		79.8		J2	P1
274	S_-5-5-5-5	78.2	82.1	3.9		59.2		J1	P6
278	T_+0+0+0+0 (2 guys)	145.5	145.5	0.0	69.5	69.5	0.0	J1	P1
	T_+0+0+0+0 (1 guy)	145.5	145.5	0.0	71.2	71.2	0.0		
	T_+0+0+0+0 (0 guys)	145.4	145.4	0.0	71.7	71.7	0.0		
279	S_-5-5-5-5	68.5	72.8	4.3		41.1		J1	P6
282	S_+0+0+0+0	78.3	51.2			70.3		J0	P7
286	S_-5-5-5-5	79.6	85.8	6.2		59.6		J2	P5
287	S_-5-5-5-5	89.2	97.9	8.7		81.4		J2	P2
455	S_+0+0+0+0	77.3	76.4			68.5		J0	P7
466	S_+0+0+0+0	79.1	69.4			82.7		J0	P7
470	S_+0+0+0+0	79.5	81.7	2.2	88.4	88.4	0.0	J1	P6
488	T_+0+0+0+0	123.8	127.7	4.0	65.6	66.2	0.6	J1	P1
491	S_+0+0+0+0	71.8	71.7			59.9		J0	P7
492	C_+0+0+0+0	93.4	192.0	98.5	48.1	0.0	-48.1	J5	P1
500	S_+0+0+0+0	76.3	75.4			75.0		J0	P7
502	S_+0+0+0+0	72.1	74.3	2.1		59.6		J1	P6
507	S_-5-5-5-5	82.4	83.5	1.1		60.1		J1	P6
521	S_-5-5-5-5	93.2	70.6			77.7		J0	P7
530	S_-5-5-5-5	78.9	62.4			57.4		J0	P7
532	S_-5-5-5-5	No supporting evidence of deficiency found.							

L23	Tower Type & Extension	Maximum Tower Structure Usage (%)		Maximum Tower Structure Usage Jump (%)	Maximum Combined Axial + Bending Member Usage (%)		Maximum Combined Axial + Bending Member Usage Jump (%)	Jump Index: J0: no increase J1: 0-5% increase J2: 5-10% increase J3: 10-15% increase J4: 15-20% increase J5: >20% increase	Priority Index: P1: max usage > 100% P2: max usage 95-100%, or J5 P3: max usage 90-95%, or J4 P4: J3 P5: J2 P6: J1 P7: J0
Str. #		(pre-deficiency)	(post-deficiency)		(pre-deficiency)	(post-deficiency)			
534	S_-5-5-5-5	89.0	94.3	5.3		67.6		J2	P2
538	S_+0+0+0+0	75.3	85.6	10.3		66.5		J3	P4
556	S_-5-5-5-5	77.5	79.9	2.4		53.7		J1	P6
563	S_-5-5-5-5	91.2	95.7	4.5		65.5		J1	P2
567	S_-5-5-5-5	69.1	72.6	3.5		41.7		J1	P6

L24	Tower Type & Extension	Maximum Tower Structure Usage (%)		Maximum Tower Structure Usage Jump (%)	Maximum Combined Axial + Bending Member Usage (%)		Maximum Combined Axial + Bending Member Usage Jump (%)	Jump Index: J0: no increase J1: 0-5% increase J2: 5-10% increase J3: 10-15% increase J4: 15-20% increase J5: >20% increase	Priority Index: P1: max usage > 100% P2: max usage 95-100%, or J5 P3: max usage 90-95%, or J4 P4: J3 P5: J2 P6: J1 P7: J0
Str. #		(pre-deficiency)	(post-deficiency)		(pre-deficiency)	(post-deficiency)			
5	B_+5+5+5+5	76.3	76.2		162.0	162.0	0.0	J1	P1
9	BB_+0+0+0+0	63.6	96.0	32.5		75.1		J5	P2
11	BB_+5+5+5+5	64.2	64.9	0.7		82.5		J1	P6
13	BB_+0+0+0+0	53.7	53.6			66.1		J0	P7
16	BB_+5+5+5+5	74.1	143.3	69.2	106.2	105.8	-0.4	J5	P1
17	BB_+5+5+5+5	70.3	82.1	11.8	94.8	94.9	0.1	J3	P3
18	BB_+5+5+5+5	75.2	87.7	12.4	110.9	110.9	0.0	J3	P1
19	BB_+5+5+5+5	71.7	81.2	9.5	99.1	98.9	-0.2	J2	P1
20	BB_+0+0+0+0	71.8	71.7		97.8	97.8	0.0	J1	P2
21	BB_-5-5-5-5	74.3	73.9		105.1	105.2	0.1	J1	P1
23	BB_+0+0+0+0	63.0	63.0	0.0		88.4		J1	P6
31	BB_+0+0+0+0	65.7	66.7	1.0		92.4		J1	P3
37	BB_-5-5-5-5	61.6	61.6	0.0		78.3		J1	P6
49	BB_+0+0+0+0	71.4	71.4	0.0	100.9	100.9	0.0	J1	P1
58	BB_-5-5-5-5	61.7	63.4	1.6		80.8		J1	P6
61	BB_-5-5-5-5	61.2	61.2	0.0		77.6		J1	P6
72	BB_-5-5-5-5	64.1	64.1	0.0		85.1		J1	P6
89	BB_+0+0+0+0	65.6	65.6			86.3		J0	P7
91	BB_-5-5-5-5	66.3	67.2	0.9		91.4		J1	P3
92	BB_-5-5-5-5	62.6	62.5			85.6		J0	P7
108	BB_+0+0+0+0	60.2	60.1			63.7		J0	P7
111	EE_-5-5-5-5	95.0	97.9	2.9	118.6	170.1	51.5	J5	P1
119	BB_-5-5-5-5	56.1	56.1	0.0		57.8		J1	P6
142	BB_+10+10+10+10	69.8	95.4	25.6	92.2	128.2	36.0	J5	P1
143	BB_+10+10+10+10	62.7	63.1	0.3		88.9		J1	P6
145	BB_+0+0+0+0	64.5	64.5	0.0		89.6		J1	P6
146	BB_+5+5+5+5	47.5	47.9	0.4		58.4		J1	P6
148	BB_+5+5+5+5	75.0	86.1	11.1	106.9	106.5	-0.4	J3	P1
150	BB_+10+10+10+10	63.5	63.2			90.4		J0	P3
153	BB_+5+5+5+5	61.9	61.8			82.5		J0	P7
155	BB_+0+0+0+0	66.8	64.5		105.7	105.8	0.1	J1	P1
168	BB_+0+0+0+0	58.0	57.9			73.7		J0	P7
170	BB_+5+5+5+5	77.0	79.4	2.4	108.1	107.6	-0.5	J1	P1
172	BB_-5-5-5-5	71.9	72.9	1.0	99.3	99.2	-0.1	J1	P1
173	BB_+0+0+0+0	69.3	70.6	1.3		93.3		J1	P3
174	BB_+10+10+10+10	71.6	97.9	26.3	98.5	117.1	18.6	J5	P1
175	BB_-5-5-5-5	63.1	65.6	2.6		86.5		J1	P6
177	BB_-5-5-5-5	61.6	61.8	0.1		82.3		J1	P6
178	BB_+10+10+10+10	78.3	105.8	27.5	119.4	143.0	23.6	J5	P1
179	BB_+0+0+0+0	67.9	110.0	42.1	93.7	93.9	0.2	J5	P1
180	BB_-5-5-5-5	72.3	73.4	1.2	99.4	218.8	119.4	J5	P1
181	BB_+5+5+5+5	69.7	69.7	0.0		94.9		J1	P3

L24	Tower Type & Extension	Maximum Tower Structure Usage (%)		Maximum Tower Structure Usage Jump (%)	Maximum Combined Axial + Bending Member Usage (%)		Maximum Combined Axial + Bending Member Usage Jump (%)	Jump Index: J0: no increase J1: 0-5% increase J2: 5-10% increase J3: 10-15% increase J4: 15-20% increase J5: >20% increase	Priority Index: P1: max usage > 100% P2: max usage 95-100%, or J5 P3: max usage 90-95%, or J4 P4: J3 P5: J2 P6: J1 P7: J0
Str. #		(pre-deficiency)	(post-deficiency)		(pre-deficiency)	(post-deficiency)			
188	BB_-5-5-5-5	53.5	53.5			56.5		J0	P7
189	BB_-5-5-5-5	70.2	71.2	1.1		84.9		J1	P6
190	BB_+0+0+0+0	64.9	64.5			90.9		J0	P3
191	BB_-5-5-5-5	57.8	58.5	0.8		76.4		J1	P6
196	BB_-5-5-5-5	66.7	66.7	0.0		86.9		J1	P6
197	BB_-5-5-5-5	73.9	75.2	1.3	100.2	108.0	7.8	J2	P1
213	BB_-5-5-5-5	53.1	53.1			77.8		J0	P7
221	BB_-5-5-5-5	81.5	81.5	0.0	118.1	118.1	0.0	J1	P1
224	BB_-5-5-5-5	64.2	64.2	0.0		92.4		J1	P3
234	BB_-5-5-5-5	69.6	69.6	0.0		97.6		J1	P2
239	BB_-5-5-5-5	63.3	63.3	0.0		85.6		J1	P6
245	BB_+0+0+0+0	71.9	71.5		98.7	98.7	0.0	J1	P2
249	BB_-5-5-5-5	60.6	60.5			74.4		J0	P7
253	BB_-5-5-5-5	78.2	78.3	0.1	107.1	107.1	0.0	J1	P1
254	BB_+5+5+5+5	67.2	67.3	0.1		87.8		J1	P6
256	BB_-5-5-5-5	60.8	61.7	0.9		85.7		J1	P6
262	BB_-5-5-5-5	60.2	60.2	0.0		72.3		J1	P6
270	BB_-5-5-5-5	68.8	210.8	142.0	86.4	86.4	0.0	J5	P1
273	BB_-5-5-5-5	74.4	74.4			90.6		J0	P3
280	BB_-5-5-5-5	67.3	68.5	1.2		90.0		J1	P6
282	BB_-5-5-5-5	64.7	66.0	1.3		87.3		J1	P6
289	BB_-5-5-5-5	61.9	62.0	0.1		75.9		J1	P6
301	BB_-5-5-5-5	55.3	55.7	0.4		57.9		J1	P6
308	BB_-5-5-5-5	54.6	54.5			78.7		J0	P7
311	BB_-5-5-5-5	62.6	63.4	0.8		77.0		J1	P6
313	BB_+0+0+0+0	48.5	48.4			59.3		J0	P7
314	BB_-5-5-5-5	52.1	52.2	0.0		66.7		J1	P6
316	BB_+20+20+20+20	54.8	102.2	47.5	132.2	135.1	2.9	J5	P1
318	BB_+0+0+0+0	66.1	67.2	1.1		83.7		J1	P6
322	EE_-5-5-5-5	95.6	97.1	1.5	122.4	180.7	58.3	J5	P1
327	BB_-5-5-5-5	43.9	43.9	0.0		57.9		J1	P6
331	BB_-5-5-5-5	61.0	61.1	0.1		78.7		J1	P6
342	BB_-5-5-5-5	66.0	65.7			87.3		J0	P7
345	BB_-5-5-5-5	73.2	73.2	0.0	95.9	95.9	0.0	J1	P2
348	BB_+5+5+5+5	71.0	84.9	13.8	106.5	106.0	-0.5	J3	P1
361	BB_+0+0+0+0	72.6	74.3	1.6	102.8	102.8	0.0	J1	P1
365	BB_+0+0+0+0	67.7	71.1	3.5		88.6		J1	P6
366	BB_-5-5-5-5	73.9	74.0	0.1	99.8	99.8	0.0	J1	P1
369	EE_+5+5+5+5	96.7	102.9	6.1	108.2	251.1	142.9	J5	P1
397	BB_+5+5+5+5	67.7	80.9	13.2	97.3	97.0	-0.3	J3	P2
400	BB_+0+0+0+0	74.4	76.1	1.7	116.9	116.9	0.0	J1	P1
434	BB_+0+0+0+0	68.7	68.9	0.1		91.3		J1	P3

L24	Tower Type & Extension	Maximum Tower Structure Usage (%)		Maximum Tower Structure Usage Jump (%)	Maximum Combined Axial + Bending Member Usage (%)		Maximum Combined Axial + Bending Member Usage Jump (%)	Jump Index: J0: no increase J1: 0-5% increase J2: 5-10% increase J3: 10-15% increase J4: 15-20% increase J5: >20% increase	Priority Index: P1: max usage > 100% P2: max usage 95-100%, or J5 P3: max usage 90-95%, or J4 P4: J3 P5: J2 P6: J1 P7: J0
Str. #		(pre-deficiency)	(post-deficiency)		(pre-deficiency)	(post-deficiency)			
440	BB_+0+0+0+0	54.4	95.8	41.4		52.4		J5	P2
442	BB_+10+10+10+10	63.5	63.4			89.5		J0	P7
444	BB_+0+0+0+0	77.7	77.7	0.0	109.2	109.2	0.0	J1	P1
445	BB_+0+0+0+0	67.6	67.6	0.0		88.4		J1	P6
448	BB_-5-5-5-5	65.5	65.5	0.0		88.8		J1	P6
456	BB_-5-5-5-5	65.4	65.5	0.0		87.1		J1	P6
464	BB_-5-5-5-5	71.9	73.6	1.8	109.8	109.6	-0.2	J1	P1
466	BB_-5-5-5-5	53.3	53.3			63.7		J0	P7
468	BB_-5-5-5-5	73.9	73.9	0.1	112.0	112.0	0.0	J1	P1
471	BB_-5-5-5-5	59.4	59.4	0.0		71.6		J1	P6
472	BB_-5-5-5-5	56.7	93.2	36.5		63.4		J5	P2
473	BB_-5-5-5-5	48.8	48.8			50.6		J0	P7
482	HH_-5-5-5-5	94.1	94.1		132.1	132.1	0.0	J1	P1
484	BB_+5+5+5+5	50.7	51.7	1.0		58.2		J1	P6
489	BB_+5+5+5+5	65.3	67.4	2.1		71.7		J1	P6
490	HH_-5-5-5-5	98.2	98.2		112.7	112.7	0.0	J1	P1
491	BB_+0+0+0+0	63.6	97.8	34.2		70.4		J5	P2
492	BB_+0+0+0+0	68.4	68.1		99.5	99.5	0.0	J1	P1
495	BB_-5-5-5-5	68.9	68.9	0.0		92.8		J1	P3
496	BB_-5-5-5-5	63.7	63.7	0.0		81.8		J1	P6
497	BB_+0+0+0+0	60.8	60.8	0.0		76.7		J1	P6
498	BB_+5+5+5+5	68.3	68.2			88.0		J0	P7
499	BB_-5-5-5-5	61.4	60.3			81.6		J0	P7
500	BB_-5-5-5-5	60.3	60.3	0.0		81.8		J1	P6
502	BB_+10+10+10+10	55.6	57.1	1.5	66.5	95.0	28.5	J5	P2
503	HH_-5-5-5-5	98.1	174.8	76.7	119.0	119.1	0.1	J5	P1
505	BB_-5-5-5-5	56.2	56.2	0.0		73.8		J1	P6
519	BB_-5-5-5-5	67.4	86.3	18.8		88.3		J4	P3
521	BB_+5+5+5+5	73.5	73.5	0.0	100.9	100.7	-0.1	J1	P1
532	BB_-5-5-5-5	64.1	64.4	0.3		82.2		J1	P6
536	BB_-5-5-5-5	60.8	60.9	0.1		77.6		J1	P6
539	BB_5+5+5+5	No supporting evidence of deficiency found.							
542	BB_-5-5-5-5	72.2	72.2	0.0	98.7	98.7	0.0	J1	P2
543	BB_+10+10+10+10	69.2	69.1		96.7	96.7	0.0	J1	P2
546	BB_+0+0+0+0	58.6	158.9	100.4	71.2	71.2	0.0	J5	P1
555	BB_-5-5-5-5	65.8	65.9	0.0		88.9		J1	P6
561	BB_-5-5-5-5	46.7	82.9	36.1		45.5		J5	P2
568	H_+0+0+0+0	179.4	211.5	32.1	115.6	115.5	-0.1	J5	P1

Appendix D – Work Plan Summary

L23	General Details					Repair & Remedy Analysis				
Str. #	Tower Type & Extension	Deficient Member			Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed Incorrectly D5: Missing Bolts D6: Altered Member	Impact of Individual Deficient Member Removal (Construction and Maintenance Loading)			Remedy Index: R1: replace member R2: create double angle R3: install redundants	Temporary Support or Tower Unloading Required
		ID	Leg	Side		Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage	Governing Member Maximum Combined Axial + Bending Usage (%)		
10	S_+0+0+0+0	131	2	left	D1				R1	
		131	4	right	D1				R1	
		131	1	right	D1				R1	
16	S_+0+0+0+0	131	3	left	D1				R1	
		131	3	right	D1				R1	
		131	2	left	D1				R1	
		131	1	left	D1				R1	
19	S_+5+5+5+5	136	2	left	D1	33.7	Fg143-1P		R1	
		136	4	right	D1	34.5	Fg143-1P	26.3	R1	
107	S_-5-5-5-5	127	2	right	D1				R1	
		127	1	left	D1				R1	
		127	1	right	D1				R1	
		127	4	left	D1				R1	
139	S_+5+5+5+5	136	2	left	D1	33.3	Fg143-4P	20.1	R1	
		136	3	right	D2	N/A	N/A	N/A	R1	
		136	3	right	D2	N/A	N/A	N/A	R1	
145	S_+0+0+0+0	131	4	left	D1				R1	
152	S_-5-5-5-5	127	4	right	D1				R1	
153	S_-5-5-5-5	127	1	right	D1				R1	
		118	3	left	D1				R1	
167	S_+0+0+0+0	131	3	right	D1				R1	
170	S_+0+0+0+0	131	2	right	D1				R1	
		131	1	left	D1				R1	
178	S_+5+5+5+5	136	2	right	D2	N/A	N/A	N/A	R1	
179	S_+0+0+0+0	131	4	left	D1	27.0	LY_131-T1P	23.4	R1	
		131	1	left	D2	N/A	N/A	N/A	R1	
189	S_-5-5-5-5	127	1	right	D1	33.2	g143-3P		R1	
		127	4	left	D2	N/A	N/A	N/A	R1	
		127	3	right	D1	31.4	g143-3P	26.4	R1	
		127	2	left	D1	33.3	g143-3P		R1	
		127	2	right	D1	31.3	g143-3P		R1	
190	S_-5-5-5-5	127	3	right	D1				R1	
		127	2	right	D2				R1	
		127	4	left	D2				R1	
		118	1	right	D1				R1	
196	S_-5-5-5-5	No supporting evidence of deficiency found.								
205	S_+0+0+0+0	131	1	right	D1				R1	
		131	3	left	D1				R1	
		131	4	left	D1				R1	
206	S_+5+5+5+5	136	3	left	D2	N/A	N/A	N/A	R1	
		136	1	left	D1	36.3	Fg142-4P		R1	
		136	3	right	D1	45.3	g141P_P	25.0	R1	
222	S_+0+0+0+0	131	1	right	D1	30.6	LXY_131-T1P		R1	
		131	3	left	D1	30.4	LXY_131-T1P		R1	
		131	4	left	D1	30.5	LXY_131-T1P	26.6	R1	
262	S_+10+10+10+10	144	4	right	D1	50.8	g141Y-P	30.3	R1	

L23	General Details						Repair & Remedy Analysis				
Str. #	Tower Type & Extension	Deficient Member				Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed Incorrectly D5: Missing Bolts D6: Altered Member	Impact of Individual Deficient Member Removal (Construction and Maintenance Loading)			Remedy Index: R1: replace member R2: create double angle R3: install redundants	Temporary Support or Tower Unloading Required
			ID	Leg	Side		Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage	Governing Member Maximum Combined Axial + Bending Usage (%)		
263	S_+5+5+5+5		136	1	right	D1	35.9	Fg143-1P		R1	
			136	3	right	D1	35.2	Fg143-2P	22.7	R1	
269	S_-5-5-5-5		127	3	left	D1				R1	
272	S_-5-5-5-5		127	1	left	D1	34.7	g142-4P	26.6	R1	
			127	2	left	D2	N/A	N/A	N/A	R1	
			127	3	left	D2	N/A	N/A	N/A	R1	
			127	3	right	D2	N/A	N/A	N/A	R1	
274	S_-5-5-5-5		127	2	left	D1				R1	
			127	4	left	D1				R1	
278	T_+0+0+0+0	with 2 guy wires	124	2	right	D1	93.0	g136P (63)		R1	
			124	1	right	D1	93.0	g136P (63)		R1	
			124	1	left	D1	93.0	g136P (63)	56.8	R1	
			124	4	left	D1	93.0	g136P (63)		R1	
			119	4	right	D1	93.0	g136P (63)		R1	
		with 1 guy wire	124	2	right	D1	93.0	g136P (63)		R1	
			124	1	right	D1	93.0	g136P (63)		R1	
			124	1	left	D1	93.1	g136P (63)		R1	
			124	4	left	D1	93.0	g136P (63)		R1	
			119	4	right	D1	93.0	g136P (63)	56.6	R1	
		with 0 guy wires	124	2	right	D1	93.0	g136P (63)		R1	
			124	1	right	D1	93.0	g136P (63)		R1	
			124	1	left	D1	93.0	g136P (63)		R1	
			124	4	left	D1	92.9	g136P (63)		R1	
			119	4	right	D1	93.0	g136P (63)	56.7	R1	
279	S_-5-5-5-5		127	1	right	D1				R1	
			118	4	left	D1				R1	
282	S_+0+0+0+0		131	2	left	D1				R1	
			131	3	left	D1				R1	
			131	2	right	D1				R1	
			131	1	left	D1				R1	
			131	1	right	D1				R1	
			131	4	left	D1				R1	
			131	3	right	D1				R1	
			131	3	left	D1				R1	
286	S_-5-5-5-5		127	4	left	D1				R1	
287	S_-5-5-5-5		127	1	right	D1	35.3	g143-4P		R1	
			127	3	right	D1	35.2	g143-4P		R1	
			127	2	left	D1	35.2	g143-4P		R1	
			127	1	left	D1	35.2	g143-4P		R1	
455	S_+0+0+0+0		131	4	right	D1				R1	
			131	3	left	D1				R1	
			131	3	right	D1				R1	
466	S_+0+0+0+0		131	2	left	D2				R1	
			131	3	left	D1				R1	
			131	1	left	D1				R1	

L23	General Details					Repair & Remedy Analysis				
Str. #	Tower Type & Extension	Deficient Member			Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed Incorrectly D5: Missing Bolts D6: Altered Member	Impact of Individual Deficient Member Removal (Construction and Maintenance Loading)			Remedy Index: R1: replace member R2: create double angle R3: install redundants	Temporary Support or Tower Unloading Required
		ID	Leg	Side		Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage	Governing Member Maximum Combined Axial + Bending Usage (%)		
470	S_+0+0+0+0	131	2	right	D1				R1	
		131	1	left	D2				R1	
		131	1	right	D2				R1	
		131	4	left	D1				R1	
		131	4	right	D1				R1	
		131	3	left	D1				R1	
		131	3	right	D2				R1	
488	T_+0+0+0+0	124	2	left	D1	31.9	g165P	22.2	R1	
		124	2	right	D1				R1	
		126	2	left	D1				R1	
		126	2	right	D1	31.9	g165P		R1	
		125	2	left	D1				R1	
491	S_+0+0+0+0	131	2	left	D1				R1	
		131	4	right	D1				R1	
		131	1	right	D2				R1	
		131	1	left	D2				R1	
492	C_+0+0+0+0	122	2	left	D1	37.7	g124P		R1	
		122	4	left	D1	37.7	g124P	24.3	R1	
500	S_+0+0+0+0	131	4	right	D1				R1	
502	S_+0+0+0+0	131	3	left	D2				R1	
		131	4	left	D1				R1	
507	S_-5-5-5-5	127	4	left	D1				R1	
		127	4	right	D6				R1	
521	S_-5-5-5-5	127	4	right	D1				R1	
		127	3	left	D1				R1	
		127	4	left	D1				R1	
		127	1	left	D1				R1	
530	S_-5-5-5-5	127	2	left	D6				R1	
		127	4	left	D6				R1	
		127	3	left	D6				R1	
		118	3	right	D1				R1	
		118	4	right	D1				R1	
		118	2	left	D1				R1	
		118	2	right	D1				R1	
		118	1	left	D1				R1	
532	S_-5-5-5-5	No supporting evidence of deficiency found.								
534	S_-5-5-5-5	118	4	right	D1	28.2	g-143-1P		R1	
		118	4	left	D1				R1	
		127	1	right	D1	28.5	g-143-1P		R1	
		127	2	left	D1	28.4	g-143-1P		R1	
538	S_+0+0+0+0	131	1	right	D1				R1	
		131	3	right	D1				R1	
		131	2	left	D1				R1	
		131	1	left	D1				R1	

L23	General Details					Repair & Remedy Analysis				
Str. #	Tower Type & Extension	Deficient Member			Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed Incorrectly D5: Missing Bolts D6: Altered Member	Impact of Individual Deficient Member Removal (Construction and Maintenance Loading)			Remedy Index: R1: replace member R2: create double angle R3: install redundants	Temporary Support or Tower Unloading Required
		ID	Leg	Side		Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage	Governing Member Maximum Combined Axial + Bending Usage (%)		
556	S_-5-5-5-5	118	4	left	D1				R1	
		118	3	left	D1				R1	
		118	4	right	D1				R1	
		118	1	right	D1				R1	
		127	4	left	D6				R1	
		127	1	left	D6				R1	
		127	4	left	D1				R1	
		127	2	right	D1				R1	
		127	1	right	D1				R1	
563	S_-5-5-5-5	127	3	left	D1	34.1	g142-4P		R1	
		127	2	left	D1	34.1	g142-4P		R1	
567	S_-5-5-5-5	127	2	left	D2				R1	
		127	4	left	D1				R1	
		127	1	right	D1				R1	

L24	General Details					Repair & Remedy Analysis				
Str. #	Tower Type & Extension	Deficient Member			Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed Incorrectly D5: Missing Bolts D6: Altered Member	Impact of Individual Deficient Member Removal (Construction and Maintenance Loading)			Remedy Index: R1: replace member R2: create double angle R3: install redundants	Temporary Support or Tower Unloading Required
		ID	Leg	Side		Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage	Governing Member Maximum Combined Axial + Bending Usage (%)		
5	B_+5+5+5+5	30	4	right	D1	35.3	217X	39.2	R1	
		22	4	right	D1				R1	
		21	2	left	D1	35.3	217X	39.2	R1	
9	BB_+0+0+0+0	75	4	center	D1					
		230	1	left	D1					
		227	1	left	D2					
		228	1	right	D1					
		227	3	left	D1					
		228	2	right	D1					
		227	2	left	D1					
		228	1	left	D1					
		227	1	right	D1					
11	BB_+5+5+5+5	252	3	right	D1					
		252	1	right	D1					
		252	1	left	D1					
		261	3	left	D1					
13	BB_+0+0+0+0	227	3	right	D1					
		228	1	right	D1					
16	BB_+5+5+5+5	251	4	center	D1	N/A	N/A	N/A	R2	X
		252	2	right	D1	57.1	251-3P (Leg 4)	46.1	R1	
		252	4	left	D1	181.9	251-3P (Leg 4)	46.1	R1	
		252	2	left	D1	57.3	251-3P (Leg 4)	46.1	R1	
		252	3	left	D1	57.2	251-3P (Leg 4)		R1	
		253	3	right	D1	57.1	251-3P (Leg 4)		R1	
		253	1	right	D1	87.9	LX-251-3P (Leg 1)	46.0	R1	
17	BB_+5+5+5+5	252	2	left	D1	53.6	LXY-251-1P (leg 2)		R1	
		252	3	left	D1	45.0	LY-251-1P (Leg 3)	27.7	R1	
		252	1	left	D1	71.0	LX-251-1P (Leg 1)		R1	
		252	1	left	D1	71.0	LX-251-1P (Leg 1)		R1	
		253	1	right	D1	71.1	LX-251-1P (Leg 1)		R1	
18	BB_+5+5+5+5	252	1	right	D1	80.8	LX-251-1P (Leg 1)	36.1	R1	
		253	2	left	D1	57.1	LXY-251-1P (leg 2)		R1	
		252	2	right	D1	56.7	LXY-251-1P (leg 2)		R1	
		253	1	left	D1	80.4	LX-251-1P (Leg 1)		R1	
		252	3	left	D1	49.9	LY-251-1P (Leg 3)	36.2	R1	
		253	3	right	D1	49.7	LY-251-1P (Leg 3)	36.2	R1	
19	BB_+5+5+5+5	253	1	right	D1	75.0	LX-251-3P (Leg 1)			
		253	4	right	D1	72.3	251-3P (Leg 4)	30.0		
		252	3	left	D1	52.6	LY-251-1P (Leg 3)			
		253	2	right	D1	60.0	LXY-251-1P (Leg 2)			
		252	2	left	D1	60.1	LXY-251-1P (Leg 2)			
20	BB_+0+0+0+0	228	2	right	D1					
		29	3	right	D1					
21	BB_-5-5-5-5	237	4	right	D1					
		237	4	left	D1					
		236	1	right	D1					

L24	General Details					Repair & Remedy Analysis				
Str. #	Tower Type & Extension	Deficient Member			Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed Incorrectly D5: Missing Bolts D6: Altered Member	Impact of Individual Deficient Member Removal (Construction and Maintenance Loading)			Remedy Index: R1: replace member R2: create double angle R3: install redundants	Temporary Support or Tower Unloading Required
		ID	Leg	Side		Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage	Governing Member Maximum Combined Axial + Bending Usage (%)		
23	BB_+0+0+0+0	227	1	left	D1					
		228	1	right	D1					
31	BB_+0+0+0+0	227	4	left	D1					
		227	1	left	D1					
37	BB_-5-5-5-5	75	4	center	D1					
49	BB_+0+0+0+0	75	3	center	D1					
		75	4	center	D1					
58	BB_-5-5-5-5	236	1	left	D1					
		236	4	left	D1					
		237	2	right	D1					
		237	1	right	D1					
		237	3	right	D1					
		234	4	right	D1					
		75	1	center	D1					
		75	3	left	D1					
		75	4	center	D1					
61	BB_-5-5-5-5	75	4	center	D1					
		75	3	center	D1					
		75	2	center	D1					
		75	1	center	D1					
72	BB_-5-5-5-5	75	3	center	D1					
		75	1	center	D1					
		75	2	center	D1					
89	BB_+0+0+0+0	227	1	left	D1					
91	BB_-5-5-5-5	237	4	left	D1					
		237	2	right	D1					
		237	2	left	D1					
		237	3	left	D1					
		237	1	left	D1					
		237	1	right	D1					
		237	3	right	D1					
92	BB_-5-5-5-5	75	4	center	D1					
		75	3	center	D1					
		75	2	center	D1					
		75	1	center	D1					
108	BB_+0+0+0+0	228	1	right	D1					
		228	3	right	D1					
111	EE_-5-5-5-5	175	2	center	D1					
119	BB_-5-5-5-5	75	2	center	D1					
		75	4	center	D1					
		75	1	center	D1					
		75	3	center	D1					
142	BB_+10+10+10+10	278	1	right	D1	110.5	LX-276-1P (Leg1)	32.6	R1	X
		278	3	right	D1	107.4	LY-276-2P (Leg 3)		R1	
		277	2	left	D1	117.9	LXY-276-2P (Leg 2)		R1	
		277	1	left	D1	110.4	LX-276-1P (Leg1)		R1	
		277	4	left	D1	113.2	276-2P (Leg 4)	34.1	R1	

L24	General Details					Repair & Remedy Analysis				
Str. #	Tower Type & Extension	Deficient Member			Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed Incorrectly D5: Missing Bolts D6: Altered Member	Impact of Individual Deficient Member Removal (Construction and Maintenance Loading)			Remedy Index: R1: replace member R2: create double angle R3: install redundants	Temporary Support or Tower Unloading Required
		ID	Leg	Side		Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage	Governing Member Maximum Combined Axial + Bending Usage (%)		
143	BB_+10+10+10+10	277	2	right	D1	91.8	276-2P (Leg 4)			
		278	4	left	D1	88.8	LXY-276-2P (Leg 2)	21.9		
145	BB_+0+0+0+0	75	4	center	D1					
146	BB_+5+5+5+5	252	2	right	D1					
		75	2	center	D1					
148	BB_+5+5+5+5	252	1	right	D1					
		252	2	left	D1					
		253	2	right	D1					
150	BB_+10+10+10+10	278	4	right	D1	59.5	276-1P (Leg 4)			
		277	3	left	D1	56.8	LX-276-1P (leg 1)			
153	BB_+5+5+5+5	253	4	left	D1					
155	BB_+0+0+0+0	228	4	left	D1					
		228	2	left	D1					
		227	3	right	D1					
		227	2	right	D1					
		75	4	center	D1					
168	BB_+0+0+0+0	228	3	right	D1					
170	BB_+5+5+5+5	253	3	right	D1					
		252	1	left	D1					
		253	4	right	D1					
		252	4	left	D1					
172	BB_-5-5-5-5	237	3	right	D1					
		237	4	right	D1					
		236	1	left	D1					
		236	3	right	D1					
		75	4	center	D1					
173	BB_+0+0+0+0	228	2	right	D1					
		227	4	left	D1					
		228	3	right	D1					
		230	2	left	D4					
		230	2	right	D4					
174	BB_+10+10+10+10	277	3	left	D1	126.3	LY-276-1P (Leg 3)		R1	X
		278	1	right	D1	127.4	LX-276-2P (Leg 1)		R1	
		277	4	left	D1	143.8	276-2P (Leg 4)	32.1	R1	
		278	2	right	D1	113.2	LXY-276-2P (Leg 2)		R1	
		278	3	right	D1	126.7	LY-276-1P (Leg 3)		R1	
175	BB_-5-5-5-5	237	4	right	D3					
		236	1	left	D1					
		23	4	left	D1					
		75	4	center	D1					

L24	General Details					Repair & Remedy Analysis				
Str. #	Tower Type & Extension	Deficient Member			Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed Incorrectly D5: Missing Bolts D6: Altered Member	Impact of Individual Deficient Member Removal (Construction and Maintenance Loading)			Remedy Index: R1: replace member R2: create double angle R3: install redundants	Temporary Support or Tower Unloading Required
		ID	Leg	Side		Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage	Governing Member Maximum Combined Axial + Bending Usage (%)		
177	BB_-5-5-5-5	233	4	left	D1					
		233	4	left	D1					
		234	2	right	D1					
		237	2	right	D1					
		236	2	left	D1					
		75	2	center	D1					
		75	2	center	D1					
		75	4	center	D1					
		75	3	center	D1					
		74	2	left	D1					
		28	2	left	D5					
178	BB_+10+10+10+10	277	1	left	D1	102.0	LX-276-1P (leg)		R1	X
		278	4	right	D1	111.0	276-1P (leg)		R1	
		277	4	left	D1	N/A	276-1P (leg)		R1	
		278	1	right	D1	102.6	LX-276-1P (leg)	38.7	R1	
		277	1	left	D1	102.0	LX-276-1P (leg)		R1	
		278	3	right	D1	157.7	LY_276-2P		R1	
		278	2	right	D1	163.8	LXY_276_1P		R1	
		277	2	left	D1	164.9	LXY_276_1P	38.7	R1	
179	BB_+0+0+0+0	226	2	center	D1	N/A	N/A	N/A	R2	
		227	3	left	D1	29.3	g141p (Leg 2)		R1	
		227	2	right	D1	44.8	g141p (Leg 2)		R1	
		228	1	left	D1	29.1	g141p (Leg 2)		R1	
		75	2	center	D1	29.5	g141p (Leg 2)		R1	
		75	3	left	D1		g141p (Leg 2)		R1	
		75	4	center	D1		g141p (Leg 2)		R1	
180	BB_-5-5-5-5	234	2	right	D2	N/A	N/A	N/A	R1	
		233	2	left	D1	29.7	157-1X	37.6	R1	
		237	2	right	D2	N/A	N/A	N/A	R1	
		236	3	left	D2	N/A	N/A	N/A	R1	
		236	3	right	D2	N/A	N/A	N/A	R1	
		236	1	left	D2	N/A	N/A	N/A	R1	
		237	1	right	D2	N/A	N/A	N/A	R1	
		236	4	left	D2	N/A	N/A	N/A	R1	
		237	4	right	D2	N/A	N/A	N/A	R1	
						N/A	N/A	N/A	R1	
181	BB_+5+5+5+5	26	1	left	D1					
188	BB_-5-5-5-5	75	1	center	D1					
		75	4	center	D1					
189	BB_-5-5-5-5	237	1	right	D1					
		236	4	left	D1					
		236	3	left	D1					
		237	3	right	D1					
		236	1	left	D1					
		75	2	center	D1					
		75	4	center	D2					

L24	General Details					Repair & Remedy Analysis				
Str. #	Tower Type & Extension	Deficient Member			Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed Incorrectly D5: Missing Bolts D6: Altered Member	Impact of Individual Deficient Member Removal (Construction and Maintenance Loading)			Remedy Index: R1: replace member R2: create double angle R3: install redundants	Temporary Support or Tower Unloading Required
		ID	Leg	Side		Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage	Governing Member Maximum Combined Axial + Bending Usage (%)		
190	BB_+0+0+0+0	228	1	right	D1					
		227	2	left	D1					
		227	3	left	D1					
		228	3	right	D1					
		228	2	right	D1					
		227	1	left	D1					
191	BB_-5-5-5-5	236	2	left	D1					
		237	1	right	D1					
		237	3	right	D1					
196	BB_-5-5-5-5	237	4	right	D1					
		74	3	left	D1					
197	BB_-5-5-5-5	75	2	center	D1					
		75	4	center	D1					
		75	4	center	D1					
		237/238	all	both	D1					
213	BB_-5-5-5-5	75	3	center	D1					
		75	2	center	D1					
		236	2	left	D1					
221	BB_-5-5-5-5	75	4	center	D3					
		75	1	center	D3					
		75	3	center	D3					
		75	2	center	D3					
		233	3	right	D1					
224	BB_-5-5-5-5	237	2	left	D1					
		236	2	right	D1					
234	BB_-5-5-5-5	75	3	center	D1					
		75	4	center	D1					
		75	2	center	D1					
239	BB_-5-5-5-5	75	2	center	D1					
		75	2	center	D1					
		75	1	center	D1					
		75	4	center	D1					
245	BB_+0+0+0+0	228	4	right	D1					
		227	3	left	D1					
		227	1	left	D1					

L24	General Details					Repair & Remedy Analysis				
Str. #	Tower Type & Extension	Deficient Member			Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed Incorrectly D5: Missing Bolts D6: Altered Member	Impact of Individual Deficient Member Removal (Construction and Maintenance Loading)			Remedy Index: R1: replace member R2: create double angle R3: install redundants	Temporary Support or Tower Unloading Required
		ID	Leg	Side		Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage	Governing Member Maximum Combined Axial + Bending Usage (%)		
249	BB_-5-5-5-5	75	1	center	D1					
		75	3	center	D1					
		75	4	center	D1					
		236	1	right	D1					
		237	1	left	D1					
		236	1	right	D1					
		237	1	left	D1					
		234	4	left	D1					
		233	4	right	D1					
253	BB_-5-5-5-5	75	1	center	D1					
		75	3	center	D1					
		75	4	center	D1					
254	BB_+5+5+5+5	252	3	left	D1					
		253	2	right	D1					
		252	1	left	D1					
		253	1	right	D1					
256	BB_-5-5-5-5	237	3	right	D1					
		236	3	left	D1					
		237	4	right	D1					
		236	4	left	D1					
		237	2	right	D1					
		236	2	left	D1					
		236	1	left	D1					
		237	1	right	D1					
262	BB_-5-5-5-5	75	3	center	D1					
		75	2	center	D1					
		75	1	center	D1					
		75	4	center	D1					
270	BB_-5-5-5-5	75	2	center	D2	N/A	N/A	N/A	R1	
		233	4	left	D1	68.1	LY-235P (Leg 3)	23.8	R1	
		234	4	right	D1				R1	
		235	3	center	D1	N/A	N/A	N/A	R1	
		237	1	right	D1	68.1	LY-235P (Leg 3)	23.8	R1	
273	BB_-5-5-5-5	233	4	left	D1					
		237	2	right	D2					

L24	General Details					Repair & Remedy Analysis				
Str. #	Tower Type & Extension	Deficient Member			Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed Incorrectly D5: Missing Bolts D6: Altered Member	Impact of Individual Deficient Member Removal (Construction and Maintenance Loading)			Remedy Index: R1: replace member R2: create double angle R3: install redundants	Temporary Support or Tower Unloading Required
		ID	Leg	Side		Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage	Governing Member Maximum Combined Axial + Bending Usage (%)		
280	BB_-5-5-5-5	74	1	left	D1					
		75	4	center	D3					
		75	3	center	D3					
		75	2	center	D3					
		75	1	center	D3					
		233	1	left	D1					
		236	1	left	D1					
		236	4	left	D1					
		237	4	right	D1					
		236	3	left	D1					
		237	1	right	D1					
282	BB_-5-5-5-5	75	1	center	D3					
		75	2	center	D3					
		75	4	center	D3					
		75	3	center	D3					
		233	1	left	D1					
		234	1	right	D1					
		233	2	left	D1					
		234	2	right	D1					
		237	4	right	D1					
		236	3	left	D1					
		237	3	right	D1					
289	BB_-5-5-5-5	75	2	center	D1					
301	BB_-5-5-5-5	74	1	left	D1					
		74	2	right	D1					
		75	4	center	D3					
		75	3	center	D3					
		75	2	center	D3					
		75	1	center	D3					
		237	2	right	D1					
		237	4	right	D1					
308	BB_-5-5-5-5	75	2	center	D1					
		75	3	center	D1					
		75	1	center	D1					
		75	3	center	D1					
311	BB_-5-5-5-5	74	3	left	D1					
		74	2	right	D1					
		74	3	right	D1					
		234	4	right	D1					
		236	2	right	D1					
		237	4	left	D1					
		237	2	right	D1					
		236	4	left	D1					
		236	3	right	D1					
		237	3	left	D1					
		236	2	left	D1					
313	BB_+0+0+0+0	75	1	center	D1					

L24	General Details					Repair & Remedy Analysis				
Str. #	Tower Type & Extension	Deficient Member			Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed Incorrectly D5: Missing Bolts D6: Altered Member	Impact of Individual Deficient Member Removal (Construction and Maintenance Loading)			Remedy Index: R1: replace member R2: create double angle R3: install redundants	Temporary Support or Tower Unloading Required
		ID	Leg	Side		Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage	Governing Member Maximum Combined Axial + Bending Usage (%)		
314	BB_-5-5-5-5	75	3	center	D1					
		75	2	center	D1					
316	BB_+20+20+20+20	52	2	left	D1	289.0	LXY-51-3P (Leg 2)	61.7	R1	X
		52	1	left	D1	278.7	LX-51-3P (Leg 1)	62.7	R1	
318	BB_+0+0+0+0	227	3	left	D1					
		228	4	right	D1					
		228	3	right	D1					
		227	1	left	D1					
		227	4	left	D1					
322	EE_-5-5-5-5	175	4	center	D1	67.1	121P	99.9	R1	X
327	BB_-5-5-5-5	75	1	center	D1					
		75	3	center	D1					
		75	4	center	D1					
		75	2	center	D1					
331	BB_-5-5-5-5	75	2	center	D1					
342	BB_-5-5-5-5	237	4	right	D1					
		236	3	left	D1					
		237	2	right	D1					
		75	2	center	D1					
345	BB_-5-5-5-5	74	4	right	D1					
348	BB_+5+5+5+5	253	1	right	D1	66.0	LX-251-3P (Leg 1)			
		252	3	left	D1	66.5	LY-251-1P (Leg 3)			
		253	3	right	D1	66.1	LY-251-1P (Leg 3)	29.1		
		252	2	left	D1	76.8	LXY-251-1P (Leg 2)			
		253	2	right	D1	77.0	LXY-251-1P (Leg 2)			
361	BB_+0+0+0+0	228	2	right	D1					
		227	4	left	D1					
		228	3	right	D1					
		227	3	left	D1					
		230	2	right	D1					
		231	2	left	D1					
365	BB_+0+0+0+0	227	4	left	D1					
		228	1	right	D1					
		228	3	right	D1					
		227	3	left	D1					
		227	2	left	D1					
		75	2	center	D1					
366	BB_-5-5-5-5	75	2	center	D1					
		75	3	center	D1					
369	EE_+5+5+5+5	75	1	center	D1	62.5	121P	172.4	R1	X

L24	General Details					Repair & Remedy Analysis				
Str. #	Tower Type & Extension	Deficient Member			Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed Incorrectly D5: Missing Bolts D6: Altered Member	Impact of Individual Deficient Member Removal (Construction and Maintenance Loading)			Remedy Index: R1: replace member R2: create double angle R3: install redundants	Temporary Support or Tower Unloading Required
		ID	Leg	Side		Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage	Governing Member Maximum Combined Axial + Bending Usage (%)		
397	BB_+5+5+5+5	252	4	left	D1					
		253	4	right	D1					
		252	2	left	D1					
		253	1	right	D1					
		253	3	right	D1					
		252	1	left	D1					
		252	3	left	D1					
400	BB_+0+0+0+0	228	3	left	D1					
		227	3	right	D1					
		228	2	left	D1					
		227	2	right	D1					
		228	1	left	D1					
		227	1	right	D1					
		227	4	right	D1					
434	BB_+0+0+0+0	228	4	right	D1					
		227	2	left	D1					
		228	2	right	D1					
		227	1	left	D1					
		228	1	right	D1					
		227	4	left	D1					
440	BB_+0+0+0+0	226	1	center	D1					
		232	3	right	D1					
		228	4	right	D1					
		75	2	center	D1					
442	BB_+10+10+10+10	277	3	left	D1					
444	BB_+0+0+0+0	227	2	right	D1					
445	BB_+0+0+0+0	74	4	left	D1					
448	BB_-5-5-5-5	23	3	left	D1					
		233	1	left	D1					
		74	1	left	D1					
		74	4	left	D2					
		74	2	right	D2					
		75	2	center	D3					
		75	3	center	D3					
		75	4	center	D3					
		75	1	center	D3					
456	BB_-5-5-5-5	75	1	center	D1					
		75	3	center	D1					
		75	4	center	D1					
		75	2	center	D1					

L24	General Details					Repair & Remedy Analysis				
Str. #	Tower Type & Extension	Deficient Member			Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed Incorrectly D5: Missing Bolts D6: Altered Member	Impact of Individual Deficient Member Removal (Construction and Maintenance Loading)			Remedy Index: R1: replace member R2: create double angle R3: install redundants	Temporary Support or Tower Unloading Required
		ID	Leg	Side		Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage	Governing Member Maximum Combined Axial + Bending Usage (%)		
464	BB_-5-5-5-5	75	2	center	D1					
		75	4	center	D1					
		236	all	all	D1					
466	BB_-5-5-5-5	75	2	center	D1					
468	BB_-5-5-5-5	75	4	center	D1					
471	BB_-5-5-5-5	75	3	center	D1					
472	BB_-5-5-5-5	75	1	center	D3					
		75	2	center	D3					
		75	3	center	D3					
		75	4	center	D3					
		235	2	center	D1					
473	BB_-5-5-5-5	75	2	center	D1					
		75	3	center	D1					
		75	4	center	D1					
482	HH_-5-5-5-5	62	1	center	D1	79.2	230Y	69.5	R1	
484	BB_+5+5+5+5	253	3	right	D1					
489	BB_+5+5+5+5	252	3	left	D1					
		253	4	right	D1					
		252	4	left	D1					
		253	3	right	D1					
		253	2	right	D1					
		252	2	left	D1					
490	HH_-5-5-5-5	24	4	right	D1	N/A	N/A	N/A	R2	
		24	1	left	D1	N/A	N/A	N/A	R2	
		22	2	left	D1	66.2	283X	31.2	R1	
		23	3	right	D1				R1	
491	BB_+0+0+0+0	227	3	left	D1					
		226	3	center	D1					
492	BB_+0+0+0+0	227	3	left	D1					
		228	1	right	D1					
		227	2	left	D1					
		227	1	left	D1					
495	BB_-5-5-5-5	75	4	center	D1					
		75	1	center	D1					
		75	2	center	D1					
496	BB_-5-5-5-5	237	1	right	D1					
		236	2	left	D1					
497	BB_+0+0+0+0	230	4	right	D1					
498	BB_+5+5+5+5	253	2	right	D1					
		252	1	left	D1					

L24	General Details					Repair & Remedy Analysis				
Str. #	Tower Type & Extension	Deficient Member			Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed Incorrectly D5: Missing Bolts D6: Altered Member	Impact of Individual Deficient Member Removal (Construction and Maintenance Loading)			Remedy Index: R1: replace member R2: create double angle R3: install redundants	Temporary Support or Tower Unloading Required
		ID	Leg	Side		Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage	Governing Member Maximum Combined Axial + Bending Usage (%)		
499	BB_-5-5-5-5	236	2	left	D1					
		237	2	right	D1					
		75	1	center	D3					
		75	4	center	D3					
		75	3	center	D3					
		75	2	center	D3					
500	BB_-5-5-5-5	234	1	right	D6					
502	BB_+10+10+10+10	277	2	left	D1					
		278	1	left	D1					
		278	3	right	D1					
503	HH_-5-5-5-5	62	3	center	D1	62.7	283P	50.5	R1	
		24	1	left	D1	N/A	N/A	N/A	R2	
		23	4	right	D2	N/A	N/A	N/A	R1	
		20	4	left	D1	62.7	283P	50.6	R1	
505	BB_-5-5-5-5	75	4	center	D3					
		75	1	center	D3					
		75	3	center	D3					
		75	2	center	D3					
519	BB_-5-5-5-5	235	1	center	D1					
		236	1	left	D1					
		236	3	left	D1					
		236	1	right	D1					
		236	3	right	D1					
		237	3	left	D1					
521	BB_+5+5+5+5	253	1	right	D1					
		252	1	left	D1					
532	BB_-5-5-5-5	75	2	center	D1					
		75	1	center	D1					
		75	4	center	D1					
		75	3	center	D1					
		236	1	right	D1					
		236	3	left	D1					
536	BB_-5-5-5-5	75	3	center	D1					
		75	1	center	D1					
		75	4	center	D1					
		75	2	center	D1					
		236	2	left	D1					
		237	2	right	D1					
539	BB_5+5+5+5	No supporting evidence of deficiency found.								
542	BB_-5-5-5-5	75	2	center	D1					
		75	1	center	D1					
		75	4	center	D1					
		75	3	center	D1					
543	BB_+10+10+10+10	277	4	left	D1					
		277	1	right	D1					

L24	General Details						Repair & Remedy Analysis				Temporary Support or Tower Unloading Required
Str. #	Tower Type & Extension	Deficient Member			Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed Incorrectly D5: Missing Bolts D6: Altered Member		Impact of Individual Deficient Member Removal (Construction and Maintenance Loading)			Remedy Index: R1: replace member R2: create double angle R3: install redundants	
		ID	Leg	Side			Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage	Governing Member Maximum Combined Axial + Bending Usage (%)		
546	BB_+0+0+0+0	75	3	center	D1		38.8	g141P (Leg 2)		R1	
		226	2	center	D1		N/A	N/A	N/A	R2	
		227	2	left	D2		N/A	N/A	N/A	R1	
		227	1	right	D1		38.9	g141P (Leg 2)		R1	
		228	2	right	D1		38.3	g141P (Leg 2)		R1	
		227	1	left	D1		38.9	g141P (Leg 2)		R1	
555	BB_-5-5-5-5	75	1	left	D1						
		75	2	left	D1						
561	BB_-5-5-5-5	21	1	center	D1						
568	H_+0+0+0+0	54	2	center	D1		111.5	198XY	56.0		X
		16	3	left	D1		110.9	198XY	60.8		

Stantec

NEWFOUNDLAND AND LABRADOR HYDRO 230KV TOWERS – DEFICIENCIES ANALYSIS OF LINES L23, L24, L23A, L24A (PHASE 2)

Results Summary and Remedy Planning

August 20, 2024

Prepared for:
Newfoundland and Labrador Hydro

Prepared by:
Stantec Consulting Ltd.

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118212548

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The conclusions in the Report titled Newfoundland and Labrador Hydro 230kV Towers – Deficiencies Analysis of Lines L23, L24, L23A, L24A (Phase 2) are Stantec's professional opinion, as of the time of the Report, and concerning the scope described in the Report. The opinions in the document are based on conditions and information existing at the time the scope of work was conducted and do not take into account any subsequent changes. The Report relates solely to the specific project for which Stantec was retained and the stated purpose for which the Report was prepared. The Report is not to be used or relied on for any variation or extension of the project, or for any other project or purpose, and any unauthorized use or reliance is at the recipient's own risk.

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1 Project Background

Newfoundland and Labrador Hydro (NLH) operates two parallel 230 kV steel tower transmission lines between Churchill Falls and Wabush. These lines are critical to NLH's grid and are used to supply safe and reliable power to residents as well as both commercial and industrial customers in the Wabush area. The lines were originally constructed in sections as follows:

- L23 - Twin Falls to Wabush – completed in 1962.
- L24 - Twin Falls to Wabush – completed in 1964.
- L23A - Churchill Falls to Twin Falls – completed in 1974.
- L24A - Churchill Falls to Twin Falls – completed in 1974.

L23 and L24 were constructed using only self-support towers for tangent, angle, and dead-end types. L23A and L24A were constructed using guyed V towers for tangent types and self-supported towers for angle and dead-end types.

Maintenance inspections were completed in 2020 by NLH operations crews and resulted in the identification of tower deficiencies, including but not limited to damaged tower members, missing tower members, and altered tower members.

The overall scope of Stantec's work assignment was to complete follow-up site inspections and confirm the details of previously identified deficiencies, simulate the deficiencies in the applicable tower models to analyze structural impacts and performance, then develop work plan to either accept or remedy each individual tower site's deficiencies.

This document summarizes the transmission line design criteria, methodology, and assumptions that were followed to carry out the described structural analysis work. Results from engineering analysis are also included along with recommendations. For the inspection work, Stantec has subcontracted Connect Atlantic Utility Services (CAUS). This document does not cover the full details pertaining to the survey work, but Appendix A can be referenced for more information.

The original project scope (Phase 1), completed in 2023, focused on deficiencies identified by NLH. The additional project scope (Phase 2), the subject of this 2024 report, focuses on assessment of additional deficiencies identified during full inspection of the subject lines that was completed in 2023.

2 Scope of Work

The transmission line engineering scope mainly consisted of structural analysis of existing towers using the PLS TOWER software. The goal was to evaluate the impact of flagged deficiencies on structural reliability and produce remedy/repair work plans for structures in the scope.

The available existing PLS TOWER models were reviewed in detail for completeness and correctness based on the corresponding structure detail drawings. The models were appropriately “trued up” per the details covered in this document prior to structural analysis and assessment. Once the flagged deficiencies were confirmed via field inspection and site data indicating the condition of affected members/sections was reviewed, the PLS tower models were updated for deficiency simulation.

A summary of structural analysis results and capacity checks is provided for all impacted tower sections/members. Based on the results of the investigation, preliminary mitigation measures (e.g. member replacement, connection reinforcement, member upsizing, addition of bracing) are proposed for all identified deficiencies to facilitate the decision-making process for potential remedial repairs.

No wire-related changes were made to the as-received PLS-CADD models of the existing lines described in Section 3 of this document (e.g. wire files, sag-tension). It is assumed that the conductor sections are properly sagged to LiDAR data with correct tensions based on the line conditions at the time of survey. No analysis of clearances was completed under this project scope.

Detailed drone inspection of the entirety of these circuits revealed additional defects beyond the original (known) list of deficiencies. The original defects were covered under Phase 1 scope (2023). The additional 2024 scope, Phase 2, covers the additional deficiencies. The following tables provide breakdowns of the additional deficiencies identified, by number of deficient structures of each type.

Table 1 - Deficiencies Breakdown for Line L23

Tower Type	Description	Count
S	Suspension/tangent, no ground wire	123
A	Suspension/tangent, with ground wire	2
T	Semi-anchor, no ground wire	8
C	Heavy anchor, with ground wire	3

Table 2 - Deficiencies Breakdown for Line L24

Tower Type	Description	Count
BB	Suspension/tangent, no ground wire	81
B	Suspension/tangent, with ground wire	0
EE	Semi-anchor, no ground wire	8
HH	Heavy anchor, no ground wire	1
H	Heavy anchor, with ground wire	1

Table 3 - Deficiencies Breakdown for Line L23A

Tower Type	Description	Count
GV-0	Guyed suspension, no ground wire	0
RT-0	Semi-anchor, with ground wire	2
RT-DE-70	Dead-End, with ground wire	0

Table 4 - Deficiencies Breakdown for Line L24A

Tower Type	Description	Count
GV-0	Guyed suspension, no ground wire	1
RT-0	Semi-anchor, with ground wire	3
RT-DE-70	Dead-End, with ground wire	1

Referring to the summary of tower types for each line that NLH has included on the Request for Proposal (RFP) document for the original scope (Phase 1), it appears that not all tower types/families are covered by the deficiencies scope, even in this larger Phase 2 additional scope.

No calculations and analysis of tower structure foundations are included in the project scope.

3 Project Files, References, and Applicable Standards

In support of the original (Phase 1) scope of work, NLH has provided the following key reference files:

- Request for Proposal (RFP) document covering various details for the original (Phase 1) scope.
- RFP Appendix A – tower structure detail drawings and original load tables for various families.
- RFP Appendix B – structure lists, structure data sheets (SDS).
- RFP Appendix C – tower deficiencies scope table, for original scope (Phase 1) only.
- PLS-CADD backup files for the L23, L24, L23A, L24A lines, complete with PLS TOWER structure models and wires graphically sagged to LiDAR point data based on operating conditions.
- 2020 Manitoba Hydro structure and line modelling and analysis report for L23, L24, L23A, L24A. The Manitoba Hydro project is the source of the PLS-CADD files that will be used on this project.
- 1982 report for a frost prevention program for the Twin Falls – Wabush area (L23, L24).
- 2011 report for NLH tower inspection program carried out on L23, L24, L23A, L24A.
- Various appendices from an AECOM report, including tower drawings list and vector loads summaries/calculations.

PLS TOWER models were first validated against the detail drawings provided, but this exercise was only completed for the tower families covered by the deficiencies scope. The complete set of tower detail drawings for line L24 Type EE and Type HH were not available from NLH. As such, the PLS TOWER models for these structure types were "trued up" partially to the extent of available information..

Two locations have been identified on L24A where inspection data suggests there is a discrepancy with the PLS TOWER models. For structures #3 and #4, the PLS TOWER model suggests that equal leg extensions are used, whereas inspection data shows different leg extensions due to ground slope. The unequal leg extensions observed were reflected in the “trued up” tower models used for analysis.

Table 5 - L24A Tower Leg Extension Discrepancies

Structure	Tower Type	Leg Extensions							
		PLS TOWER Model				Inspection			
		Leg 1	Leg 2	Leg 3	Leg 4	Leg 1	Leg 2	Leg 3	Leg 4
3	RT-0	+20	+20	***+20***	***+20***	+20	+20	***+10***	***+10***
4	RT-0	+5	+5	+5	***+5***	+5	+5	+5	***+0***

Apart from locations in Table 5, the structure types indicated in the SDS and included in the PLS-CADD models were identified as correct, based on photos and agreement between the tower models and LiDAR point data for structure geometries.

The following codes and standards are applicable given the project scope:

- CSA 22.3 No.1 -2020 Overhead Design Systems
- CSA 22.3 No.60826 -2019 Design Criteria of Overhead Transmission Lines

- CAN/CSA-S16, “Limit States Design of Steel Structures”
- CSA C83-17: Communication and Power Line Hardware
- CSA C411.1-10: AC Suspension Insulators
- CSA-G12, Zinc Coated Steel Wire Strand
- CAN/CSA C57–98 (R2011): Electric Power Connectors for Use in Overhead Line Conductors
- ASCE 10: Design of Latticed Steel Transmission Structures
- CSA G40.20 General Requirements for Rolled or Welded Structural Quality Steel
- CSA G40.21 Structural Quality Steel
- ASTM A394: Standard Specification for Steel Transmission Tower Bolts, Zinc-Coated and Bare
- ASTM A123/123M: Standard Specification for Zinc (Hot Dip Galvanized Coatings on Iron and Steel Products)

4 Inspection Results

The full set of inspection results are in included in Appendix A. The following constitutes a list of all key deficiencies captured by CAUS at the time of structure inspections. The impact of these deficiencies on tower structure performance under defined loadings was assessed.

- Member is bent.
- Member is broken.
- Member is missing.
- Member is missing bolts or loose nuts.
- Member is altered.

The following constitutes a list of additional deficiencies flagged that were not considered relevant for structural performance assessment and subsequent structural remedy/repair planning. These deficiencies can be categorized as geotechnical, environmental, or operation/serviceability issues.

- Tower is leaning.
- Tower base fill is too high or low.
- Tower base is overgrown by vegetation.
- Insulator is worn.
- Insulator is porcelain (not considered a deficiency by NLH).
- Insulator is not plumb.
- Raptor nest at structure.
- Tower is missing jumper.
- Tower member is rusted (unless its severity is medium/high).

Table 6 provides a basic breakdown of key deficiency counts across the circuits, by quantity of structures where the deficiency types occur. Note that the same structure could be included in multiple counts if multiple deficiency types occur at that particular structure.

Table 6 - Deficiencies Breakdown (by # of structures)

Circuit	Member Deficiency Type					
	Bent	Broken	Missing	Missing Bolts	Loose Nuts	Altered
L23	133	7	1	0	0	2
L24	77	4	11	1	1	3
L23A	2	0	0	0	0	0
L24A	4	0	0	0	0	1

The field inspectors manually assigned severity level of low, medium, or high to each individual deficiency flagged throughout the lines. The criteria for severity were subjective based on the nature of the visually observed deficiency, the member of the tower where it occurs, and the intensity of the deficiency (e.g.

degree of deformation). However, this deficiency rating does not necessarily corelate to critical members and was not directly used to develop the recommended priority system for repairs that was identified after the structural analysis.

Table 7 provides a break down of the key deficiency types by severity level. Note that this refers to individual deficiency counts as opposed to structure counts.

Table 7 - Severities Breakdown (by # of deficiencies)

Circuit	Severity Level	Member Deficiency Type					
		Bent	Broken	Missing	Missing Bolts	Loose nuts	Altered
L23	Low	256	1	0	0	0	2
	Medium	2	7	1	0	0	0
	High	0	0	0	0	0	0
L24	Low	207	5	2	0	1	5
	Medium	4	4	37	1	0	1
	High	0	0	0	0	0	0
L23A	Low	2	0	0	0	0	0
	Medium	0	0	0	0	0	0
	High	0	0	0	0	0	0
L24A	Low	4	0	0	0	0	1
	Medium	0	0	0	0	0	0
	High	0	0	0	0	0	0

Around 96% of the key deficiencies observed in the L23 circuit, and around 79% in the L24 circuit, were bent members, the majority of which were flagged as low severity. Trends were observed in which member was bent on each specific tower type. Table 8 and Figure 1 provide a summary of this trend for L23. The values provided are frequency of the specific member ID being bent, out of all the members found to be bent across all towers on the circuit.

Table 8 - Bent Members, L23 (by % of occurences)

Member ID	Description	Tower Type	Frequency
118	Horizontal diaphragm (belt member)	S	2%
124	Main leg diagonal bracing (0ft leg extension)	T	6%
127	Main leg diagonal bracing (-5ft leg extension)	S	10%
131	Main leg diagonal bracing (0ft leg extension)	S	59%
136	Main leg diagonal bracing (5ft leg extension)	S	7%

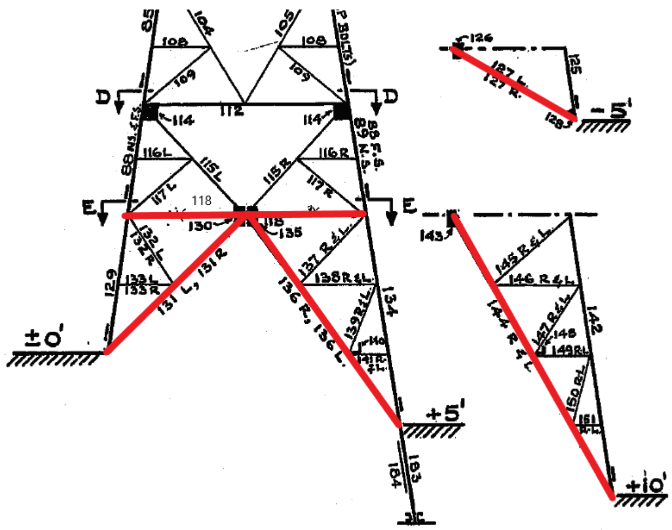

Figure 1 - Key Deficient Members, L23 Type S Tower

Similar to L23, Table 9 indicates bent member trends for circuit L24 with Figure 2 depicting the members.

Table 9 - Bent Members on Line L24 (by % of occurences)

Member ID	Description	Tower Type	Frequency
75	Plan brace in horizontal diaphragm	BB	2%
227 / 228	Main leg diagonal bracing (0ft leg extension)	BB	17%
236 / 237	Main leg diagonal bracing (-5ft leg extension)	BB	9%
252 / 253	Main leg diagonal bracing (5ft leg extension)	BB	17%
277 / 278	Main leg diagonal bracing (10ft leg extension)	BB	13%

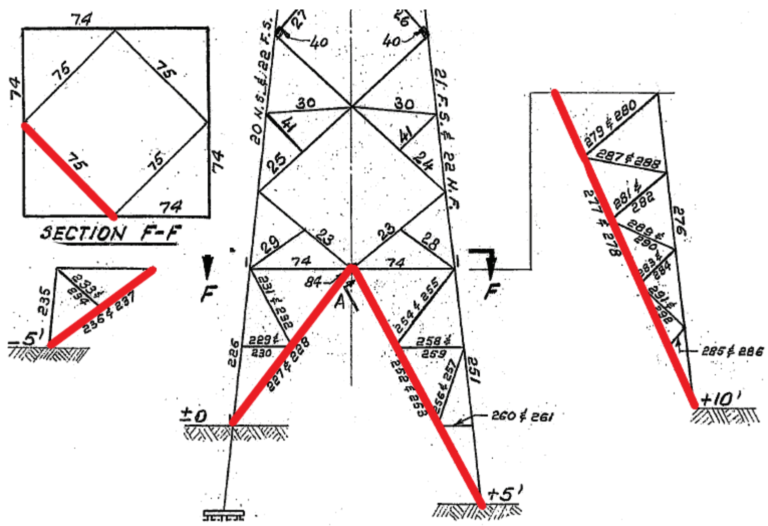

Figure 2 - Key Deficient Members, L24 Type BB Tower

While there were much fewer deficiencies identified on circuits L23A and L24A, the deficient members were located in the legs for these structures as well. Figure 3 shows the key deficient members of type RT-0 tower in L23A and L24A circuits.

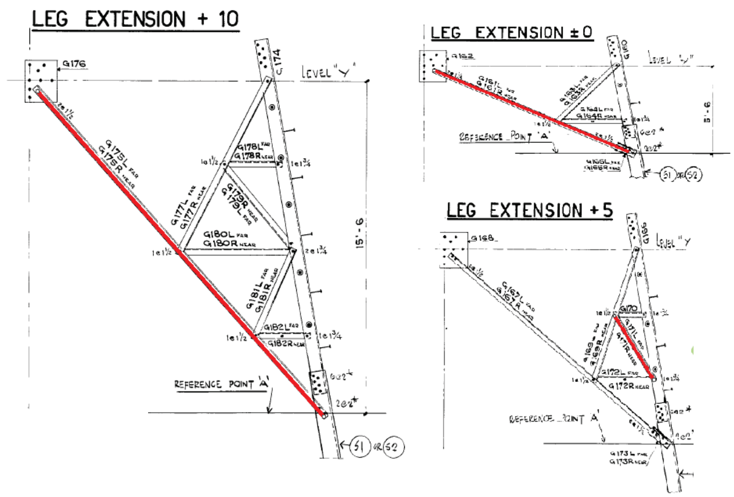

Figure 3 - Key Deficient Members, L23A and L24A, Tower Type RT-0

Some trends were also observed within the results for broken members and missing members. Although these trends are not as significant as for bent members due to the lower number of occurrences, it is worth noting the following:

- L23 – of the broken members, 50% were member #131 in the Type S tower.
  - #131 = main inside leg diagonal (0ft leg extension), appearing in Table 8.

- L24 – of the missing members, 95% were member #75 in the Type BB tower.
  - #75 = inside member of diaphragm (where legs connect to body), appearing in Table 9.

For all other specific instances of deficiencies observed throughout towers on these lines, please see the full inspection report output in Appendix A of this report.

5 Analysis Criteria and Approach

5.1 Assumptions and Methodology

The following assumptions and remarks reflect how Stantec completed tower structure analysis and modelling on this project:

- Validating ("trueing up") of available tower models was done in the context of the relevant standards they were modelled to, and assumptions made to accurately reflect the original design. For modelling of deficiencies and, where required, structural remedies, the same guiding principles were followed. Similar material, member sizes, connection style/properties, and structural system geometry were followed.

  <u>Tower Member Check Criteria:</u>

Slenderness Ratio	• If the member capacity, as determined by ASCE 10 Standard, without limitation to the L/r ranges, meets or exceeds the new member force, then it may not be necessary to change or modify the member to meet the slenderness ratio recommendations in ASCE 10. • Any new or replacement members added to the existing tower shall meet the requirements of the latest version of ASCE 10 standard.
Man-Load/Climbing Check	• Climbing check of members will not be completed considering alternate maintenance procedures (step bolts).
Minimum Distances	• Minimum end and edge distances will not be checked for the existing tower members. • Replacement or reinforcement members should meet the end distances, center-to-center bolt hole spacing, and edge distance criteria recommendations in the ASCE 10 standard.
Member Usage Ratios	• Reinforcement will be recommended for members whose loads exceed the calculated design capacity (e.g. > 100%). Reinforcement may include addition of members and bolts or complete replacement. This criterion may be adjusted on a case-by-case basis depending on how critical NLH deems a member.

- Available tower models for L23 utilize G40.4 and G40.6 steel grades, while L24 models utilize G40.4 and G40.8. Both L23A and L24A tower models utilize ASTM A36 and G40.12 steel grades in accordance with the original tower detail drawings. The properties of these materials are as follows:

Assumed Tower Material Properties, L23 and L24 circuits

	G40.4 ASTM A7-52T	G40.6 ASTM A94	G40.8	Bolts
Yield Stress (MPa):	230	310	275	5/8" – ASTM A394 Type 0 Hole Dia: 19.05mm Shear Capacity: 49.60kN
Ultimate Stress (MPa:	410	550	448	

Assumed Tower Material Properties, L23A and L24A circuits

	ASTM A36	G40.12	Bolts
Yield Stress (MPa):	248	303	5/8" – ASTM A394 Type 0 Hole Dia: 19.05mm Shear Capacity: 49.60kN
Ultimate Stress (MPa):	400	448	

New Reinforcement Material Properties

- All new steel for reinforcement designed in the future is recommended to be CSA G40.20-13/G40.21-13 Grade 350W for structural steel. New bolts shall be as per ASTM A394 Type T1. Member connection detailing was not considered when the available tower models were created. As such, member connections such as number of bolts and shear planes, will be modelled and checked as part of this project scope. However, minimum end and edge distances and connection rupture checking will not be completed as part of the tower analysis.
- Member checking shall primarily be completed for compression capacity (buckling) and tension capacity (net section) using PLS TOWER in accordance with methodology from ASCE 10 code built into the PLS-TOWER. No climbing load check will be completed.
- All redundant members are modelled and will be included in Finite Element Analysis (FEA). Redundant members are checked based on the actual force in redundant members.
- Deficiencies shall be simulated using specific approaches on a case-by-case basis at each tower location, depending on the exact deficiencies observed. This may include artificial reduction in member properties, steel material strength, basic connection strength, or complete elimination of a member from a tower model. The following are deficiency modelling techniques utilized in analysis:

Table 10 - Deficiency Modelling Techniques Considered

Type of Deficiency	Model Alteration
Rusted Members	Reduction in the thickness of the steel section (in case of severe corrosion)
Bent or Buckled Members	Member to be modelled as Tension-Only (severe), or member compression capacity to be reduced (minor)
Broken Members	Member to be removed from the tower model
Broken Connections	Member to be removed from the tower model, or rotational restraint to be modified

- Per findings in the Manitoba Hydro report, tower lean was not found to significantly impact analysis of the towers modelled. As tower lean is primarily a foundation issue and even the PLS TOWER manual (v19.00) states “the ability to specify rotations is really not applicable to latticed towers for which there is no good way to account for the effects of foundation rotations” and that “the feature is included because the [input] table is shared with [the] PLS-POLE program for poles and frames”, the impact of tower leans is not being considered during assessment work.
- PLS-CADD structure analysis shall be completed with SAPS level L2.

5.2 Structure Loads

The Manitoba Hydro report from 2020 is based on a very comprehensive, in-depth investigation of the original loading criteria applicable to the lines from Churchill Falls to Wabush, specific to each of the four circuits/segments (L23, L24, L23A, L24A). The report concludes that original climatic line loading criteria was difficult to back-calculate due to the limited amount of information in the tower detail drawings. As reliability-based loading calculations and analysis was not yet common practice at the time these lines were designed, Manitoba Hydro concluded that CSA C22.3 No. 1-15 deterministic loads were most suitable to apply for analysis of these towers at the time of the project. Additionally, Manitoba Hydro did not find any evidence of security load cases considered in the tower design either.

Based on Stantec’s interpretation of Manitoba Hydro’s approach as well as separate investigation and observation of the available project information, the ambiguity in what original structure loads are included on the tower detail drawings suggests that Manitoba Hydro’s conclusions were reasonable. As reliability-based climatic loading criteria is unrealistic to apply on structures designed around 60 years ago, the basic deterministic CSA 22.3 No. 1-20 (newer version of the standard than available at the time of Manitoba Hydro’s report) criteria is deemed appropriate for minimum climatic loading. In conjunction with the climatic loading, typical security loading cases specific to each tower type shall be considered as well.

The following are the structural analysis load cases proposed by Stantec to apply for the purpose of analyzing towers on this project without deficiencies, with deficiencies, and after remedy:

For climatic loading per CSA C22.3 No. 1-20 (deterministic), the following shall be applied:

- CSA Medium B loading area:
  - 12.5mm radial ice, -20°C, 300 Pa wind on wire, 960 Pa wind on tower,

- Grade 2 construction load factors for steel structures:
  - Vertical: 1.15
  - Transverse: 1.10
  - Longitudinal (dead-end): 1.10
  - Longitudinal (suspension/tangent): 1.00

For security loading (to utilize CSA Medium B loading and Grade 2 load factors per above):

- Suspension/tangent structures
  - *Includes L23 Types S & A, L24 Types BB & B, and L23A/L24A Type GV-0.*
  - Unbalanced Ice (single wire)
    - All wires on structure loaded, except any one wire on one side of structure.
- Semi-anchor structures
  - *Includes L23 Type T, L24 Type EE, and L23A/L24A Type RT-0.*
  - Unbalanced Ice (single wire)
    - All wires on structure loaded, except any one wire on one side of structure.
  - Broken Wire (single wire)
    - All wires on structure loaded, any one wire broken on one side of structure.
- Dead-end structures
  - *Includes L23 Type C, L24 Types HH & H, and L23A/L24A Type RT-DE-70.*
  - Unbalanced Ice (Full Span)
    - All wires on structure loaded on one side of structure, unloaded on opposite side.
  - Broken Wire (single wire)
    - All wires on structure loaded, any one wire broken on one side of structure.

All analysis cases shall utilize strength reduction factors of 1.0 for all structure components since the load cases are based on deterministic loads and already consider overload factors.

For safety loading, a Construction and Maintenance case will be considered:

- C&M load case, bare conductor, -20°C, 50 Pa wind on wire, 160 Pa wind on tower

The Construction and Maintenance loading case is recommended to be considered in the tower analysis to evaluate safe works method during tower repair. The subject members to be repaired will be removed from the tower model one at a time to check the stability of the structure. In case the tower cannot withstand the C&M loads after member removal with overload factor of 2.0, temporary support or reinforcement should be considered as part of the repair work method.

Development of suitable temporary support methods should be investigated in a subsequent detailed design stage as part of reinforcement/repair design. No tower types shall be treated and analyzed as full anti-cascading structures (i.e. no load cases considering full dead end or “broken span” conditions shall be checked). It is assumed that no structures on this line were designed for those conditions and the results that such an analysis would produce would not be meaningful given the project scope.

6 Structural Assessment

Structural assessment for scope locations was completed on the proofed (trued up) tower models (i.e. received tower models that were updated for better completion and to better reflect detailing in their drawing sets). Site-specific loads were applied per the assumed weather conditions and criteria on each individual structure based on the PLS-CADD line models received from NLH.

The following analysis outputs were documented for each tower:

- Maximum tower structure usage
- Governing member under maximum structure usage
- Maximum usage of deficient members
- Controlling member behaviour for deficient members (compression or tension)
- KL/R (slenderness ratio) for deficient members
- Combined loading (axial + bending) member checks (hand calculation)
    - This check was completed to document the impact of bending in “beam” elements within the tower model, as well as evaluate the impact of utilizing “Tension-Only” member definitions for diagonal bracing in the post-deficiency analysis (specially for horizontal diaphragm/hip bracing).

One round of analysis was completed on proofed tower models prior to simulation of deficiencies. A second round of analysis was completed the after site-specific deficiency simulation approach was determined for each deficiency. The same outputs listed above were documented for both analyses.

The deficiency simulation was completed by applying one of the following member or member property override cases in each tower model:

- M1 - Deficient member (and any associated redundants) removed from tower model.
- M2 - Deficient member compression capacity set to 0% (i.e. member changed to tension-only).
- M3 - Deficient member compression capacity reduced to 25%.
- M4 - Deficient member compression capacity reduced to 50%.
- M5 - Deficient member compression capacity reduced to 75%.

The full set of detailed results for pre-deficiency and post-deficiency tower analysis can be found in Appendix B.

6.1 Results – L23

The L23 analysis scope consisted of 136 structures in total, of which 123 (90%) were Type S suspension/tangent (no ground wire). As such, the majority of L23 analysis and results pertain to Type S towers.

Though the Type S tower is a suspension/tangent type structure, conductors at structure #95 specifically are attached with dead-end assemblies per Figure 4. This is assumed to be because the structure is located at a water crossing, or because some sort of maintenance/repair work was done in the past in this area. As the Type S tower was not designed for semi-anchor or heavy anchor tower loadings, analysis of structure #95 was completed with suspension/tangent criteria per Section 5.2. Due to the circumstances at this structure and also considering analysis results, this is considered a high priority location.

Figure 4 - Structure #95, Type S tower in L23

At two structure locations (#349 and #522), the inspections show supporting guy wire. This is considered makeshift guying as the tower type S is self-supported suspension/tangent structure (perhaps done to mitigate tower lean). Similarly, few other Type C and Type T towers were also found to have makeshift guying. Guy wire properties were assumed in the absence of information. The guys themselves were not analyzed though; only the impact on tower structure usage was considered. The attachment of guys to specific tower members may have adverse impacts on bending moments of those members, but this was not quantified or evaluated. Table 11 summarizes the effect of guy wires on tower usage for these tower locations.

Table 11 - Guying Impact on Tower Usages, L23 Locations

Str #	Type	Tower Usage (Post-Def.)	
		With Guy Wire	Without Guy Wire
323	Type T	120.0%	120.0%
349	Type S	73.5%	77.1%
407	Type C	184.5%	181.9%
412	Type C	84.6%	88.5%
522	Type S	86.0%	78.1%

The following tables summarize L23 pre-deficiency and post-deficiency assessment results.

Table 12 - Max Structure Usages, L23 Type S (pre-deficiency)

Max Usage Range (%)	Quantity
0 – 60	1
60 – 70	10
70 - 80	56
80 - 90	37
90 - 100	17
> 100	2

For the 123 Type S structures on which deficiencies were simulated:

- 64 structures experienced increased maximum usage (expected).
- 19 structures experienced no change in maximum usage.
- 40 structures experienced reductions in maximum usage.

NOTE: *In specific deficiency simulation cases where buckling members were set to be tension-only in analysis, overall structure usage is reduced in post-deficiency conditions. Use of tension-only members is not recommended for new tower structure design; it is only considered as a method to model members with large slenderness ratios that were designed prior to ASCE 10 "Guide for Design of Steel Transmission Towers" in 1971. Utilizing tension-only members will redistribute stresses into other members such as main legs and horizontals, which can contribute to overall reduction in usage.*

The Type S maximum structure usage increases due to simulation of deficiencies are summarized in Table 13. It can be observed that the vast majority of usage increases are in the 0-15% range.

Table 13 - Max Structure Usage Increases, L23 Type S (post-deficiency)

Increase Range (%)	Quantity
0 < usage increment < 5	23
5 ≤ usage increment < 10	21
10 ≤ usage increment < 15	18
15 ≤ usage increment < 20	2
40 ≤ usage increment < 50	1

Analysis results for L23 towers other than Type S are shown in Table 14.

Table 14 - Analysis Results, L23 Types A, T and C

Structure	Type	Max Pre-Deficiency Usage (%)	Max post-deficiency Usage (%)	Usage Change (%)
5	A	63	63	0
570	A	59	59	0
109	T	123	123	0
323	T	119	119	0
324	T	116	116	0
371	T	130	130	0
418	T	117	117	0
423	T	123	123	0
430	T	128	128	0
432	T	131	131	0
407	C	91	184	93
412	C	84	84	0
568	C	122	122	0

One important finding is that all Type T semi-anchor towers inspected (eight total, all with +0 ft leg extensions) have usages exceeding 100%, even in the pre-deficiency analysis. However, member #63 (not flagged as deficient at any structure location) is the governing high usage member. This is believed to be the case because it is undersized (44x32x3.2). Figure 5 shows where this controlling member in the Type T tower is located.

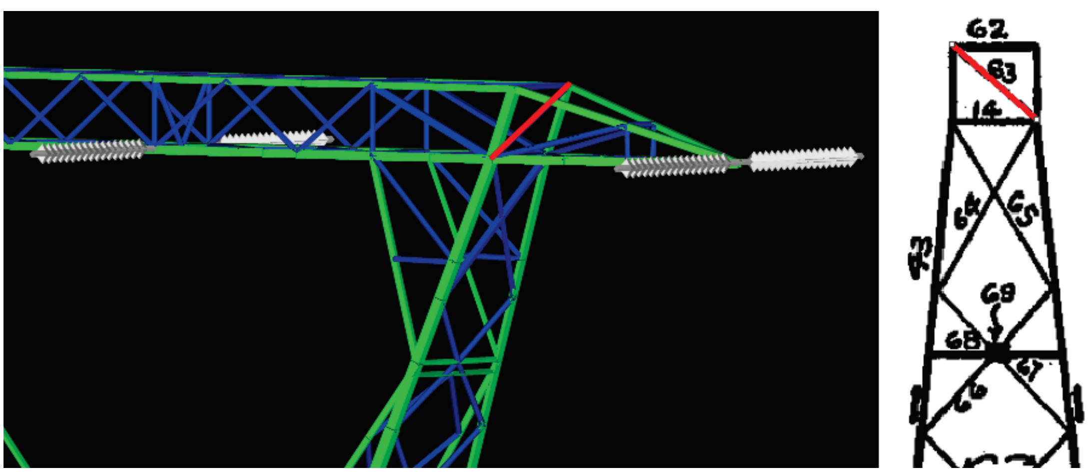

Figure 5 - Usage-Controlling Members, L23 Type T Tower

A very large jump in usage due to deficiency is observed at structure #407, a Type C structure. This is a heavy anchor structure with ground wire, so the loading conditions (security loads) are more stringent than for suspension or semi-anchor structure as outlined in Section 5.2. The deficiency simulation impact is emphasized greatly at this structure so special attention must be given to the remedy work plan. Figure 6 displays the deficient member of this location (#407), responsible for the large increase in usage.

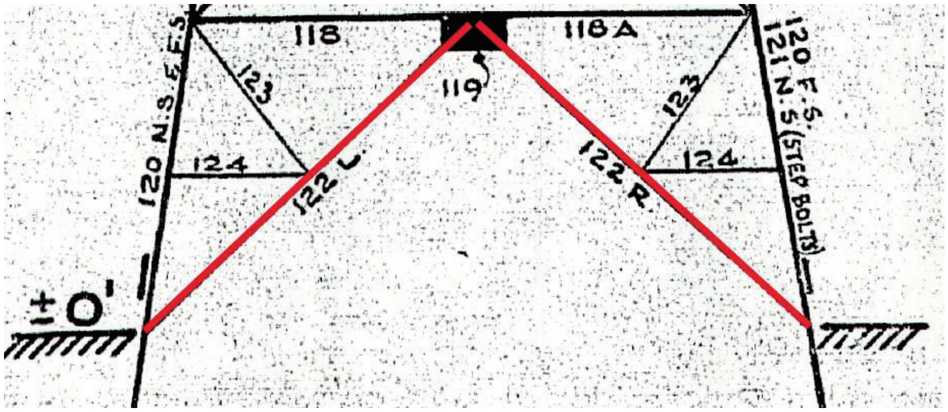

Figure 6 - Deficient Member (#122), Structure #407 (Type C)

After L23 structures analysis, the following conclusions were drawn regarding governing members producing maximum structure usage across the various structure types:

- In about 95% of cases, both pre-deficiency and post-deficiency maximum tower usages were governed by the same member (either the exact one, or the same member ID on a different face).
- In about 82% of cases, the deficient member governed the structure usage. This was especially the case for the Type S suspension/tangent towers. The other towers (Types A, T, C) had maximum usage governed by members other than deficient ones.

6.2 Results – L24

The L24 analysis scope consisted of 91 structures in total, 81 of which (89%) were Type BB suspension/tangent type (no ground wire). As such, the majority of L24 results pertain to the Type BB tower. Some discrepancies were found between survey data and the tower models in the PLS-CADD files received.

Structure locations where survey discrepancies were observed:

#100	• Survey images do not match with the TOWER model. More likely L23_100 tower was captured instead of L24_100 by mistaken.
#349	• Survey images do not match with the TOWER model. More likely L23_349 tower was captured instead of L24_349 by mistaken.

#427	• Tower body extension of the survey images does not match with the TOWER model. Type_BB(-5ft) is used in the model while images represent a Type_BB(+0ft) tower.

Three towers of this circuit were found to have makeshift guying similar to L23 structures and Table 15 summarizes the impact of guy wires on tower usage for these L24 structures. Guy wire properties were assumed but only the impact on tower was considered. Proper guy wire attachment to the tower is recommended to avoid inducing additional moment in tower members, however the exact function and impacts of makeshift guying on these self-supported towers must be investigated before any action should be taken with respect to the makeshift guying.

Table 15 - Guying Impact on Tower Usages, L24 Locations

Str #	Type	Tower Usage (Post-Def.)	
		With Guy Wire	Without Guy Wire
4	Type H	155.8%	155.8%
410	Type HH	97.0%	97.0%
428	Type EE	144.0%	144.1%

Per Table 16, the L24 Type BB structures are all well-utilized under the load cases defined and checked prior to simulation of observed deficiencies.

Table 16 - Max Structure Usages, L24 Type BB (pre-deficiency)

Max Usage Range (%)	Quantity
0 – 50	0
50 – 60	12
60 - 80	67
80 - 100	2
> 100	0

For the 81 Type BB structures on which deficiencies were simulated:

- 33 structures experienced increased maximum usage (expected).
- 28 structures experienced no change in maximum usage.
- 17 structures experienced reductions in maximum usage.
- 3 structures were not analysed due to survey error.
    - See note regarding tension-only members in Section 6.1 of this report.

The Type BB usage increases upon simulation of deficiencies are summarized in Table 17. The majority of increases (roughly 75% of locations) were minor (up to 5%), but the remainder experienced substantial jumps in usage (> 20%). These jumps in usage are indicative of which locations are deficiency-critical and are used as a metric to help define the suggested remedial repair priorities.

Table 17 - Max Structure Usage Increases, L24 Type BB (post-deficiency)

Increase Range (%)	Quantity
Increase Range (%)	Quantity
0 < usage increment < 10	36
10 ≤ usage increment < 20	7
20 ≤ usage increment < 30	2
30 ≤ usage increment < 40	2
40 ≤ usage increment < 50	1

Deficiencies on L24 were captured for 10 other structures that are not Type BB. See Table 18 for a summary of pre-deficiency and post-deficiency analysis results for those structures. High usages were observed for all these other structures, and all structures except one exceed 100% usage even in pre-deficiency analysis.

Table 18 - Analysis Results, L24 Types B, EE, HH, H

Structure	Type	Max Pre-Deficiency Usage (%)	Max Post-Deficiency Usage (%)	Usage Change (%)
4	H	155.8	222.8	67.0
121	EE	136.9	136.9	0.0
130	EE	128.5	167.8	39.3
186	EE	102.1	134.0	31.9
410	HH	97.0	97.0	0.0
415	EE	153.7	153.8	0.1
416	EE	134.3	163.1	28.8
421	EE	142.1	223.6	81.5
428	EE	144.0	266.6	122.6
430	EE	146.5	146.5	0.0
410	HH	155.8	222.8	67.0

The following figures depict common deficient members of tower types other than Type BB.

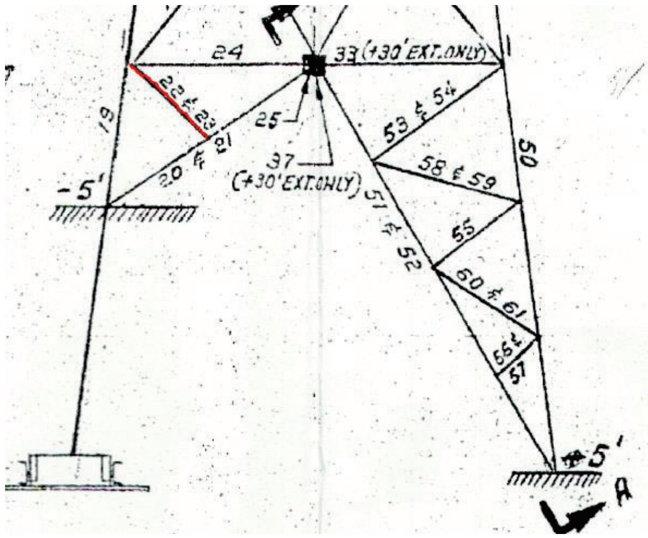

Figure 7 - Deficient Members (#22/23), Structure #410 (Type HH)

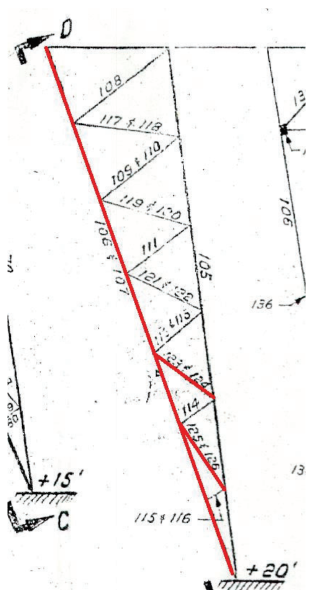

Figure 8 - Deficient Members (#106/107124/125/126), Structure #4 (Type H)

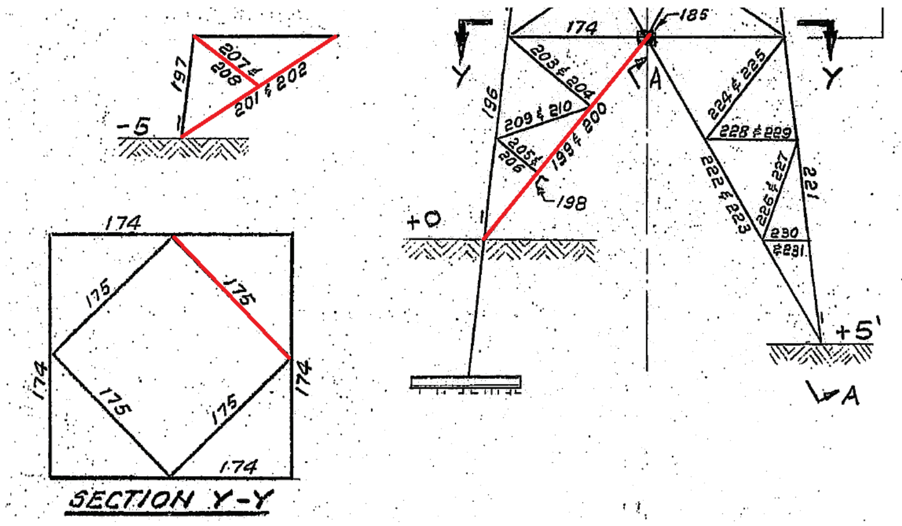

Figure 9 - Common Deficient Members, Type EE

After L24 structures analysis, the following conclusions were drawn regarding governing members producing maximum structure usage across the various structure types:

- In about 78% of cases, both pre-deficiency and post-deficiency maximum tower usages were governed by the same member (either the exact one, or the same member ID on a different face).
- With the exception of three locations (structures # 151, 186, 428), defective members were not found to be governing maximum structure usages in pre-deficiency and post-deficiency analysis. This indicates that replacement of deficient members, while important, is not sufficient to improve the reliability of these structures due to high utilization of other critical/over-stressed members that may fail in future.

6.3 Results – L23A

The L23A analysis scope only consisted of two structures, both Type RT-0 (semi-anchor). Table 19 summarizes the analysis results.

Table 19 - Analysis Results, L23A (Type RT-0)

Structure	Type	Max Pre-Deficiency Usage (%)	Max Post-Deficiency Usage (%)	Usage Change (%)
2	RT-0	107.7	107.7	0.0
3	RT-0	97.2	98.8	1.6

Structure #2 exceeds 100% usage, even in pre-deficiency state, while structure #3 experiences high usage and a small increase after deficiency simulation. Figure 10 and Figure 11 show the deficient members of these L23A structures.

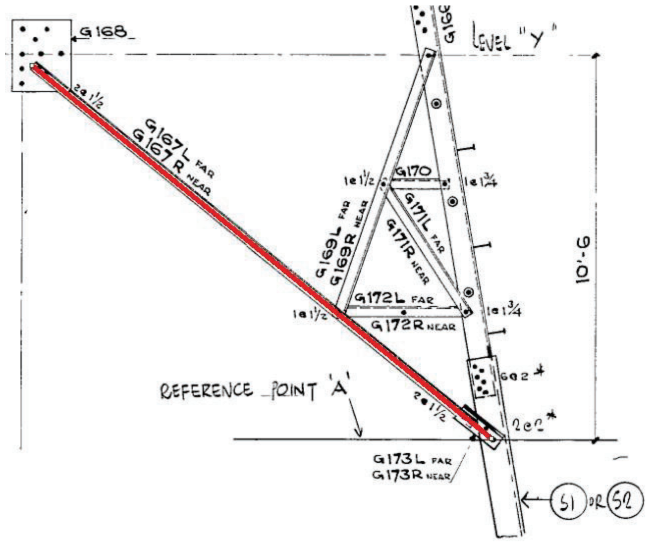

Figure 10 - Deficient Member (#167), Structure #2 (Type RT-0)

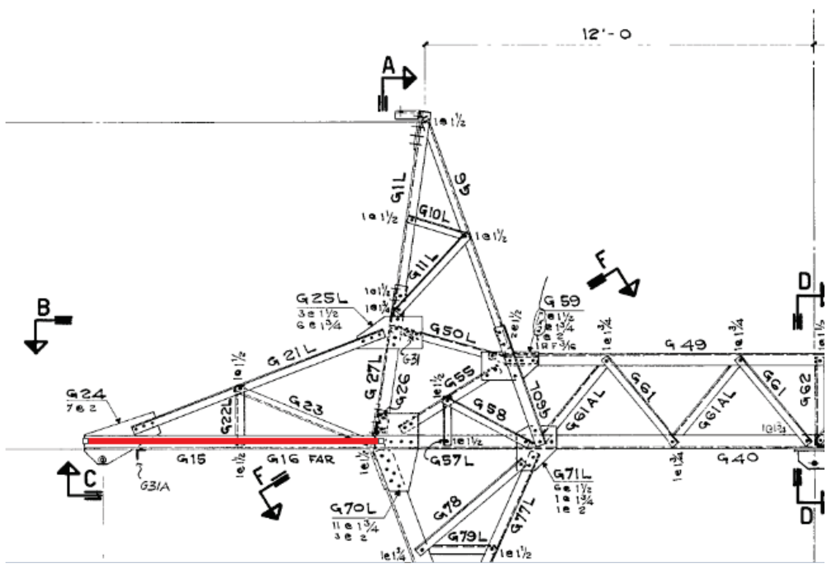

Figure 11 - Deficient Member (#15), Structure #3 (Type RT-0)

After L23A structures analysis, the following conclusions were drawn regarding governing members producing maximum structure usage across all structure types:

- For structure #2, the same member (#140) governs both pre-deficiency and post-deficiency usage. The deficient member, #167, is not governing structure usage in either analysis for this structure.
- For structure #3, member #140 controls structure usage under pre-deficiency conditions. However, since the deficiency simulation method for this structure was to reduce the compression

capacity of deficient member #15 to 50% (as it is a crossarm member and cannot be set to tension-only), member #15 governed usage in post-deficiency analysis.

6.4 Results – L24A

The L24A analysis scope only consisted of 5 towers total. Of the three Type RT-0 structures (semi-anchor), two tower models were identified to have leg extension discrepancies. See Table 5 in Section 3 of this document. The tower models for these structures, #3 and #4, were updated to reflect the unequal leg extension configurations per inspection data for more accurate analysis results. Table 20 summarizes the analysis results of the L24A towers.

Table 20 - Analysis Results, L24A (Types GV-0, RT-0, and RT-DE-70)

Structure	Type	Max Pre-Deficiency Usage (%)	Max Post-Deficiency Usage (%)	Usage Increment (%)
2	RT-0	116.1	116.2	0.1
3	RT-0	110.6	110.4	-0.2
4	RT-0	161.1	161.1	0.0
7	RT-DE-70	88.2	88.2	0.0
63	GV-0	46.4	46.4	0.0

All RT-0 tower types exceeded 100% usage even in pre-deficiency state and no significant usage increase was observed due to deficiency modelling. This highlights the importance of a detailed investigation to find and replace non-deficient usage exceeding members of RT-0 towers.

- Structure #3 - See note regarding Tension-Only members in Section 6.1 of this report.

The following figures show common deficient members of towers in the L24A circuit.

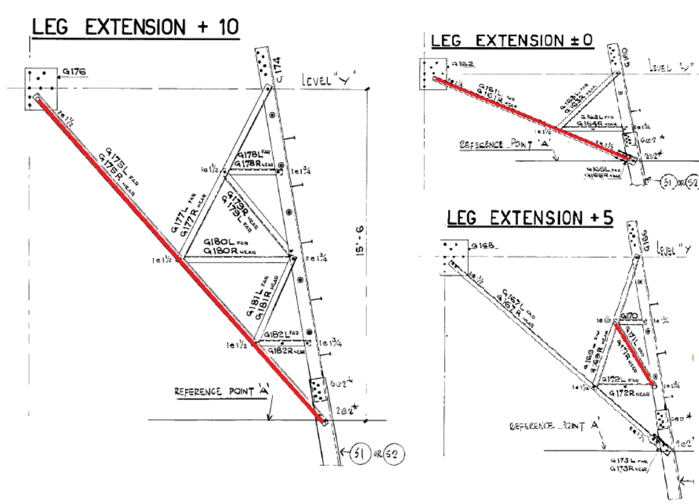

Figure 12 - Deficient Members (#161, 171 ,175), Type RT-0

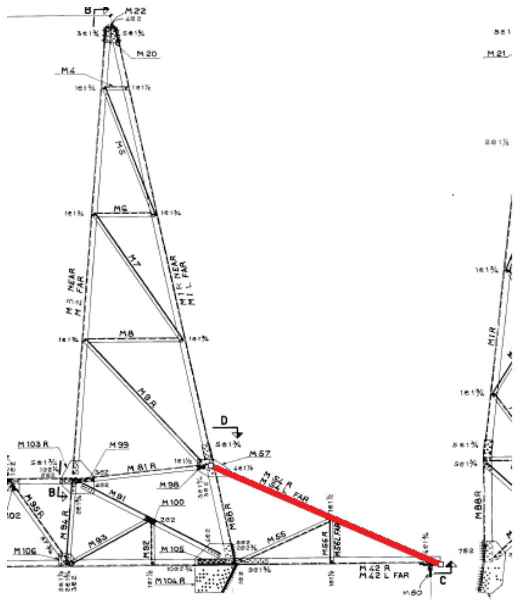

Figure 13 - Deficient Member (#54), Type RT-DE-70

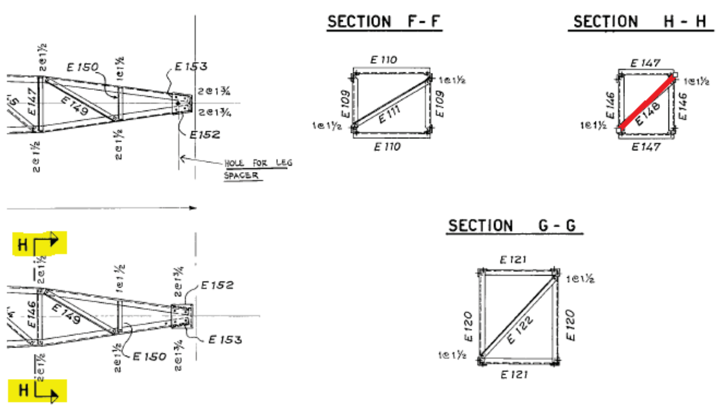

Figure 14 - Deficient Member (#E148), Type GV-0

After L24A structures analysis, the following conclusions were drawn regarding governing members producing maximum structure usage across the various structure types:

- For all five structures, the same member governed pre-deficiency and post-deficiency usages.
- For all structures other than #4, structure usages were governed by members other than the deficient member. For structure #4, deficient member #175 governed maximum usages.

7 Proposed Remedies and Repairs

7.1 Interpretation of Results

Based on the post-deficiency tower analysis results, the first suggested step for remedy and repair planning is to develop a priority designation system. This system should be based on the performance of towers in their idealized existing state as well as their sensitivity to their deficiencies under their site-specific conditions.

Table 21 outlines the classification system developed for structure usage jumps. Table 22 summarizes the priority system developed and summarizes the distribution of structure behaviours for each line. Note that maximum structure usage refers to the maximum of pre-deficiency and post-deficiency usages. See Appendix C for the full detailed list of priorities for each scope structure.

Table 21 - Structure Usage Jump Categories (post-deficiency)

Category	Usage Increase Range (%)	# of Structures			
		L23	L24	L23A	L24A
J0	No Increase	67	47	1	5
J1	0 – 5	26	22	1	0
J2	5 – 10	21	2	0	0
J3	10 – 15	18	5	0	0
J4	15 – 20	2	2	0	0
J5	> 20	2	10	0	0

Table 22 - Remedy and Repair Priorities

Category	Description	# of Structures			
		L23	L24	L23A	L24A
P1	Max structure usage > 100%	20	12	1	3
P2	> 20% jump in max usage (J5), or 95-100% max usage	8	3	0	0
P3	15-20% jump in max usage (J4), or 90-95% max usage	16	2	0	0
P4	10-15% jump in max usage (J3)	8	5	0	0
P5	5-10% jump in max usage (J2)	15	2	0	0
P6	0-5% jump in max usage (J1)	14	34	0	0
P7	0% increase in max usage (J0)	55	33	1	2

On all lines/circuits, all semi-anchor and heavy-anchor (dead-end) structure types in the scope (11 in total on L23, 10 in total on L24, 2 in total on L23A, and 4 in total on L24A) were assigned priority level P1 for remedy and repair. This is due to the criteria developed but also because they are higher importance structures within the lines as they support conductor terminations.

7.2 Work Plan Development

The deficiency simulation results are classified for each line and structure type, with a priority index developed to help determine a strategic order of operations for remedy and repair work. The final step in engineering analysis is to investigate and prescribe work plans to rectify the deficiencies identified in the project scope. It is understood that the preference would be to utilize work methods that minimize outage durations (if any) and allow for repair/replacement work to be carried out within safe working zones while the lines are energized.

Table 23 summarizes the remedy/repair methods deemed to be appropriate to rectify the spectrum of deficiencies observed throughout these four lines/circuits. For structures where either pre-deficiency or post-deficiency usages were found to exceed 100%, further analysis was completed to ensure that if deficient members were removed from a tower one at a time, structure usages did not exceed 100% at the Construction and Maintenance load case only (see Section 5.2 of this document). This analysis was also completed on several other priority P1 and P2 structures even when usage did not exceed 100%.

Table 23 - Remedy/Repair Method Breakdown

Category	Description	# of Member Instances			
		L23	L24	L23A	L24A
R1	Complete replacement of deficient member	267	268	1	4
R2	Addition of new member along existing deficient member to create double angle member	3	5	0	0
R3	Installation of additional redundant members	0	0	0	0
R4	No actions needed (very minor deficiency with no affect on tower performance)	0	0	1	1

In all cases possible, it is recommended to rectify deficient members by complete replacement. There are particular instances where member replacement is not feasible, such as where the members are primary leg members, or part of a critical compression arrangement of the tower. In such locations, it is proposed to strengthen deficient members by adding new member along them (creating a double angle).

For L24 structure #130, it's recommended to apply both R2 and R3 methodology, adding steel to make the deficient member a double angle as well as adding new redundant members to reduce unbraced length. Firstly, the bent leg of the deficient angle should be straightened out, then another angle member of a higher profile as recommended in section 8.3 can be connected along the original member to convert it to a back-to-back double angle member. Lastly, redundants can be added as shown in Figure 15 for additional support. While completing this work for the deficient member, it's recommended to carry out the same action (doubling up the member, plus supporting with new redundants) to symmetric members in the structure as well.

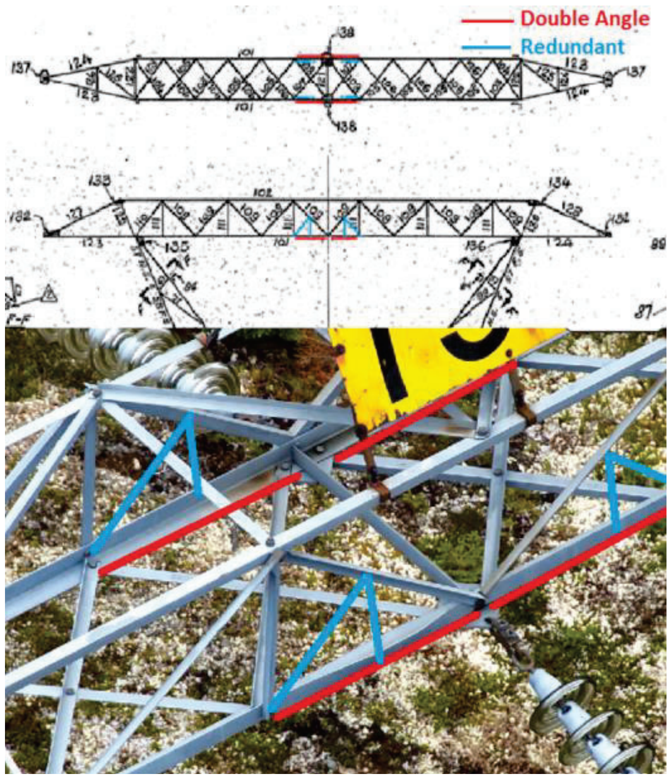

Figure 15 - Proposed Remedies, L24 Structure #130

For towers where the C&M load case (simulating removal of an individual deficient member during construction) yielded failing structure analysis results, it was determined that the work plan for those structures must include some form of temporary structural support or off-loading the tower by lifting conductors during construction.

- For lines/circuits L23, L23A, and L24A, none of the work methods prescribed were found to require temporary support.
- For line L24, a total of 20 structure locations were found to require temporary support so the necessary remedy/repair methods can be applied to the structure to rectify all deficiencies.

See Appendix D for the full work plan summary covering all project scope structures. This appendix outlines the remedy/repair method prescribed for each structure and flags critical structures where temporary support (or conductor lift) is recommended before the work is started on the existing towers. The temporary support must be set up before deficient member work plans are carried out in order to provide reinforcement and alleviate/redistribute forces, to avoid overloading of any members during construction.

Appendix D recommends that 20 deficient members in eight different structures in the L24 circuit need temporary supports to replace the deficient members. 85% of these cases correspond to leg member failures when the deficient member is removed under C&M loading. This is not by coincidence, as all these eight structures are tall extensions (+10 and +20) and when the deficient diagonal member is removed, unbraced length ratios of the leg member to which the deficient diagonal was attached will be increased significantly, specifically RLx (or RLy). Therefore, it is important to secure these leg members before proceeding with the repair works of these locations.

Furthermore, as the majority of deficient members across all structure types across all four lines/circuits are primary, secondary, or redundant members in the tower legs, the default recommended solution to allow for prescribed remedy/repair works is to provide additional support to the tower legs on which work is being done. This additional support should be provided as close to redundant connection points as possible.

Figure 16 depicts a possible temporary support solution to reinforce legs via temporary cable ties. Another option would be to support the tower at critical points with a crane, or completely unload the tower (temporarily lifting of conductors and ground wires). The cable tie option would provide increased member stability if cables are installed at the leg joints, but it would increase compressive loads in the supported member. The feasibility of cable ties should only be determined with detailed analysis.

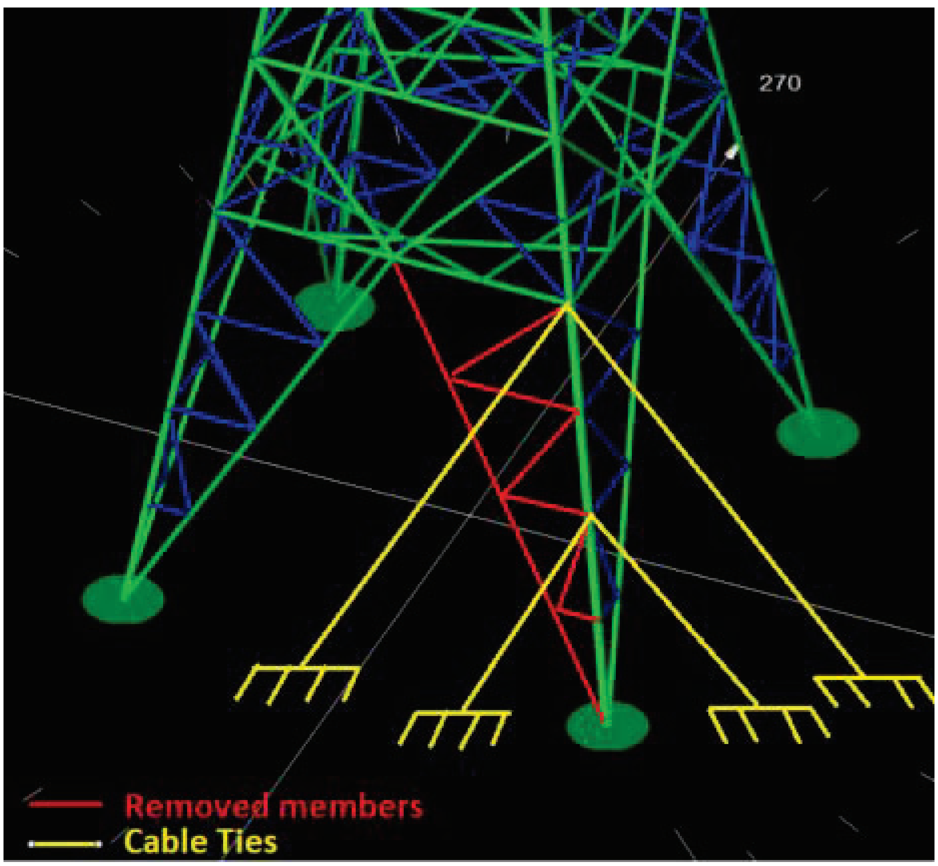

Figure 16 - Potential Cable Tie Support Solution, L23 Type S

A secondary solution is to provide additional hip bracing (oblique bracing) redundant members to connect together and strengthen diagonal leg elements. Figure 17 outlines one possible temporary support solution to reinforce legs via hip bracing. The red lines indicate additional bracing members that could be installed.

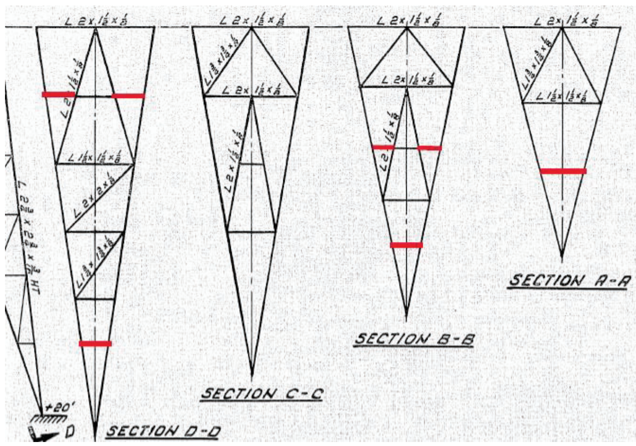

Figure 17 - Potential Hip/Oblique Bracing Solution, L24 Type BB

Investigation and detailed design of temporary support mechanisms is not part of the current project scope. The high-level example information provided in this section of the report is for reference only.

8 Discussions and Recommendations

8.1 Historical Precedent

For transmission lattice towers design completed in the 1950s and 1960s, manufacturers completed the design utilized their own specific compression formulas. It was only in 1971 when first edition of "Guide for Design of Steel Transmission Towers" was published by ASCE (Manual 52) that standard formulas for calculation of effective length, slenderness ratio (KL/r), and compression curves were introduced. These calculations were supported by verification through testing. The older formulations and member design principles did not typically utilize an adjustment factor (K) to modify the allowable compression stresses. Older towers often contain members that have a larger calculated capacities based on the original curves in higher L/r ranges. This is specifically the case for diagonal bracing members, which are eccentric at both ends because of the addition of the K factor. The majority of deficiencies observed in the lines/circuits investigated are diagonal bracing members and this is not by coincidence. In other words, present day or more historically recent ASCE-recommended calculations for diagonal bracing member capacities will yield lower capacities than the original design calculations would have produced back in the day. It is for this reason that bracing members in older tower structures are commonly found to be undersized.

8.2 Loading Scenarios

As discussed in Section 5.2, the deterministic load case of CSA Medium B per CSA C22.3 No. 1 along with Grade 2 construction load factors and unity (1.0) strength reduction factors were used for all structure analysis and assessment. While these loading definitions were found to be the best representation of the original tower design loads and specifications, these loads are optimistic and may not represent recently adopted reliability weather and structure loading conditions outlined in CSA C22.3 No. 60826-19. However, these lines and structures have been in service for about 60 years and the successful history of operation with minimal known structure failures shows the original design load specifications has resulted in overall satisfactory outcome. Statistically, the probability of weather events producing radial wire ice accretions and wind speeds exceeding the original design loads of the towers in these lines/circuits should be considered increasingly higher in any given year and as time passes. The loading results observed for some of the investigated structures, even under deterministic loading, suggests that these lines and structures should be closely and regularly monitored, as they experience significant reliability-scale weather events throughout the remainder of their service life.

8.3 Recommended Action

Considering the topics in Sections 8.1 and 8.2 of this report, it is strongly recommended that all identified critical and undersized diagonal bracings to be replaced with members having structural capacity that exceeds the compression forces in compliance with KL/r limitations specified in ASCE 10. The recommended remedy and repair priorities and work plans discussed in Section 7 of this report should be followed. Temporary structural support solutions are recommended to ensure safe replacement of main leg diagonal bracings at specific critical tower locations and for specific leg extensions.

It is recommended that angle profiles with longer web width and higher thickness to be utilized for repair/replacement work to increase buckling and bending capacities of brace members. Connection details of the members should be checked to verify if any of the members (new or existing) will require cuts to fit. The below table shows recommended sizes for new angle members, but these are experience-based high level recommendations being provided without any detailed project/site-specific analyses.

Table 24 - Recommended Angle Sizes for Replaced Members

Existing Member Angle Size	New Member Angle Size
1.75 x 1.75 x 1/8	2 x 2 x 3/16
2 x 1.5 x 1/8	2.5 x 2.5 x 3/16
2 x 2 x 1/8	2.5 x 2.5 x 3/16
2.5 x 2 x 1/8	3 x 3 x 3/16
2.5 x 2.5 x 1/8	3 x 3 x 3/16

Detailed engineering of the recommended repair solutions in this report will be required beyond the project scope. In particular, further analysis should be completed for the towers experiencing excessive usages under pre-deficiency analysis, and the deficient members are not the ones controlling the usage. In other words, there are several towers that are overloaded, even under deterministic loading, in their idealized existing state (ignoring deficiencies), and towers where high usages were observed in members other than the ones that were the focus of this deficiencies scope. Additionally, there are few locations where the deficient member governs the maximum tower usage while experiencing excessive tower usage. These locations shall also be analyzed in detail, to find solution improving structural reliability of towers. Below tables show such locations where further investigation is recommended.

Table 25 - Suggested Locations for Further Investigation, L23

Str. #	Type/Ext.	Pre-def. Usage (%)	Deficient Member Controls Max. Tower Usage (Y/N)
32	S_+5+5+5+5	99.5	N
95	S_+0+0+0+0	151.0	Y
109	T_+0+0+0+0	123.6	N
244	S_-5-5-5-5	103.8	N
323	T_+0+0+0+0	120.0	N
324	T_+0+0+0+0	116.6	N
371	T_+0+0+0+0	130.3	N
418	T_+0+0+0+0	117.0	N
423	T_+0+0+0+0	123.0	N
430	T_+0+0+0+0	127.9	N
432	T_+0+0+0+0	131.1	N
568	C_+10+10+10+10	122.0	N

Table 26 - Suggested Locations for Further Investigation, L24

Str. #	Type/Ext.	Pre-def. Usage (%)	Deficient Member Controls Max. Tower Usage (Y/N)
4	H_+20+20+20+20	155.8	N
121	EE_-5+-5+-5+-5	136.9	N
130	EE_+5+5+5+5	128.5	N
186	EE_+0+0+0+0	102.1	N
415	EE_-5+-5+-5+-5	153.7	N
416	EE_-5+-5+-5+-5	134.3	N
421	EE_-5+-5+-5+-5	142.1	N
428	EE_-5+-5+-5+-5	144.1	N
430	EE_-5+-5+-5+-5	146.5	N

Table 27 - Suggested Locations for Further Investigation, L23A & L24A

Str. #	Type/Ext.	Pre-def. Usage (%)	Deficient Member Controls Max. Tower Usage (Y/N)
L23A_2	RT-0_+5+5+5+5	107.7	N
L24A_2	RT-0_+5+5+5+5	116.1	N
L24A_3	RT-0 +20+20+10+10	110.6	Y
L24A_4	RT-0_+5+5+5+0	161.1	N

APPENDICES

Appendix A – CAUS Inspection Report

Line Number	Structure Identifier	Structure Type	Extension	Image File	Feature	ID	Defect	Severity	Lg	Side
L23	L23_5	A	0	DJI_20230620062230_0034_Z.JPG	Member	109	['bent']	low	2	left
L23	L23_5	A	0	DJI_20230620062302_0042_Z.JPG	Member	109	['bent']	low	4	right
L23	L23_5	A	0	DJI_20230620062339_0052_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_8	C	0	DJI_20230620063241_0144_Z.JPG	Footings		['fill too high']	low		
L23	L23_8	C	0	DJI_20230620063241_0144_Z.JPG	Footings		['fill too high']	low		
L23	L23_8	C	0	DJI_20230620063241_0144_Z.JPG	Footings		['fill too high']	low		
L23	L23_8	C	0	DJI_20230620063241_0144_Z.JPG	Footings		['fill too high']	low		
L23	L23_9	S	0	DJI_20230621211630_0104_Z.JPG	Member	131	['bent']	low	4	right
L23	L23_9	S	0	DJI_20230621211803_0129_Z.JPG	Member	131	['bent']	low	1	left
L23	L23_9	S	0	DJI_20230621211803_0129_Z.JPG	Member	131	['bent']	low	3	right
L23	L23_11	S	5	DJI_20230621210907_0039_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_13	S	0	DJI_20230621223148_0223_Z.JPG	Member	131	['bent']	low	4	right
L23	L23_13	S	0	DJI_20230621223148_0223_Z.JPG	Member	131	['bent']	low	2	left
L23	L23_13	S	0	DJI_20230621223339_0247_Z.JPG	Member	131	['bent']	low	1	left
L23	L23_14	S	5	DJI_20230621223058_0217_Z.JPG	Footings		['fill too high']	low		
L23	L23_14	S	5	DJI_20230621223058_0217_Z.JPG	Footings		['fill too high']	low		
L23	L23_14	S	5	DJI_20230621223058_0217_Z.JPG	Footings		['fill too high']	low		
L23	L23_14	S	5	DJI_20230621223058_0217_Z.JPG	Footings		['fill too high']	low		
L23	L23_15	S	0	DJI_20230621222807_0180_Z.JPG	Footings		['fill too high']	low		
L23	L23_15	S	0	DJI_20230621222807_0180_Z.JPG	Footings		['fill too high']	low		
L23	L23_15	S	0	DJI_20230621222807_0180_Z.JPG	Footings		['fill too high']	low		
L23	L23_15	S	0	DJI_20230621222807_0180_Z.JPG	Footings		['fill too high']	low		
L23	L23_15	S	0	DJI_20230621222854_0189_Z.JPG	Member	131	['bent']	low	3	right
L23	L23_17	S	5	DJI_20230621222342_0123_Z.JPG	Member	136	['bent']	low	3	right
L23	L23_18	S	5	DJI_20230621222134_0092_Z.JPG	Member	136	['bent']	low	4	right
L23	L23_18	S	5	DJI_20230621222134_0092_Z.JPG	Member	136	['bent']	low	4	left
L23	L23_18	S	5	DJI_20230621222134_0092_Z.JPG	Member	136	['bent']	low	1	left
L23	L23_18	S	5	DJI_20230621222134_0092_Z.JPG	Member	136	['bent']	low	3	right
L23	L23_21	S	0	DJI_20230620021810_0004_Z.JPG	Member	131	['bent']	low	2	left
L23	L23_21	S	0	DJI_20230620021906_0019_Z.JPG	Member	131	['bent']	low	2	right
L23	L23_22	S	5	DJI_20230620022135_0046_Z.JPG	Member	136	['bent']	low	3	right
L23	L23_22	S	5	DJI_20230620022202_0053_Z.JPG	Member	136	['bent']	low	2	right
L23	L23_22	S	5	DJI_20230620022340_0067_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_23	S	0	DJI_20230620022444_0075_Z.JPG	Member	131	['bent']	low	3	left
L23	L23_23	S	0	DJI_20230620022612_0093_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_25	S	0	DJI_20230620023038_0138_Z.JPG	Member	131	['bent']	low	3	right
L23	L23_25	S	0	DJI_20230620023038_0138_Z.JPG	Member	131	['bent']	low	3	left
L23	L23_28	S	10	DJI_20230620024054_0032_Z.JPG	Structure		['rusted']	low		
L23	L23_29	S	10	DJI_20230620024412_0073_Z.JPG	Structure		['rusted']	low		
L23	L23_30	S	5	DJI_20230620024744_0108_Z.JPG	Footings		['fill too high']	low		
L23	L23_30	S	5	DJI_20230620024744_0108_Z.JPG	Footings		['fill too high']	low		
L23	L23_30	S	5	DJI_20230620024744_0108_Z.JPG	Footings		['fill too high']	low		
L23	L23_30	S	5	DJI_20230620024817_0117_Z.JPG	Footings		['fill too high']	low		
L23	L23_32	S	5	DJI_20230622043758_0010_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_32	S	5	DJI_20230622043812_0013_Z.JPG	Member	136	['bent']	low	1	right
L23	L23_33	S	5	DJI_20230622043233_0226_W.JPG	Structure		['leaning']	low		
L23	L23_34	S	0	DJI_20230622043043_0204_Z.JPG	Footings		['fill too high']	low		
L23	L23_34	S	0	DJI_20230622043043_0204_Z.JPG	Footings		['fill too high']	low		
L23	L23_34	S	0	DJI_20230622043043_0204_Z.JPG	Footings		['fill too high']	low		
L23	L23_36	S	5	DJI_20230622042538_0133_Z.JPG	Footings		['fill too high']	low		
L23	L23_36	S	5	DJI_20230622042538_0133_Z.JPG	Footings		['fill too high']	low		
L23	L23_36	S	5	DJI_20230622042538_0133_Z.JPG	Footings		['fill too high']	low		
L23	L23_36	S	5	DJI_20230622042538_0133_Z.JPG	Footings		['fill too high']	low		
L23	L23_37	S	5	DJI_20230622042457_0127_Z.JPG	Footings		['fill too high']	low		
L23	L23_37	S	5	DJI_20230622042457_0127_Z.JPG	Footings		['overgrown']	low		
L23	L23_37	S	5	DJI_20230622042457_0127_Z.JPG	Footings		['fill too high']	low		
L23	L23_37	S	5	DJI_20230622042457_0127_Z.JPG	Footings		['overgrown']	low		
L23	L23_38	S	0	DJI_20230622042123_0087_Z.JPG	Member	133	['bent']	low	2	left
L23	L23_39	S	5	DJI_20230622042002_0070_Z.JPG	Footings		['overgrown']	low		
L23	L23_39	S	5	DJI_20230622042002_0070_Z.JPG	Footings		['overgrown']	low		
L23	L23_39	S	5	DJI_20230622042002_0070_Z.JPG	Footings		['overgrown']	low		
L23	L23_39	S	5	DJI_20230622042002_0070_Z.JPG	Footings		['overgrown']	low		
L23	L23_42	S	0	DJI_20230622025323_0029_Z.JPG	Footings		['fill too high']	low		
L23	L23_42	S	0	DJI_20230622025434_0048_Z.JPG	Footings		['fill too high']	low		
L23	L23_42	S	0	DJI_20230622025434_0048_Z.JPG	Footings		['fill too high']	low		
L23	L23_42	S	0	DJI_20230622025434_0048_Z.JPG	Footings		['fill too high']	low		
L23	L23_43	S	0	DJI_20230622025139_0011_Z.JPG	Footings		['fill too high']	low		
L23	L23_43	S	0	DJI_20230622025139_0011_Z.JPG	Footings		['fill too high']	low		
L23	L23_43	S	0	DJI_20230622025139_0011_Z.JPG	Footings		['fill too high']	low		
L23	L23_43	S	0	DJI_20230622025139_0011_Z.JPG	Footings		['fill too high']	low		
L23	L23_44	S	5	DJI_20230622024249_0136_Z.JPG	Member	136	['bent']	low	3	left
L23	L23_45	S	10	DJI_20230622024127_0122_Z.JPG	Footings		['fill too high']	low		

Line Number	Structure Identifier	Structure Type	Extension	Image File	Feature	ID	Defect	Severity	Lg	Side
L23	L23_46	S	10	DJI_20230622023822_0083_W.JPG	Structure		['leaning']	low		
L23	L23_49	S	0	DJI_20230622023226_0012_Z.JPG	Member	131	['bent']	low	3	left
L23	L23_49	S	0	DJI_20230622023309_0026_Z.JPG	Footings		['fill too high']	low		
L23	L23_49	S	0	DJI_20230622023309_0026_Z.JPG	Footings		['fill too high']	low		
L23	L23_49	S	0	DJI_20230622023309_0026_Z.JPG	Footings		['fill too high']	low		
L23	L23_49	S	0	DJI_20230622023309_0026_Z.JPG	Footings		['fill too high']	low		
L23	L23_53	S	0	DJI_20230622005820_0133_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_53	S	0	DJI_20230622005837_0136_Z.JPG	Footings		['overgrown']	low		
L23	L23_53	S	0	DJI_20230622005837_0136_Z.JPG	Footings		['overgrown']	low		
L23	L23_53	S	0	DJI_20230622005837_0136_Z.JPG	Footings		['overgrown']	low		
L23	L23_53	S	0	DJI_20230622005837_0136_Z.JPG	Footings		['overgrown']	low		
L23	L23_54	S	0	DJI_20230622005556_0095_Z.JPG	Member	131	['bent']	low	2	right
L23	L23_54	S	0	DJI_20230622005612_0101_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_54	S	0	DJI_20230622005633_0104_Z.JPG	Member	131	['bent']	low	1	left
L23	L23_54	S	0	DJI_20230622005641_0105_Z.JPG	Member	131	['bent']	low	3	right
L23	L23_54	S	0	DJI_20230622005706_0110_Z.JPG	Footings		['fill too high']	low		
L23	L23_54	S	0	DJI_20230622005706_0110_Z.JPG	Footings		['fill too high']	low		
L23	L23_54	S	0	DJI_20230622005706_0110_Z.JPG	Footings		['fill too high']	low		
L23	L23_54	S	0	DJI_20230622005706_0110_Z.JPG	Footings		['fill too high']	low		
L23	L23_55	S	0	DJI_20230622005418_0074_Z.JPG	Footings		['fill too high']	low		
L23	L23_55	S	0	DJI_20230622005418_0074_Z.JPG	Footings		['fill too high']	low		
L23	L23_55	S	0	DJI_20230622005418_0074_Z.JPG	Footings		['fill too high']	low		
L23	L23_55	S	0	DJI_20230622005418_0074_Z.JPG	Footings		['fill too high']	low		
L23	L23_56	S	5	DJI_20230622005234_0050_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_57	S	0	DJI_20230622004915_0013_Z.JPG	Footings		['overgrown']	low		
L23	L23_57	S	0	DJI_20230622004923_0016_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_60	S	0	DJI_20230620223017_0071_Z.JPG	Environmental		['raptor']	low		
L23	L23_60	S	0	DJI_20230620223017_0071_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_60	S	0	DJI_20230620223110_0082_Z.JPG	Footings		['overgrown']	low		
L23	L23_61	S	5	DJI_20230620222736_0049_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_62	S	0	DJI_20230620222500_0025_Z.JPG	Member	131	['bent']	low	3	right
L23	L23_62	S	0	DJI_20230620222500_0025_Z.JPG	Footings		['fill too high']	low	3	right
L23	L23_63	S	0	DJI_20230620223930_0158_Z.JPG	Member	131	['broken']	low	1	right
L23	L23_63	S	0	DJI_20230620224008_0168_Z.JPG	Member	131	['bent']	low	1	left
L23	L23_64	S	0	DJI_20230620225643_0142_Z.JPG	Footings		['overgrown']	low		
L23	L23_64	S	0	DJI_20230620225643_0142_Z.JPG	Footings		['overgrown']	low		
L23	L23_65	S	0	DJI_20230620225347_0105_Z.JPG	Footings		['fill too high']	low		
L23	L23_65	S	0	DJI_20230620225347_0105_Z.JPG	Footings		['fill too high']	low		
L23	L23_65	S	0	DJI_20230620225347_0105_Z.JPG	Footings		['fill too high']	low		
L23	L23_65	S	0	DJI_20230620225347_0105_Z.JPG	Footings		['fill too high']	low		
L23	L23_65	S	0	DJI_20230620225404_0111_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_66	S	5	DJI_20230620225135_0081_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_66	S	5	DJI_20230620225143_0083_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_67	S	0	DJI_20230620224908_0054_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_68	S	20	DJI_20230620224624_0021_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_68	S	20	DJI_20230620224636_0023_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_69	S	10	DJI_20230620233039_0020_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_70	S	5	DJI_20230620233300_0037_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_70	S	5	DJI_20230620233303_0038_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_71	S	5	DJI_20230620233814_0084_Z.JPG	Environmental		['raptor']	low		
L23	L23_71	S	5	DJI_20230620233814_0084_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_72	S	0	DJI_20230620233913_0091_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_72	S	0	DJI_20230620233919_0093_Z.JPG	Hardware		['worn hardware']	medium		
L23	L23_73	S	0	DJI_20230620234133_0115_Z.JPG	Footings		['fill too high']	low		
L23	L23_73	S	0	DJI_20230620234133_0115_Z.JPG	Footings		['fill too high']	low		
L23	L23_73	S	0	DJI_20230620234133_0115_Z.JPG	Footings		['fill too high']	low		
L23	L23_73	S	0	DJI_20230620234133_0115_Z.JPG	Footings		['fill too high']	low		
L23	L23_74	S	0	DJI_20230620234923_0020_Z.JPG	Footings		['fill too low']	low		
L23	L23_75	S	0	DJI_20230620235238_0053_Z.JPG	Member	131	['bent']	low	4	left
L23	L23_75	S	0	DJI_20230620235238_0053_Z.JPG	Member	131	['bent']	low	2	right
L23	L23_77	S	0	DJI_20230620235721_0100_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_78	S	5	DJI_20230621000201_0142_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_78	S	5	DJI_20230621000201_0142_Z.JPG	Environmental		['raptor']	low		
L23	L23_79	S	0	DJI_20230621000346_0156_Z.JPG	Member	131	['bent']	low	2	left
L23	L23_79	S	0	DJI_20230621000415_0163_W.JPG	Structure		['leaning']	low		
L23	L23_79	S	0	DJI_20230621000453_0171_Z.JPG	Member	131	['bent']	low	4	left
L23	L23_79	S	0	DJI_20230621000453_0171_Z.JPG	Member	131	['bent']	low	2	right
L23	L23_79	S	0	DJI_20230621000517_0177_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_81	S	0	DJI_20230621013552_0099_Z.JPG	Environmental		['raptor']	low		
L23	L23_81	S	0	DJI_20230621013552_0099_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_83	S	5	DJI_20230621013131_0051_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_85	S	15	DJI_20230701014537_0009_Z.JPG	Environmental		['raptor nest']	low		

Line Number	Structure Identifier	Structure Type	Extension	Image File	Feature	ID	Defect	Severity	Lg	Side
L23	L23_86	S	0	DJI_20230616004750_0091_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_87	T	0	DJI_20230616004551_0083_Z.JPG	Environmental		['raptor']	low		
L23	L23_90	S	0	DJI_20230616005155_0114_Z.JPG	Member	129	['bent']	low	3	center
L23	L23_90	S	0	DJI_20230616005319_0128_Z.JPG	Member	131	['bent']	low	3	right
L23	L23_90	S	0	DJI_20230616005341_0133_Z.JPG	Member	127	['bent']	low	1	left
L23	L23_92	S	5	DJI_20230616032242_0013_Z.JPG	Footings		['fill too high']	low		
L23	L23_92	S	5	DJI_20230616032336_0019_Z.JPG	Footings		['fill too high']	low		
L23	L23_92	S	5	DJI_20230616032336_0019_Z.JPG	Footings		['fill too high']	low		
L23	L23_92	S	5	DJI_20230616032336_0019_Z.JPG	Footings		['fill too high']	low		
L23	L23_93	S	5	DJI_20230616032809_0054_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_93	S	5	DJI_20230616032855_0061_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_94	S	0	DJI_20230616033016_0065_Z.JPG	Member	131	['bent']	low	2	left
L23	L23_94	S	0	DJI_20230616033131_0076_Z.JPG	Member	131	['bent']	low	3	left
L23	L23_95	S	0	DJI_20230616033606_0108_Z.JPG	Member	131	['bent']	low	4	left
L23	L23_95	S	0	DJI_20230616033606_0108_Z.JPG	Member	131	['bent']	low	4	right
L23	L23_96	S	5	DJI_20230616033855_0132_Z.JPG	Hardware		['worn hardware']	medium		
L23	L23_96	S	5	DJI_20230616033901_0133_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_96	S	5	DJI_20230616033901_0133_Z.JPG	Hardware		[]	good		
L23	L23_96	S	5	DJI_20230616033949_0138_Z.JPG	Member	127	['bent']	low	4	right
L23	L23_96	S	5	DJI_20230616034003_0140_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_96	S	5	DJI_20230616034043_0146_Z.JPG	Member	127	['bent']	low	1	left
L23	L23_96	S	5	DJI_20230616034043_0146_Z.JPG	Member	127	['bent']	low	1	right
L23	L23_98	S	5	DJI_20230616050702_0044_Z.JPG	Footings		['fill too high']	low		
L23	L23_98	S	5	DJI_20230616050702_0044_Z.JPG	Footings		['fill too high']	low		
L23	L23_98	S	5	DJI_20230616050737_0050_Z.JPG	Footings		['fill too high']	low		
L23	L23_98	S	5	DJI_20230616050758_0054_Z.JPG	Footings		['fill too high']	low		
L23	L23_100	S	0	DJI_20230616051356_0094_Z.JPG	Hardware		['worn hardware']	medium		
L23	L23_100	S	0	DJI_20230616051427_0098_Z.JPG	Member	131	['bent']	low	3	left
L23	L23_100	S	0	DJI_20230616051604_0110_Z.JPG	Member	131	['bent']	low	4	right
L23	L23_100	S	0	DJI_20230616051604_0110_Z.JPG	Member	131	['bent']	low	3	right
L23	L23_100	S	0	DJI_20230616051610_0111_Z.JPG	Member	131	['bent']	low	1	left
L23	L23_101	S	5	DJI_20230616051749_0117_Z.JPG	Member	140	['bent']	low	2	center
L23	L23_101	S	5	DJI_20230616052009_0138_Z.JPG	Member	136	['bent']	low	3	left
L23	L23_101	S	5	DJI_20230616052009_0138_Z.JPG	Member	136	['bent']	low	2	right
L23	L23_101	S	5	DJI_20230616052009_0138_Z.JPG	Member	136	['bent']	low	2	left
L23	L23_102	S	5	DJI_20230616062946_0016_Z.JPG	Guy		['not standard practice']	high		
L23	L23_102	S	5	DJI_20230616062946_0016_Z.JPG	Guy		['not standard practice']	high		
L23	L23_103	S	15	DJI_20230616063331_0042_Z.JPG	Environmental		['raptor nest', 'raptor']	low		
L23	L23_104	S	15	DJI_20230616063758_0075_Z.JPG	Member	154	['bent']	low	3	left
L23	L23_104	S	15	DJI_20230616063825_0079_Z.JPG	Member	154	['bent']	low	2	right
L23	L23_104	S	15	DJI_20230616063839_0082_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_104	S	15	DJI_20230616063912_0087_Z.JPG	Member	154	['bent']	low	3	right
L23	L23_104	S	15	DJI_20230616063912_0087_Z.JPG	Member	152	['bent']	low	3	center
L23	L23_105	S	5	DJI_20230616064159_0106_Z.JPG	Footings		['fill too high']	low		
L23	L23_105	S	5	DJI_20230616064159_0106_Z.JPG	Footings		['fill too high']	low		
L23	L23_108	S	5	DJI_20230617072023_0118_Z.JPG	Footings		['fill too high']	low		
L23	L23_108	S	5	DJI_20230617072023_0118_Z.JPG	Footings		['fill too high']	low		
L23	L23_108	S	5	DJI_20230617072023_0118_Z.JPG	Footings		['fill too high']	low		
L23	L23_108	S	5	DJI_20230617072023_0118_Z.JPG	Footings		['fill too high']	low		
L23	L23_109	T	0	DJI_20230617071706_0089_Z.JPG	Member	124	['bent']	low	3	right
L23	L23_110	S	5	DJI_20230617071347_0055_Z.JPG	Footings		['fill too high']	medium		
L23	L23_110	S	5	DJI_20230617071347_0055_Z.JPG	Footings		['fill too high']	medium		
L23	L23_110	S	5	DJI_20230617071347_0055_Z.JPG	Footings		['fill too high']	medium		
L23	L23_110	S	5	DJI_20230617071347_0055_Z.JPG	Footings		['fill too high']	medium		
L23	L23_112	S	5	DJI_20230617191608_0028_Z.JPG	Footings		['fill too high']	low		
L23	L23_112	S	5	DJI_20230617191608_0028_Z.JPG	Footings		['fill too high']	low		
L23	L23_112	S	5	DJI_20230617191608_0028_Z.JPG	Footings		['fill too high']	low		
L23	L23_112	S	5	DJI_20230617191608_0028_Z.JPG	Footings		['fill too high']	low		
L23	L23_113	S	0	DJI_20230617191749_0044_Z.JPG	Footings		['fill too high']	low		
L23	L23_113	S	0	DJI_20230617191749_0044_Z.JPG	Footings		['fill too high']	low		
L23	L23_113	S	0	DJI_20230617191749_0044_Z.JPG	Footings		['fill too high']	low		
L23	L23_113	S	0	DJI_20230617191749_0044_Z.JPG	Footings		['fill too high']	low		
L23	L23_113	S	0	DJI_20230617191851_0057_Z.JPG	Member	131	['bent']	low	1	left
L23	L23_114	S	5	DJI_20230617192039_0071_Z.JPG	Member	115	['bent']	low	4	right
L23	L23_114	S	5	DJI_20230617192142_0085_Z.JPG	Member	115	['bent']	low	2	left
L23	L23_115	S	15	DJI_20230617192450_0117_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_116	S	0	DJI_20230617192734_0144_Z.JPG	Member	131	['bent']	low	1	left
L23	L23_117	S	0	DJI_20230617192929_0160_Z.JPG	Member	131	['bent']	low	3	left
L23	L23_117	S	0	DJI_20230617193036_0174_Z.JPG	Member	131	['bent']	low	1	left
L23	L23_117	S	0	DJI_20230617193058_0179_Z.JPG	Member	131	['bent']	low	4	right
L23	L23_120	S	0	DJI_20230617210455_0024_Z.JPG	Footings		['fill too high']	low		
L23	L23_120	S	0	DJI_20230617210455_0024_Z.JPG	Footings		['fill too high']	low		

Line Number	Structure Identifier	Structure Type	Extension	Image File	Feature	ID	Defect	Severity	Lg	Side
L23	L23_120	S	0	DJI_20230617210455_0024_Z.JPG	Footings		['fill too high']	low		
L23	L23_120	S	0	DJI_20230617210455_0024_Z.JPG	Footings		['fill too high']	low		
L23	L23_134	S	0	DJI_20230618005857_0092_Z.JPG	Member	131	['bent']	low	3	right
L23	L23_134	S	0	DJI_20230618005935_0098_Z.JPG	Member	131	['bent']	low	2	left
L23	L23_136	S	0	DJI_20230618010549_0157_Z.JPG	Footings		['fill too high']	low		
L23	L23_136	S	0	DJI_20230618010549_0157_Z.JPG	Footings		['fill too high']	low		
L23	L23_136	S	0	DJI_20230618010549_0157_Z.JPG	Footings		['fill too high']	low		
L23	L23_136	S	0	DJI_20230618010549_0157_Z.JPG	Footings		['fill too high']	low		
L23	L23_144	S	10	DJI_20230621022253_0112_Z.JPG	Footings		['overgrown']	low		
L23	L23_144	S	10	DJI_20230621022253_0112_Z.JPG	Footings		['overgrown']	low		
L23	L23_144	S	10	DJI_20230621022253_0112_Z.JPG	Footings		['overgrown']	low		
L23	L23_144	S	10	DJI_20230621022253_0112_Z.JPG	Footings		['overgrown']	low		
L23	L23_146	S	0	DJI_20230621022854_0173_Z.JPG	Footings		['overgrown']	low		
L23	L23_146	S	0	DJI_20230621022854_0173_Z.JPG	Footings		['overgrown']	low		
L23	L23_146	S	0	DJI_20230621022854_0173_Z.JPG	Footings		['overgrown']	low		
L23	L23_146	S	0	DJI_20230621022854_0173_Z.JPG	Footings		['overgrown']	low		
L23	L23_148	S	10	DJI_20230622221617_0006_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_148	S	10	DJI_20230622221620_0007_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_148	S	10	DJI_20230622221624_0008_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_149	S	5	DJI_20230622221918_0031_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_149	S	5	DJI_20230622221925_0033_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_150	S	0	DJI_20230622222147_0052_Z.JPG	Footings		['overgrown']	low		
L23	L23_150	S	0	DJI_20230622222147_0052_Z.JPG	Footings		['overgrown']	low		
L23	L23_150	S	0	DJI_20230622222147_0052_Z.JPG	Footings		['overgrown']	low		
L23	L23_150	S	0	DJI_20230622222158_0055_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_151	S	0	DJI_20230622222412_0079_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_151	S	0	DJI_20230622222421_0081_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_151	S	0	DJI_20230622222458_0090_Z.JPG	Member	131	['bent']	low	2	right
L23	L23_154	S	0	DJI_20230622234329_0023_Z.JPG	Footings		['overgrown']	low		
L23	L23_154	S	0	DJI_20230622234329_0023_Z.JPG	Footings		['overgrown']	low		
L23	L23_154	S	0	DJI_20230622234329_0023_Z.JPG	Footings		['overgrown']	low		
L23	L23_155	S	0	DJI_20230622234528_0042_Z.JPG	Footings		['overgrown']	low		
L23	L23_155	S	0	DJI_20230622234528_0042_Z.JPG	Footings		['overgrown']	low		
L23	L23_155	S	0	DJI_20230622234528_0042_Z.JPG	Footings		['overgrown']	low		
L23	L23_155	S	0	DJI_20230622234528_0042_Z.JPG	Footings		['overgrown']	low		
L23	L23_156	S	5	DJI_20230622234643_0051_W.JPG	Structure		['leaning']	low		
L23	L23_158	S	10	DJI_20230622235129_0104_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_158	S	10	DJI_20230622235136_0106_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_158	S	10	DJI_20230622235228_0119_Z.JPG	Footings		['overgrown']	low		
L23	L23_158	S	10	DJI_20230622235228_0119_Z.JPG	Footings		['overgrown']	low		
L23	L23_158	S	10	DJI_20230622235228_0119_Z.JPG	Footings		['overgrown']	low		
L23	L23_158	S	10	DJI_20230622235228_0119_Z.JPG	Footings		['overgrown']	low		
L23	L23_163	S	5	DJI_20230623002935_0040_Z.JPG	Footings		['fill too high']	low		
L23	L23_163	S	5	DJI_20230623002935_0040_Z.JPG	Footings		['fill too high']	low		
L23	L23_163	S	5	DJI_20230623002935_0040_Z.JPG	Footings		['fill too high']	low		
L23	L23_163	S	5	DJI_20230623002935_0040_Z.JPG	Footings		['fill too high']	low		
L23	L23_165	S	0	DJI_20230623003311_0076_Z.JPG	Footings		['overgrown']	low		
L23	L23_165	S	0	DJI_20230623003311_0076_Z.JPG	Footings		['overgrown']	low		
L23	L23_168	S	0	DJI_20230623004333_0176_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_168	S	0	DJI_20230623004346_0179_Z.JPG	Footings		['overgrown']	low		
L23	L23_168	S	0	DJI_20230623004346_0179_Z.JPG	Footings		['overgrown']	low		
L23	L23_168	S	0	DJI_20230623004346_0179_Z.JPG	Footings		['overgrown']	low		
L23	L23_168	S	0	DJI_20230623004346_0179_Z.JPG	Footings		['overgrown']	low		
L23	L23_168	S	0	DJI_20230623004406_0184_Z.JPG	Member	131	['bent']	low	2	right
L23	L23_169	S	0	DJI_20230623004607_0210_W.JPG	Structure		['leaning']	low		
L23	L23_169	S	0	DJI_20230623004612_0212_Z.JPG	Member	131	['bent']	low	1	left
L23	L23_169	S	0	DJI_20230623004612_0212_Z.JPG	Member	131	['bent']	low	2	right
L23	L23_171	S	5	DJI_20230623020649_0058_Z.JPG	Footings		['overgrown']	low		
L23	L23_171	S	5	DJI_20230623020649_0058_Z.JPG	Footings		['overgrown']	low		
L23	L23_171	S	5	DJI_20230623020649_0058_Z.JPG	Footings		['overgrown']	low		
L23	L23_171	S	5	DJI_20230623020649_0058_Z.JPG	Footings		['overgrown']	low		
L23	L23_171	S	5	DJI_20230623020658_0060_Z.JPG	Member	118	['bent']	low	3	right
L23	L23_172	S	0	DJI_20230623020850_0083_Z.JPG	Member	131	['bent']	low	2	right
L23	L23_172	S	0	DJI_20230623020850_0083_Z.JPG	Member	131	['bent']	low	4	left
L23	L23_172	S	0	DJI_20230623020907_0089_Z.JPG	Footings		['overgrown']	low		
L23	L23_172	S	0	DJI_20230623020907_0089_Z.JPG	Footings		['overgrown']	low		
L23	L23_172	S	0	DJI_20230623020907_0089_Z.JPG	Footings		['overgrown']	low		
L23	L23_172	S	0	DJI_20230623020907_0089_Z.JPG	Footings		['overgrown']	low		
L23	L23_173	S	5	DJI_20230623021014_0095_Z.JPG	Member	136	['bent']	low	1	left
L23	L23_173	S	5	DJI_20230623021047_0104_Z.JPG	Member	136	['bent']	low	3	left
L23	L23_174	S	0	DJI_20230623021250_0129_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_174	S	0	DJI_20230623021256_0131_Z.JPG	Hardware		['worn hardware']	low		

Line Number	Structure Identifier	Structure Type	Extension	Image File	Feature	ID	Defect	Severity	Lg	Side
L23	L23_174	S	0	DJI_20230623021313_0135_Z.JPG	Member	131	['bent']	low	3	left
L23	L23_175	S	0	DJI_20230623021528_0167_Z.JPG	Footings		['overgrown']	low		
L23	L23_175	S	0	DJI_20230623021541_0172_Z.JPG	Member	131	['bent']	low	3	right
L23	L23_176	S	5	DJI_20230623021706_0188_Z.JPG	Footings		['overgrown']	low		
L23	L23_177	S	5	DJI_20230623023731_0026_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_180	S	5	DJI_20230623024335_0098_Z.JPG	Footings		['fill too high']	low		
L23	L23_180	S	5	DJI_20230623024335_0098_Z.JPG	Footings		['fill too high']	low		
L23	L23_180	S	5	DJI_20230623024335_0098_Z.JPG	Footings		['overgrown']	low		
L23	L23_181	S	0	DJI_20230623024444_0110_Z.JPG	Member	131	['bent']	low	4	right
L23	L23_181	S	0	DJI_20230623024515_0119_Z.JPG	Footings		['overgrown']	low		
L23	L23_181	S	0	DJI_20230623024515_0119_Z.JPG	Footings		['overgrown']	low		
L23	L23_182	S	0	DJI_20230623024745_0149_Z.JPG	Footings		['overgrown']	low		
L23	L23_184	S	10	DJI_20230624213257_0017_Z.JPG	Member	144	['bent']	low	2	right
L23	L23_185	S	10	DJI_20230624213409_0030_Z.JPG	Footings		['overgrown']	low		
L23	L23_185	S	10	DJI_20230624213409_0030_Z.JPG	Footings		['overgrown']	low		
L23	L23_186	T	0	DJI_20230624213649_0071_Z.JPG	Footings		['overgrown']	low		
L23	L23_186	T	0	DJI_20230624213649_0071_Z.JPG	Footings		['overgrown']	low		
L23	L23_188	S	5	DJI_20230624214018_0112_Z.JPG	Member	127	['bent']	low	1	right
L23	L23_194	S	20	DJI_20230624215430_0037_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_200	S	0	DJI_20230624235051_0083_Z.JPG	Footings		['overgrown']	low		
L23	L23_200	S	0	DJI_20230624235051_0083_Z.JPG	Footings		['overgrown']	low		
L23	L23_200	S	0	DJI_20230624235051_0083_Z.JPG	Footings		['overgrown']	low		
L23	L23_201	S	5	DJI_20230624235156_0098_Z.JPG	Footings		['overgrown']	low		
L23	L23_201	S	5	DJI_20230624235156_0098_Z.JPG	Footings		['overgrown']	low		
L23	L23_202	S	10	DJI_20230624235417_0137_Z.JPG	Footings		['overgrown']	low		
L23	L23_202	S	10	DJI_20230624235417_0137_Z.JPG	Footings		['overgrown']	low		
L23	L23_202	S	10	DJI_20230624235417_0137_Z.JPG	Footings		['overgrown']	low		
L23	L23_202	S	10	DJI_20230624235417_0137_Z.JPG	Footings		['overgrown']	low		
L23	L23_207	S	5	DJI_20230625000903_0012_Z.JPG	Footings		['fill too high']	low		
L23	L23_207	S	5	DJI_20230625000903_0012_Z.JPG	Footings		['fill too high']	low		
L23	L23_207	S	5	DJI_20230625000903_0012_Z.JPG	Footings		['fill too high']	low		
L23	L23_207	S	5	DJI_20230625000903_0012_Z.JPG	Footings		['fill too high']	low		
L23	L23_208	S	0	DJI_20230625001046_0037_Z.JPG	Footings		['overgrown']	low		
L23	L23_208	S	0	DJI_20230625001046_0037_Z.JPG	Footings		['overgrown']	low		
L23	L23_208	S	0	DJI_20230625001046_0037_Z.JPG	Footings		['overgrown']	low		
L23	L23_211	S	0	DJI_20230625001543_0096_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_214	S	20	DJI_20230625002150_0164_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_214	S	20	DJI_20230625002156_0166_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_216	S	0	DJI_20230625005522_0048_Z.JPG	Footings		['overgrown']	low		
L23	L23_216	S	0	DJI_20230625005522_0048_Z.JPG	Footings		['overgrown']	low		
L23	L23_216	S	0	DJI_20230625005522_0048_Z.JPG	Footings		['overgrown']	low		
L23	L23_216	S	0	DJI_20230625005522_0048_Z.JPG	Footings		['overgrown']	low		
L23	L23_217	S	0	DJI_20230625005724_0075_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_223	S	5	DJI_20230625011304_0015_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_224	S	5	DJI_20230625011446_0042_Z.JPG	Footings		['overgrown']	low		
L23	L23_225	S	0	DJI_20230625011623_0061_Z.JPG	Member	131	['bent']	low	4	right
L23	L23_225	S	0	DJI_20230625011623_0061_Z.JPG	Member	131	['bent']	low	1	right
L23	L23_226	S	5	DJI_20230625011804_0078_Z.JPG	Footings		['overgrown']	low		
L23	L23_228	S	0	DJI_20230625012206_0139_Z.JPG	Member	131	['bent']	low	2	right
L23	L23_231	S	0	DJI_20230625205809_0040_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_233	S	0	DJI_20230625210251_0113_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_234	S	0	DJI_20230625210406_0131_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_235	S	0	DJI_20230625210535_0148_Z.JPG	Member	131	['bent']	low	4	left
L23	L23_238	S	5	DJI_20230625211027_0216_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_239	S	5	DJI_20230625211643_0021_Z.JPG	Footings		['fill too high']	low		
L23	L23_239	S	5	DJI_20230625211643_0021_Z.JPG	Footings		['fill too high']	low		
L23	L23_239	S	5	DJI_20230625211643_0021_Z.JPG	Footings		['fill too high']	low		
L23	L23_239	S	5	DJI_20230625211643_0021_Z.JPG	Footings		['fill too high']	low		
L23	L23_239	S	5	DJI_20230625211643_0021_Z.JPG	Member	127	['bent']	low	1	left
L23	L23_240	S	5	DJI_20230625211902_0048_Z.JPG	Footings		['overgrown']	low		
L23	L23_240	S	5	DJI_20230625211902_0048_Z.JPG	Footings		['overgrown']	low		
L23	L23_240	S	5	DJI_20230625211902_0048_Z.JPG	Footings		['overgrown']	low		
L23	L23_240	S	5	DJI_20230625211902_0048_Z.JPG	Footings		['overgrown']	low		
L23	L23_240	S	5	DJI_20230625211904_0050_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_241	S	5	DJI_20230625212047_0072_Z.JPG	Member	127	['bent']	low	3	right
L23	L23_242	S	0	DJI_20230625212132_0076_W.JPG	good		[]	good		
L23	L23_242	S	0	DJI_20230625212233_0096_Z.JPG	Footings		['overgrown']	low		
L23	L23_242	S	0	DJI_20230625212233_0096_Z.JPG	Footings		['overgrown']	low		
L23	L23_242	S	0	DJI_20230625212233_0096_Z.JPG	Footings		['overgrown']	low		
L23	L23_242	S	0	DJI_20230625212233_0096_Z.JPG	Footings		['overgrown']	low		
L23	L23_243	S	5	DJI_20230625212338_0107_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_243	S	5	DJI_20230625212339_0108_Z.JPG	Hardware		['worn hardware']	low		

Line Number	Structure Identifier	Structure Type	Extension	Image File	Feature	ID	Defect	Severity	Lg	Side
L23	L23_243	S	5	DJI_20230625212352_0111_Z.JPG	Footings		['fill too high']	low		
L23	L23_243	S	5	DJI_20230625212352_0111_Z.JPG	Footings		['fill too high']	low		
L23	L23_243	S	5	DJI_20230625212352_0111_Z.JPG	Footings		['fill too high']	low		
L23	L23_243	S	5	DJI_20230625212352_0111_Z.JPG	Footings		['fill too high']	low		
L23	L23_244	S	5	DJI_20230625212519_0128_Z.JPG	Footings		['fill too high']	low		
L23	L23_244	S	5	DJI_20230625212519_0128_Z.JPG	Footings		['fill too high']	low		
L23	L23_244	S	5	DJI_20230625212519_0128_Z.JPG	Footings		['fill too high']	low		
L23	L23_244	S	5	DJI_20230625212519_0128_Z.JPG	Footings		['fill too high']	low		
L23	L23_244	S	5	DJI_20230625212621_0147_Z.JPG	Member	118	['bent']	low	1	left
L23	L23_245	S	0	DJI_20230625212746_0162_Z.JPG	Member	131	['bent']	low	1	right
L23	L23_245	S	0	DJI_20230625212805_0168_Z.JPG	Footings		['fill too high']	low		
L23	L23_245	S	0	DJI_20230625212805_0168_Z.JPG	Footings		['fill too high']	low		
L23	L23_245	S	0	DJI_20230625212805_0168_Z.JPG	Footings		['fill too high']	low		
L23	L23_245	S	0	DJI_20230625212805_0168_Z.JPG	Footings		['fill too high']	low		
L23	L23_247	S	5	DJI_20230625225818_0044_Z.JPG	Footings		['overgrown']	low		
L23	L23_247	S	5	DJI_20230625225818_0044_Z.JPG	Member	127	['bent']	low	2	left
L23	L23_247	S	5	DJI_20230625225818_0044_Z.JPG	Footings		['overgrown']	low		
L23	L23_247	S	5	DJI_20230625225818_0044_Z.JPG	Footings		['overgrown']	low		
L23	L23_247	S	5	DJI_20230625225818_0044_Z.JPG	Footings		['overgrown']	low		
L23	L23_248	S	5	DJI_20230625225904_0050_Z.JPG	Member	136	['bent']	low	4	right
L23	L23_249	S	0	DJI_20230625230148_0094_Z.JPG	Member	131	['bent']	low	3	right
L23	L23_251	S	0	DJI_20230625230444_0127_Z.JPG	Member	131	['bent']	low	4	right
L23	L23_253	S	0	DJI_20230625230916_0181_Z.JPG	Footings		['overgrown']	low		
L23	L23_253	S	0	DJI_20230625230916_0181_Z.JPG	Footings		['overgrown']	low		
L23	L23_253	S	0	DJI_20230625230916_0181_Z.JPG	Footings		['fill too high']	low		
L23	L23_253	S	0	DJI_20230625230916_0181_Z.JPG	Footings		['fill too high']	low		
L23	L23_253	S	0	DJI_20230625231045_0204_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_254	S	0	DJI_20230625231216_0225_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_255	S	0	DJI_20230625231647_0007_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_255	S	0	DJI_20230625231702_0011_Z.JPG	Member	131	['bent']	low	4	right
L23	L23_258	S	0	DJI_20230625232206_0081_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_258	S	0	DJI_20230625232213_0083_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_258	S	0	DJI_20230625232248_0096_Z.JPG	Footings		['overgrown']	low		
L23	L23_259	S	5	DJI_20230625232417_0115_Z.JPG	Footings		['fill too high']	low		
L23	L23_259	S	5	DJI_20230625232417_0115_Z.JPG	Footings		['fill too high']	low		
L23	L23_259	S	5	DJI_20230625232417_0115_Z.JPG	Footings		['fill too high']	low		
L23	L23_259	S	5	DJI_20230625232417_0115_Z.JPG	Footings		['fill too high']	low		
L23	L23_260	S	10	DJI_20230625232523_0129_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_260	S	10	DJI_20230625232543_0134_Z.JPG	Member	144	['bent']	low	3	left
L23	L23_264	S	5	DJI_20230626000320_0102_Z.JPG	Member	127	['bent']	low	1	right
L23	L23_264	S	5	DJI_20230626000333_0107_Z.JPG	Footings		['fill too high']	low		
L23	L23_264	S	5	DJI_20230626000333_0107_Z.JPG	Footings		['fill too high']	low		
L23	L23_264	S	5	DJI_20230626000333_0107_Z.JPG	Footings		['fill too high']	low		
L23	L23_264	S	5	DJI_20230626000333_0107_Z.JPG	Footings		['fill too high']	low		
L23	L23_267	S	5	DJI_20230626000749_0168_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_268	S	0	DJI_20230626001358_0018_Z.JPG	Footings		['overgrown']	low		
L23	L23_268	S	0	DJI_20230626001413_0024_Z.JPG	Footings		['fill too high']	low		
L23	L23_270	S	0	DJI_20230626001759_0066_Z.JPG	Footings		['overgrown']	low		
L23	L23_270	S	0	DJI_20230626001759_0066_Z.JPG	Footings		['fill too high']	low		
L23	L23_270	S	0	DJI_20230626001759_0066_Z.JPG	Footings		['fill too high']	low		
L23	L23_271	S	0	DJI_20230626001951_0092_Z.JPG	Member	131	['bent']	low	4	right
L23	L23_273	S	5	DJI_20230626002408_0150_Z.JPG	Member	127	['bent']	low	3	right
L23	L23_276	S	0	DJI_20230626002901_0209_Z.JPG	Member	131	['bent']	low	4	right
L23	L23_276	S	0	DJI_20230626002940_0219_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_280	S	5	DJI_20230626022219_0094_Z.JPG	Member	118	['bent']	low	1	right
L23	L23_280	S	5	DJI_20230626022245_0105_Z.JPG	Member	118	['bent']	low	1	left
L23	L23_284	S	5	DJI_20230626023016_0206_Z.JPG	Member	127	['bent']	low	2	left
L23	L23_285	S	5	DJI_20230626023246_0243_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_285	S	5	DJI_20230626023327_0259_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_290	S	10	DJI_20230626024718_0118_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_292	S	5	DJI_20230626210330_0029_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_292	S	5	DJI_20230626210432_0046_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_293	S	5	DJI_20230626210600_0059_Z.JPG	Member	136	['bent']	low	1	right
L23	L23_293	S	5	DJI_20230626210656_0071_Z.JPG	Member	136	['bent']	low	1	left
L23	L23_297	S	15	DJI_20230626211457_0172_W.JPG	Structure		['leaning']	low		
L23	L23_298	S	5	DJI_20230626212035_0009_W.JPG	Structure		['leaning']	low		
L23	L23_299	S	5	DJI_20230626212342_0051_Z.JPG	Member	136	['bent']	low	1	right
L23	L23_299	S	5	DJI_20230626212346_0054_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_300	S	0	DJI_20230626212535_0078_Z.JPG	Member	131	['bent']	low	1	left
L23	L23_300	S	0	DJI_20230626212535_0078_Z.JPG	Member	131	['bent']	low	3	right
L23	L23_301	T	0	DJI_20230626212743_0105_Z.JPG	Footings		['overgrown']	low		
L23	L23_303	S	0	DJI_20230626213049_0138_Z.JPG	Member	131	['bent']	low	2	left

Line Number	Structure Identifier	Structure Type	Extension	Image File	Feature	ID	Defect	Severity	Lg	Side
L23	L23_303	S	0	DJI_20230626213049_0138_Z.JPG	Member	131	['bent']	low	4	right
L23	L23_303	S	0	DJI_20230626213128_0150_Z.JPG	Member	131	['bent']	low	3	left
L23	L23_303	S	0	DJI_20230626213128_0150_Z.JPG	Member	131	['bent']	low	4	left
L23	L23_303	S	0	DJI_20230626213221_0167_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_304	S	0	DJI_20230626213321_0178_Z.JPG	Footings		['overgrown']	low		
L23	L23_305	S	0	DJI_20230626213519_0203_Z.JPG	Member	131	['bent']	low	1	right
L23	L23_305	S	0	DJI_20230626213600_0212_Z.JPG	Footings		['fill too high']	low		
L23	L23_306	S	5	DJI_20230626234048_0020_Z.JPG	Member	127	['bent']	low	2	right
L23	L23_307	S	5	DJI_20230626234217_0036_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_307	S	5	DJI_20230626234302_0049_Z.JPG	Footings		['fill too high']	low		
L23	L23_307	S	5	DJI_20230626234302_0049_Z.JPG	Footings		['fill too high']	low		
L23	L23_307	S	5	DJI_20230626234302_0049_Z.JPG	Footings		['fill too high']	low		
L23	L23_307	S	5	DJI_20230626234302_0049_Z.JPG	Footings		['fill too high']	low		
L23	L23_308	S	5	DJI_20230626234444_0074_Z.JPG	Footings		['fill too high']	low		
L23	L23_308	S	5	DJI_20230626234444_0074_Z.JPG	Footings		['fill too high']	low		
L23	L23_308	S	5	DJI_20230626234444_0074_Z.JPG	Member	127	['bent']	low	1	left
L23	L23_308	S	5	DJI_20230626234444_0074_Z.JPG	Footings		['fill too high']	low		
L23	L23_308	S	5	DJI_20230626234444_0074_Z.JPG	Footings		['fill too high']	low		
L23	L23_309	S	5	DJI_20230626234539_0080_Z.JPG	Member	127	['bent']	low	4	right
L23	L23_309	S	5	DJI_20230626234539_0080_Z.JPG	Footings		['fill too high']	low		
L23	L23_309	S	5	DJI_20230626234539_0080_Z.JPG	Footings		['fill too high']	low		
L23	L23_309	S	5	DJI_20230626234627_0098_Z.JPG	Member	127	['bent']	low	1	left
L23	L23_309	S	5	DJI_20230626234641_0102_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_311	S	5	DJI_20230626234949_0139_Z.JPG	Footings		['overgrown']	low		
L23	L23_311	S	5	DJI_20230626234956_0142_W.JPG	Structure		['leaning']	low		
L23	L23_313	S	5	DJI_20230626235257_0184_Z.JPG	Member	127	['bent']	low	4	right
L23	L23_313	S	5	DJI_20230626235257_0184_Z.JPG	Member	127	['bent']	low	2	left
L23	L23_313	S	5	DJI_20230626235312_0190_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_313	S	5	DJI_20230626235317_0191_W.JPG	Environmental		['raptor nest']	low		
L23	L23_313	S	5	DJI_20230626235401_0201_Z.JPG	Member	127	['bent']	low	4	left
L23	L23_313	S	5	DJI_20230626235401_0201_Z.JPG	Member	127	['broken']	medium	1	right
L23	L23_313	S	5	DJI_20230626235424_0208_Z.JPG	Member	127	['bent']	low	1	left
L23	L23_314	S	5	DJI_20230626235619_0235_Z.JPG	Footings		['fill too high']	low		
L23	L23_314	S	5	DJI_20230626235619_0235_Z.JPG	Footings		['fill too high']	low		
L23	L23_314	S	5	DJI_20230626235619_0235_Z.JPG	Footings		['fill too high']	low		
L23	L23_314	S	5	DJI_20230626235619_0235_Z.JPG	Footings		['fill too high']	low		
L23	L23_315	S	5	DJI_20230627000025_0008_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_315	S	5	DJI_20230627000037_0011_Z.JPG	Footings		['fill too high']	low		
L23	L23_315	S	5	DJI_20230627000037_0011_Z.JPG	Footings		['fill too high']	low		
L23	L23_315	S	5	DJI_20230627000037_0011_Z.JPG	Footings		['fill too high']	low		
L23	L23_315	S	5	DJI_20230627000037_0011_Z.JPG	Footings		['fill too high']	low		
L23	L23_315	S	5	DJI_20230627000039_0013_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_316	S	5	DJI_20230627000146_0027_Z.JPG	Footings		['fill too high']	low		
L23	L23_316	S	5	DJI_20230627000247_0045_Z.JPG	Footings		['fill too high']	low		
L23	L23_316	S	5	DJI_20230627000247_0045_Z.JPG	Footings		['fill too high']	low		
L23	L23_316	S	5	DJI_20230627000247_0045_Z.JPG	Footings		['fill too high']	low		
L23	L23_317	S	0	DJI_20230627000351_0057_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_318	S	0	DJI_20230627000551_0087_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_318	S	0	DJI_20230627000614_0092_Z.JPG	Member	131	['bent']	low	1	right
L23	L23_318	S	0	DJI_20230627000628_0098_Z.JPG	Member	131	['bent']	low	4	left
L23	L23_318	S	0	DJI_20230627000652_0107_Z.JPG	Member	131	['bent']	low	2	left
L23	L23_318	S	0	DJI_20230627000652_0107_Z.JPG	Member	131	['bent']	low	1	left
L23	L23_319	S	0	DJI_20230627000809_0123_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_319	S	0	DJI_20230627000901_0138_Z.JPG	Member	131	['bent']	low	1	left
L23	L23_319	S	0	DJI_20230627000901_0138_Z.JPG	Member	131	['bent']	low	4	right
L23	L23_319	S	0	DJI_20230627000901_0138_Z.JPG	Member	131	['bent']	low	2	left
L23	L23_319	S	0	DJI_20230627000901_0138_Z.JPG	Member	131	['bent']	low	3	right
L23	L23_320	S	0	DJI_20230627001028_0152_Z.JPG	Member	131	['bent']	low	4	right
L23	L23_320	S	0	DJI_20230627001055_0160_Z.JPG	Member	131	['bent']	low	3	left
L23	L23_320	S	0	DJI_20230627001055_0160_Z.JPG	Member	131	['bent']	low	1	right
L23	L23_320	S	0	DJI_20230627001154_0176_Z.JPG	Member	131	['bent']	low	2	left
L23	L23_320	S	0	DJI_20230627001154_0176_Z.JPG	Member	131	['bent']	low	3	right
L23	L23_320	S	0	DJI_20230627001154_0176_Z.JPG	Member	131	['bent']	low	1	left
L23	L23_321	S	10	DJI_20230627003602_0008_Z.JPG	Insulator		['broken']	low		
L23	L23_322	S	0	DJI_20230627003855_0049_Z.JPG	Member	131	['bent']	low	4	left
L23	L23_322	S	0	DJI_20230627003910_0054_Z.JPG	Member	131	['bent']	low	3	right
L23	L23_322	S	0	DJI_20230627003910_0054_Z.JPG	Member	131	['bent']	low	2	left
L23	L23_323	T	0	DJI_20230627003956_0060_Z.JPG	Footings		['fill too high']	low		
L23	L23_323	T	0	DJI_20230627003956_0060_Z.JPG	Footings		['fill too high']	low		
L23	L23_323	T	0	DJI_20230627003956_0060_Z.JPG	Footings		['fill too high']	low		
L23	L23_323	T	0	DJI_20230627003956_0060_Z.JPG	Footings		['fill too high']	low		
L23	L23_323	T	0	DJI_20230627004051_0074_Z.JPG	Member	131	['bent']	low	2	right

Line Number	Structure Identifier	Structure Type	Extension	Image File	Feature	ID	Defect	Severity	Lg	Side
L23	L23_323	T	0	DJI_20230627004051_0074_Z.JPG	Member	131	['bent']	low	4	left
L23	L23_323	T	0	DJI_20230627004051_0074_Z.JPG	Member	131	['bent']	low	1	left
L23	L23_324	T	0	DJI_20230627004210_0087_Z.JPG	Member	124	['bent']	low	2	left
L23	L23_324	T	0	DJI_20230627004232_0095_Z.JPG	Footings		['overgrown']	low		
L23	L23_324	T	0	DJI_20230627004232_0095_Z.JPG	Footings		['overgrown']	low		
L23	L23_324	T	0	DJI_20230627004232_0095_Z.JPG	Footings		['overgrown']	low		
L23	L23_325	S	5	DJI_20230627004452_0127_Z.JPG	Footings		['overgrown']	low		
L23	L23_325	S	5	DJI_20230627004452_0127_Z.JPG	Footings		['overgrown']	low		
L23	L23_325	S	5	DJI_20230627004452_0127_Z.JPG	Footings		['overgrown']	low		
L23	L23_325	S	5	DJI_20230627004452_0127_Z.JPG	Footings		['overgrown']	low		
L23	L23_325	S	5	DJI_20230627004520_0135_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_326	S	5	DJI_20230627004630_0142_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_326	S	5	DJI_20230627004726_0158_Z.JPG	Footings		['fill too high']	low		
L23	L23_326	S	5	DJI_20230627004726_0158_Z.JPG	Footings		['fill too high']	low		
L23	L23_326	S	5	DJI_20230627004726_0158_Z.JPG	Footings		['fill too high']	low		
L23	L23_326	S	5	DJI_20230627004726_0158_Z.JPG	Footings		['fill too high']	low		
L23	L23_326	S	5	DJI_20230627004729_0160_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_327	S	5	DJI_20230627004911_0182_Z.JPG	Footings		['fill too high']	low		
L23	L23_327	S	5	DJI_20230627004911_0182_Z.JPG	Footings		['fill too high']	low		
L23	L23_327	S	5	DJI_20230627004911_0182_Z.JPG	Footings		['fill too high']	low		
L23	L23_327	S	5	DJI_20230627004911_0182_Z.JPG	Footings		['fill too high']	low		
L23	L23_329	S	0	DJI_20230627005331_0231_Z.JPG	Footings		['overgrown']	low		
L23	L23_329	S	0	DJI_20230627005331_0231_Z.JPG	Footings		['overgrown']	low		
L23	L23_329	S	0	DJI_20230627005331_0231_Z.JPG	Footings		['overgrown']	low		
L23	L23_332	S	5	DJI_20230627010333_0061_W.JPG	Structure		['leaning']	low		
L23	L23_332	S	5	DJI_20230627010342_0064_Z.JPG	Footings		['overgrown']	low		
L23	L23_332	S	5	DJI_20230627010342_0064_Z.JPG	Footings		['overgrown']	low		
L23	L23_332	S	5	DJI_20230627010342_0064_Z.JPG	Footings		['overgrown']	low		
L23	L23_332	S	5	DJI_20230627010421_0077_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_333	S	0	DJI_20230627010557_0094_Z.JPG	Footings		['fill too high']	low		
L23	L23_333	S	0	DJI_20230627010557_0094_Z.JPG	Footings		['fill too high']	low		
L23	L23_333	S	0	DJI_20230627010557_0094_Z.JPG	Footings		['fill too high']	low		
L23	L23_333	S	0	DJI_20230627010557_0094_Z.JPG	Footings		['fill too high']	low		
L23	L23_333	S	0	DJI_20230627010629_0102_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_334	S	10	DJI_20230627010847_0111_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_337	S	0	DJI_20230627022924_0012_Z.JPG	Member	131	['bent']	low	1	right
L23	L23_338	S	10	DJI_20230627023145_0038_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_338	S	10	DJI_20230627023152_0040_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_338	S	10	DJI_20230627023533_0083_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_339	S	10	DJI_20230627023718_0107_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_340	S	5	DJI_20230627023802_0112_Z.JPG	Footings		['fill too low']	low		
L23	L23_340	S	5	DJI_20230627023841_0123_Z.JPG	Member	127	['bent']	low	1	right
L23	L23_341	S	5	DJI_20230627024020_0143_Z.JPG	Footings		['fill too high']	low		
L23	L23_341	S	5	DJI_20230627024020_0143_Z.JPG	Footings		['fill too high']	low		
L23	L23_341	S	5	DJI_20230627024020_0143_Z.JPG	Footings		['fill too high']	low		
L23	L23_342	S	5	DJI_20230627024240_0180_Z.JPG	Member	127	['bent']	low	1	right
L23	L23_342	S	5	DJI_20230627024240_0180_Z.JPG	Member	127	['bent']	low	3	left
L23	L23_342	S	5	DJI_20230627024253_0185_Z.JPG	Member	127	['broken']	medium	2	right
L23	L23_343	S	5	DJI_20230627212110_0034_Z.JPG	Footings		['fill too high']	low		
L23	L23_343	S	5	DJI_20230627212110_0034_Z.JPG	Footings		['fill too high']	low		
L23	L23_343	S	5	DJI_20230627212110_0034_Z.JPG	Footings		['fill too high']	low		
L23	L23_343	S	5	DJI_20230627212110_0034_Z.JPG	Footings		['fill too high']	low		
L23	L23_344	S	5	DJI_20230627212221_0045_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_344	S	5	DJI_20230627212231_0046_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_344	S	5	DJI_20230627212233_0047_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_344	S	5	DJI_20230627212319_0055_Z.JPG	Footings		['fill too high']	low		
L23	L23_344	S	5	DJI_20230627212319_0055_Z.JPG	Footings		['fill too high']	low		
L23	L23_344	S	5	DJI_20230627212319_0055_Z.JPG	Footings		['fill too high']	low		
L23	L23_344	S	5	DJI_20230627212319_0055_Z.JPG	Footings		['fill too high']	low		
L23	L23_344	S	5	DJI_20230627212321_0057_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_345	S	5	DJI_20230627212518_0085_Z.JPG	Footings		['fill too high']	low		
L23	L23_345	S	5	DJI_20230627212518_0085_Z.JPG	Footings		['fill too high']	low		
L23	L23_345	S	5	DJI_20230627212518_0085_Z.JPG	Footings		['fill too high']	low		
L23	L23_345	S	5	DJI_20230627212518_0085_Z.JPG	Footings		['fill too high']	low		
L23	L23_346	S	5	DJI_20230627212752_0110_Z.JPG	Footings		['fill too high']	low		
L23	L23_346	S	5	DJI_20230627212752_0110_Z.JPG	Footings		['fill too high']	low		
L23	L23_346	S	5	DJI_20230627212752_0110_Z.JPG	Footings		['fill too high']	low		
L23	L23_346	S	5	DJI_20230627212752_0110_Z.JPG	Footings		['fill too high']	low		
L23	L23_347	S	5	DJI_20230627212903_0125_Z.JPG	Member	127	['bent']	low	3	left
L23	L23_347	S	5	DJI_20230627212903_0125_Z.JPG	Member	127	['bent']	low	1	right
L23	L23_347	S	5	DJI_20230627212917_0130_Z.JPG	Footings		['fill too high']	low		
L23	L23_347	S	5	DJI_20230627212917_0130_Z.JPG	Footings		['fill too high']	low		

Line Number	Structure Identifier	Structure Type	Extension	Image File	Feature	ID	Defect	Severity	Lg	Side
L23	L23_347	S	5	DJI_20230627212917_0130_Z.JPG	Footings		['fill too high']	low		
L23	L23_347	S	5	DJI_20230627212917_0130_Z.JPG	Footings		['fill too high']	low		
L23	L23_348	S	0	DJI_20230627213038_0143_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_349	S	0	DJI_20230627213254_0169_Z.JPG	Member	131	['bent']	low	4	right
L23	L23_349	S	0	DJI_20230627213331_0179_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_349	S	0	DJI_20230627213344_0182_Z.JPG	Member	131	['bent']	low	2	right
L23	L23_349	S	0	DJI_20230627213344_0182_Z.JPG	Footings		['fill too low']	low		
L23	L23_349	S	0	DJI_20230627213400_0186_W.JPG	Structure		['leaning']	medium		
L23	L23_349	S	0	DJI_20230627213414_0189_Z.JPG	Footings		['fill too low']	low		
L23	L23_349	S	0	DJI_20230627213414_0189_Z.JPG	Footings		['fill too low']	low		
L23	L23_349	S	0	DJI_20230627213414_0189_Z.JPG	Footings		['fill too low']	low		
L23	L23_350	S	10	DJI_20230627220133_0024_Z.JPG	Member	144	['bent']	low	1	left
L23	L23_351	S	0	DJI_20230627220308_0042_Z.JPG	Member	131	['bent']	low	1	right
L23	L23_351	S	0	DJI_20230627220308_0042_Z.JPG	Member	131	['bent']	low	3	left
L23	L23_351	S	0	DJI_20230627220355_0058_Z.JPG	Member	131	['bent']	low	1	left
L23	L23_351	S	0	DJI_20230627220355_0058_Z.JPG	Member	131	['bent']	low	3	right
L23	L23_356	S	0	DJI_20230627221205_0171_Z.JPG	Footings		['fill too high']	low		
L23	L23_356	S	0	DJI_20230627221205_0171_Z.JPG	Footings		['fill too high']	low		
L23	L23_356	S	0	DJI_20230627221205_0171_Z.JPG	Footings		['fill too high']	low		
L23	L23_356	S	0	DJI_20230627221205_0171_Z.JPG	Footings		['fill too high']	low		
L23	L23_357	S	0	DJI_20230627221352_0199_Z.JPG	Member	131	['bent']	low	4	right
L23	L23_359	S	10	DJI_20230627235954_0054_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_360	S	10	DJI_20230628000145_0078_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_361	S	0	DJI_20230628000402_0109_Z.JPG	Environmental		['raptor']	low		
L23	L23_361	S	0	DJI_20230628000402_0109_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_362	S	0	DJI_20230628000501_0120_Z.JPG	Footings		['overgrown']	low		
L23	L23_362	S	0	DJI_20230628000501_0120_Z.JPG	Footings		['overgrown']	low		
L23	L23_362	S	0	DJI_20230628000501_0120_Z.JPG	Footings		['overgrown']	low		
L23	L23_363	S	0	DJI_20230628000803_0166_Z.JPG	Member	131	['bent']	low	4	left
L23	L23_363	S	0	DJI_20230628000803_0166_Z.JPG	Member	131	['bent']	low	3	right
L23	L23_363	S	0	DJI_20230628000803_0166_Z.JPG	Member	131	['bent']	low	1	left
L23	L23_363	S	0	DJI_20230628000803_0166_Z.JPG	Member	131	['bent']	low	3	left
L23	L23_363	S	0	DJI_20230628000803_0166_Z.JPG	Member	131	['bent']	low	4	right
L23	L23_363	S	0	DJI_20230628000803_0166_Z.JPG	Member	131	['bent']	low	2	left
L23	L23_364	S	5	DJI_20230628001002_0184_Z.JPG	Member	127	['bent']	low	4	left
L23	L23_364	S	5	DJI_20230628001002_0184_Z.JPG	Member	127	['altered member']	low	4	left
L23	L23_366	S	5	DJI_20230628001739_0019_Z.JPG	Footings		['overgrown']	low		
L23	L23_367	S	5	DJI_20230628002007_0047_Z.JPG	Member	127	['missing']	medium	1	right
L23	L23_368	S	5	DJI_20230628002208_0078_Z.JPG	Footings		['fill too high']	low		
L23	L23_368	S	5	DJI_20230628002208_0078_Z.JPG	Footings		['fill too high']	low		
L23	L23_368	S	5	DJI_20230628002208_0078_Z.JPG	Footings		['fill too high']	low		
L23	L23_368	S	5	DJI_20230628002208_0078_Z.JPG	Footings		['fill too high']	low		
L23	L23_369	S	0	DJI_20230628002317_0094_Z.JPG	Member	131	['bent']	low	1	right
L23	L23_371	T	0	DJI_20230628002840_0172_Z.JPG	Member	124	['bent']	low	1	left
L23	L23_371	T	0	DJI_20230628002840_0172_Z.JPG	Member	124	['bent']	low	3	right
L23	L23_372	S	10	DJI_20230628003104_0208_Z.JPG	Member	144	['bent']	low	1	left
L23	L23_372	S	10	DJI_20230628003104_0208_Z.JPG	Member	144	['bent']	low	3	right
L23	L23_373	S	10	DJI_20230624025425_0007_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_373	S	10	DJI_20230624025432_0009_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_374	S	0	DJI_20230624025700_0032_Z.JPG	Member	131	['bent']	low	2	left
L23	L23_374	S	0	DJI_20230624025731_0040_Z.JPG	Footings		['fill too high']	low		
L23	L23_374	S	0	DJI_20230624025731_0040_Z.JPG	Footings		['fill too high']	low		
L23	L23_374	S	0	DJI_20230624025731_0040_Z.JPG	Footings		['fill too high']	low		
L23	L23_374	S	0	DJI_20230624025731_0040_Z.JPG	Footings		['fill too high']	low		
L23	L23_374	S	0	DJI_20230624025808_0049_Z.JPG	Member	131	['bent']	low	2	right
L23	L23_376	S	5	DJI_20230624030225_0094_W.JPG	Structure		['leaning']	low		
L23	L23_376	S	5	DJI_20230624030250_0101_Z.JPG	Footings		['overgrown']	low		
L23	L23_378	S	0	DJI_20230624030758_0158_Z.JPG	Footings		['overgrown']	low		
L23	L23_378	S	0	DJI_20230624030758_0158_Z.JPG	Footings		['overgrown']	low		
L23	L23_378	S	0	DJI_20230624030758_0158_Z.JPG	Footings		['overgrown']	low		
L23	L23_378	S	0	DJI_20230624030758_0158_Z.JPG	Footings		['overgrown']	low		
L23	L23_381	S	0	DJI_20230624031812_0038_Z.JPG	Footings		['fill too low']	low		
L23	L23_381	S	0	DJI_20230624031812_0038_Z.JPG	Footings		['fill too low']	low		
L23	L23_381	S	0	DJI_20230624031812_0038_Z.JPG	Footings		['fill too low']	low		
L23	L23_381	S	0	DJI_20230624031812_0038_Z.JPG	Footings		['fill too low']	low		
L23	L23_381	S	0	DJI_20230624031900_0048_Z.JPG	Member	131	['bent']	low	1	right
L23	L23_381	S	0	DJI_20230624031936_0054_Z.JPG	Member	131	['bent']	low	4	left
L23	L23_382	S	10	DJI_20230624032057_0066_Z.JPG	Member	144	['bent']	low	2	right
L23	L23_382	S	10	DJI_20230624032057_0066_Z.JPG	Member	144	['bent']	low	3	right
L23	L23_382	S	10	DJI_20230624032057_0066_Z.JPG	Member	144	['bent']	low	1	right
L23	L23_382	S	10	DJI_20230624032057_0066_Z.JPG	Member	144	['bent']	low	2	left
L23	L23_382	S	10	DJI_20230624032057_0066_Z.JPG	Member	144	['bent']	low	4	right

Line Number	Structure Identifier	Structure Type	Extension	Image File	Feature	ID	Defect	Severity	Lg	Side
L23	L23_382	S	10	DJI_20230624032057_0066_Z.JPG	Member	144	['bent']	low	4	left
L23	L23_382	S	10	DJI_20230624032057_0066_Z.JPG	Member	144	['bent']	low	1	left
L23	L23_382	S	10	DJI_20230624032254_0093_Z.JPG	Member	150	['bent']	low	2	left
L23	L23_382	S	10	DJI_20230624032254_0093_Z.JPG	Member	150	['bent']	low	2	right
L23	L23_385	S	5	DJI_20230628043606_0021_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_385	S	5	DJI_20230628043621_0024_Z.JPG	Footings		['overgrown']	low		
L23	L23_385	S	5	DJI_20230628043621_0024_Z.JPG	Footings		['fill too high']	low		
L23	L23_385	S	5	DJI_20230628043621_0024_Z.JPG	Footings		['overgrown']	low		
L23	L23_385	S	5	DJI_20230628043621_0024_Z.JPG	Footings		['overgrown']	low		
L23	L23_385	S	5	DJI_20230628043636_0029_Z.JPG	Member	127	['bent']	low	4	right
L23	L23_385	S	5	DJI_20230628043656_0036_Z.JPG	Environmental		['raptor']	low		
L23	L23_385	S	5	DJI_20230628043656_0036_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_388	S	0	DJI_20230628044136_0092_Z.JPG	Member	131	['bent']	low	4	right
L23	L23_388	S	0	DJI_20230628044231_0110_Z.JPG	Member	131	['bent']	low	1	left
L23	L23_391	S	0	DJI_20230628045115_0063_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_397	S	10	DJI_20230628050252_0217_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_398	S	0	DJI_20230628051201_0024_Z.JPG	Footings		['fill too high']	low		
L23	L23_398	S	0	DJI_20230628051201_0024_Z.JPG	Footings		['fill too high']	low		
L23	L23_398	S	0	DJI_20230628051201_0024_Z.JPG	Footings		['fill too high']	low		
L23	L23_398	S	0	DJI_20230628051201_0024_Z.JPG	Footings		['fill too high']	low		
L23	L23_400	S	5	DJI_20230628224215_0021_Z.JPG	Footings		['overgrown']	low		
L23	L23_400	S	5	DJI_20230628224215_0021_Z.JPG	Footings		['overgrown']	low		
L23	L23_400	S	5	DJI_20230628224215_0021_Z.JPG	Footings		['overgrown']	low		
L23	L23_400	S	5	DJI_20230628224215_0021_Z.JPG	Footings		['overgrown']	low		
L23	L23_401	S	0	DJI_20230628005941_0012_Z.JPG	Member	131	['bent']	low	3	left
L23	L23_401	S	0	DJI_20230628005941_0012_Z.JPG	Member	131	['bent']	low	1	right
L23	L23_402	S	0	DJI_20230628010235_0054_Z.JPG	Member	131	['bent']	low	4	left
L23	L23_402	S	0	DJI_20230628010235_0054_Z.JPG	Member	131	['bent']	low	1	right
L23	L23_402	S	0	DJI_20230628010235_0054_Z.JPG	Member	131	['bent']	low	2	right
L23	L23_402	S	0	DJI_20230628010235_0054_Z.JPG	Member	131	['bent']	low	1	left
L23	L23_402	S	0	DJI_20230628010307_0065_Z.JPG	Member	131	['bent']	low	3	right
L23	L23_403	S	0	DJI_20230628010355_0071_Z.JPG	Footings		['overgrown']	low		
L23	L23_403	S	0	DJI_20230628010355_0071_Z.JPG	Footings		['overgrown']	low		
L23	L23_403	S	0	DJI_20230628010355_0071_Z.JPG	Footings		['overgrown']	low		
L23	L23_403	S	0	DJI_20230628010355_0071_Z.JPG	Footings		['overgrown']	low		
L23	L23_404	S	10	DJI_20230628010652_0120_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_405	S	0	DJI_20230628010726_0124_Z.JPG	Member	131	['bent']	low	4	right
L23	L23_405	S	0	DJI_20230628010815_0138_Z.JPG	Member	129	['bent']	medium	2	left
L23	L23_405	S	0	DJI_20230628010900_0148_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_406	S	10	DJI_20230628011100_0176_Z.JPG	Environmental		['raptor']	low		
L23	L23_406	S	10	DJI_20230628011100_0176_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_407	C	0	DJI_20230628011154_0181_Z.JPG	Member	122	['bent']	low	2	left
L23	L23_407	C	0	DJI_20230628011319_0199_Z.JPG	Guy		['not standard practice']	high		
L23	L23_408	S	10	DJI_20230628011559_0233_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_409	S	5	DJI_20230628012031_0014_Z.JPG	Environmental		['raptor']	low		
L23	L23_409	S	5	DJI_20230628012031_0014_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_409	S	5	DJI_20230628012050_0018_Z.JPG	Member	136	['altered member']	low	1	left
L23	L23_411	S	10	DJI_20230628012435_0073_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_412	C	0	DJI_20230628012711_0103_Z.JPG	Member	123	['bent']	low	4	right
L23	L23_412	C	0	DJI_20230628012711_0103_Z.JPG	Member	123	['bent']	low	3	right
L23	L23_412	C	0	DJI_20230628012711_0103_Z.JPG	Member	123	['bent']	low	1	right
L23	L23_412	C	0	DJI_20230628012711_0103_Z.JPG	Member	123	['bent']	low	1	left
L23	L23_412	C	0	DJI_20230628012711_0103_Z.JPG	Member	123	['bent']	low	4	left
L23	L23_412	C	0	DJI_20230628012711_0103_Z.JPG	Member	123	['bent']	low	2	left
L23	L23_412	C	0	DJI_20230628012711_0103_Z.JPG	Member	123	['bent']	low	1	left
L23	L23_412	C	0	DJI_20230628012711_0103_Z.JPG	Member	123	['bent']	low	2	right
L23	L23_413	S	0	DJI_20230628012928_0132_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_414	S	0	DJI_20230628024026_0024_Z.JPG	Footings		['overgrown']	low		
L23	L23_414	S	0	DJI_20230628024026_0024_Z.JPG	Footings		['overgrown']	low		
L23	L23_414	S	0	DJI_20230628024026_0024_Z.JPG	Footings		['overgrown']	low		
L23	L23_414	S	0	DJI_20230628024026_0024_Z.JPG	Footings		['overgrown']	low		
L23	L23_414	S	0	DJI_20230628024037_0027_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_417	T	0	DJI_20230628024603_0103_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_418	T	0	DJI_20230628024731_0115_Z.JPG	Member	124	['bent']	low	3	left
L23	L23_419	S	0	DJI_20230629203406_0013_Z.JPG	Member	131	['bent']	low	3	left
L23	L23_419	S	0	DJI_20230629203453_0028_Z.JPG	Member	131	['broken']	medium	3	right
L23	L23_420	S	0	DJI_20230629203644_0048_Z.JPG	Member	131	['bent']	low	4	left
L23	L23_420	S	0	DJI_20230629203644_0048_Z.JPG	Member	131	['bent']	low	1	right
L23	L23_420	S	0	DJI_20230629203729_0064_Z.JPG	Member	131	['bent']	low	2	left
L23	L23_420	S	0	DJI_20230629203729_0064_Z.JPG	Member	131	['bent']	low	3	left
L23	L23_420	S	0	DJI_20230629203729_0064_Z.JPG	Member	131	['bent']	low	2	right
L23	L23_420	S	0	DJI_20230629203729_0064_Z.JPG	Member	131	['bent']	low	1	left

Line Number	Structure Identifier	Structure Type	Extension	Image File	Feature	ID	Defect	Severity	Lg	Side
L23	L23_421	S	0	DJI_20230629203859_0079_Z.JPG	Footings		['overgrown']	low		
L23	L23_421	S	0	DJI_20230629203859_0079_Z.JPG	Footings		['overgrown']	low		
L23	L23_421	S	0	DJI_20230629203859_0079_Z.JPG	Footings		['overgrown']	low		
L23	L23_421	S	0	DJI_20230629203859_0079_Z.JPG	Footings		['overgrown']	low		
L23	L23_421	S	0	DJI_20230629203921_0086_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_422	S	0	DJI_20230629204022_0096_Z.JPG	Member	131	['bent']	low	4	right
L23	L23_422	S	0	DJI_20230629204022_0096_Z.JPG	Member	131	['bent']	low	3	right
L23	L23_422	S	0	DJI_20230629204100_0110_Z.JPG	Environmental		['raptor']	low		
L23	L23_422	S	0	DJI_20230629204116_0113_Z.JPG	Member	131	['bent']	low	4	left
L23	L23_422	S	0	DJI_20230629204116_0113_Z.JPG	Member	131	['bent']	low	2	right
L23	L23_423	T	0	DJI_20230629204234_0129_Z.JPG	Member	124	['bent']	low	4	right
L23	L23_423	T	0	DJI_20230629204234_0129_Z.JPG	Member	124	['bent']	low	2	left
L23	L23_423	T	0	DJI_20230629204307_0138_Z.JPG	Member	124	['broken']	medium	1	right
L23	L23_423	T	0	DJI_20230629204307_0138_Z.JPG	Member	124	['broken']	medium	1	left
L23	L23_424	S	0	DJI_20230629204641_0175_Z.JPG	Footings		['overgrown']	low		
L23	L23_424	S	0	DJI_20230629204641_0175_Z.JPG	Footings		['overgrown']	low		
L23	L23_424	S	0	DJI_20230629204641_0175_Z.JPG	Member	131	['bent']	low	4	left
L23	L23_424	S	0	DJI_20230629204641_0175_Z.JPG	Footings		['overgrown']	low		
L23	L23_424	S	0	DJI_20230629204641_0175_Z.JPG	Footings		['overgrown']	low		
L23	L23_425	S	0	DJI_20230629204829_0195_Z.JPG	Footings		['overgrown']	low		
L23	L23_425	S	0	DJI_20230629204829_0195_Z.JPG	Footings		['overgrown']	low		
L23	L23_425	S	0	DJI_20230629204829_0195_Z.JPG	Footings		['overgrown']	low		
L23	L23_425	S	0	DJI_20230629204829_0195_Z.JPG	Footings		['overgrown']	low		
L23	L23_426	S	0	DJI_20230629205330_0019_Z.JPG	Footings		['overgrown']	low		
L23	L23_426	S	0	DJI_20230629205330_0019_Z.JPG	Footings		['overgrown']	low		
L23	L23_426	S	0	DJI_20230629205330_0019_Z.JPG	Footings		['overgrown']	low		
L23	L23_426	S	0	DJI_20230629205330_0019_Z.JPG	Footings		['overgrown']	low		
L23	L23_426	S	0	DJI_20230629205345_0024_Z.JPG	Member	131	['bent']	low	1	left
L23	L23_427	S	0	DJI_20230629205455_0037_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_427	S	0	DJI_20230629205510_0041_Z.JPG	Member	131	['bent']	low	3	left
L23	L23_427	S	0	DJI_20230629205510_0041_Z.JPG	Member	131	['bent']	low	1	right
L23	L23_428	S	0	DJI_20230629205648_0064_Z.JPG	Member	131	['bent']	low	2	left
L23	L23_428	S	0	DJI_20230629205648_0064_Z.JPG	Member	131	['bent']	low	4	right
L23	L23_428	S	0	DJI_20230629205755_0085_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_429	S	0	DJI_20230629205913_0097_Z.JPG	Member	131	['bent']	low	3	right
L23	L23_429	S	0	DJI_20230629205939_0104_Z.JPG	Member	131	['broken']	medium	4	right
L23	L23_429	S	0	DJI_20230629210003_0112_Z.JPG	Footings		['overgrown']	low		
L23	L23_429	S	0	DJI_20230629210003_0112_Z.JPG	Member	131	['bent']	low	3	left
L23	L23_429	S	0	DJI_20230629210003_0112_Z.JPG	Footings		['overgrown']	low		
L23	L23_429	S	0	DJI_20230629210003_0112_Z.JPG	Footings		['overgrown']	low		
L23	L23_429	S	0	DJI_20230629210003_0112_Z.JPG	Footings		['overgrown']	low		
L23	L23_429	S	0	DJI_20230629210005_0114_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_430	T	0	DJI_20230629210115_0128_Z.JPG	Member	124	['bent']	low	3	left
L23	L23_430	T	0	DJI_20230629210159_0141_Z.JPG	Member	124	['bent']	low	2	left
L23	L23_430	T	0	DJI_20230629210159_0141_Z.JPG	Member	124	['bent']	low	1	left
L23	L23_431	S	10	DJI_20230629210348_0169_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_431	S	10	DJI_20230629210348_0169_Z.JPG	Environmental		['raptor']	low		
L23	L23_431	S	10	DJI_20230629210348_0169_Z.JPG	Environmental		['raptor']	low		
L23	L23_432	T	0	DJI_20230629225920_0013_Z.JPG	Member	124	['bent']	low	3	left
L23	L23_432	T	0	DJI_20230629225920_0013_Z.JPG	Member	124	['bent']	low	1	right
L23	L23_432	T	0	DJI_20230629225954_0025_Z.JPG	Member	124	['bent']	low	1	left
L23	L23_433	S	0	DJI_20230629230116_0045_Z.JPG	Footings		['overgrown']	low		
L23	L23_433	S	0	DJI_20230629230116_0045_Z.JPG	Footings		['overgrown']	low		
L23	L23_433	S	0	DJI_20230629230116_0045_Z.JPG	Footings		['overgrown']	low		
L23	L23_433	S	0	DJI_20230629230116_0045_Z.JPG	Footings		['overgrown']	low		
L23	L23_434	S	0	DJI_20230629230257_0071_Z.JPG	Footings		['overgrown']	low		
L23	L23_434	S	0	DJI_20230629230257_0071_Z.JPG	Footings		['overgrown']	low		
L23	L23_434	S	0	DJI_20230629230257_0071_Z.JPG	Footings		['overgrown']	low		
L23	L23_434	S	0	DJI_20230629230257_0071_Z.JPG	Footings		['overgrown']	low		
L23	L23_437	S	0	DJI_20230629230845_0151_Z.JPG	Footings		['overgrown']	low		
L23	L23_437	S	0	DJI_20230629230845_0151_Z.JPG	Footings		['overgrown']	low		
L23	L23_437	S	0	DJI_20230629230845_0151_Z.JPG	Footings		['overgrown']	low		
L23	L23_437	S	0	DJI_20230629230845_0151_Z.JPG	Footings		['overgrown']	low		
L23	L23_438	S	0	DJI_20230629230949_0158_Z.JPG	Member	131	['bent']	low	4	right
L23	L23_438	S	0	DJI_20230629230949_0158_Z.JPG	Member	131	['bent']	low	2	left
L23	L23_438	S	0	DJI_20230629231042_0179_Z.JPG	Footings		['overgrown']	low		
L23	L23_438	S	0	DJI_20230629231042_0179_Z.JPG	Footings		['overgrown']	low		
L23	L23_438	S	0	DJI_20230629231042_0179_Z.JPG	Footings		['overgrown']	low		
L23	L23_438	S	0	DJI_20230629231042_0179_Z.JPG	Footings		['overgrown']	low		
L23	L23_440	S	0	DJI_20230629231321_0216_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_440	S	0	DJI_20230629231401_0229_Z.JPG	Environmental		['raptor']	low		
L23	L23_440	S	0	DJI_20230629231401_0229_Z.JPG	Environmental		['raptor nest']	low		

Line Number	Structure Identifier	Structure Type	Extension	Image File	Feature	ID	Defect	Severity	Lg	Side
L23	L23_442	S	0	DJI_20230629232324_0032_Z.JPG	Member	131	['bent']	low	4	right
L23	L23_442	S	0	DJI_20230629232324_0032_Z.JPG	Member	131	['bent']	low	2	left
L23	L23_442	S	0	DJI_20230629232427_0053_Z.JPG	Footings		['overgrown']	low		
L23	L23_442	S	0	DJI_20230629232427_0053_Z.JPG	Footings		['overgrown']	low		
L23	L23_442	S	0	DJI_20230629232427_0053_Z.JPG	Footings		['overgrown']	low		
L23	L23_442	S	0	DJI_20230629232427_0053_Z.JPG	Footings		['overgrown']	low		
L23	L23_445	S	0	DJI_20230629232908_0119_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_446	S	0	DJI_20230629233108_0146_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_447	S	0	DJI_20230629235910_0003_Z.JPG	Footings		['fill too high']	low		
L23	L23_447	S	0	DJI_20230629235910_0003_Z.JPG	Footings		['fill too high']	low		
L23	L23_447	S	0	DJI_20230629235910_0003_Z.JPG	Footings		['fill too high']	low		
L23	L23_447	S	0	DJI_20230629235910_0003_Z.JPG	Footings		['fill too high']	low		
L23	L23_450	S	0	DJI_20230630000508_0093_Z.JPG	Member	131	['bent']	low	4	left
L23	L23_450	S	0	DJI_20230630000530_0099_Z.JPG	Footings		['overgrown']	low		
L23	L23_450	S	0	DJI_20230630000530_0099_Z.JPG	Footings		['overgrown']	low		
L23	L23_450	S	0	DJI_20230630000530_0099_Z.JPG	Footings		['overgrown']	low		
L23	L23_450	S	0	DJI_20230630000530_0099_Z.JPG	Footings		['overgrown']	low		
L23	L23_451	S	0	DJI_20230623223037_0100_Z.JPG	Member	131	['bent']	low	4	left
L23	L23_451	S	0	DJI_20230623223059_0105_Z.JPG	Footings		['fill too high']	low		
L23	L23_451	S	0	DJI_20230623223119_0110_Z.JPG	Footings		['fill too high']	low		
L23	L23_451	S	0	DJI_20230623223119_0110_Z.JPG	Footings		['fill too high']	low		
L23	L23_451	S	0	DJI_20230623223119_0110_Z.JPG	Footings		['fill too high']	low		
L23	L23_458	S	0	DJI_20230623223957_0190_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_458	S	0	DJI_20230623224000_0191_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_458	S	0	DJI_20230623224042_0204_Z.JPG	Member	131	['bent']	low	3	right
L23	L23_458	S	0	DJI_20230623224042_0204_Z.JPG	Member	131	['bent']	low	1	left
L23	L23_460	S	15	DJI_20230624002208_0046_Z.JPG	Footings		['overgrown']	low		
L23	L23_460	S	15	DJI_20230624002208_0046_Z.JPG	Footings		['overgrown']	low		
L23	L23_460	S	15	DJI_20230624002208_0046_Z.JPG	Footings		['overgrown']	low		
L23	L23_461	S	0	DJI_20230624002305_0055_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_461	S	0	DJI_20230624002311_0057_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_463	S	10	DJI_20230624002753_0106_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_463	S	10	DJI_20230624002802_0108_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_464	S	0	DJI_20230624003000_0127_Z.JPG	Footings		['overgrown']	low		
L23	L23_464	S	0	DJI_20230624003000_0127_Z.JPG	Footings		['overgrown']	low		
L23	L23_464	S	0	DJI_20230624003000_0127_Z.JPG	Footings		['overgrown']	low		
L23	L23_464	S	0	DJI_20230624003000_0127_Z.JPG	Footings		['overgrown']	low		
L23	L23_464	S	0	DJI_20230624003008_0130_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_464	S	0	DJI_20230624003011_0131_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_464	S	0	DJI_20230624003015_0132_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_464	S	0	DJI_20230624003035_0134_Z.JPG	Footings		['fill too high']	low		
L23	L23_465	S	0	DJI_20230624003402_0168_Z.JPG	Footings		['overgrown']	low		
L23	L23_465	S	0	DJI_20230624003402_0168_Z.JPG	Footings		['fill too high']	low		
L23	L23_468	S	0	DJI_20230630011033_0062_Z.JPG	Footings		['overgrown']	low		
L23	L23_468	S	0	DJI_20230630011033_0062_Z.JPG	Footings		['overgrown']	low		
L23	L23_473	S	5	DJI_20230630012150_0198_Z.JPG	Footings		['overgrown']	low		
L23	L23_473	S	5	DJI_20230630012150_0198_Z.JPG	Footings		['overgrown']	low		
L23	L23_473	S	5	DJI_20230630012150_0198_Z.JPG	Footings		['overgrown']	low		
L23	L23_473	S	5	DJI_20230630012150_0198_Z.JPG	Footings		['overgrown']	low		
L23	L23_474	S	0	DJI_20230630012735_0013_Z.JPG	Member	131	['bent']	low	3	left
L23	L23_475	S	0	DJI_20230630012935_0041_Z.JPG	Footings		['overgrown']	low		
L23	L23_476	T	0	DJI_20230630013112_0058_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_476	T	0	DJI_20230630013112_0058_Z.JPG	Environmental		['raptor']	low		
L23	L23_476	T	0	DJI_20230630013123_0060_Z.JPG	Footings		['overgrown']	low		
L23	L23_476	T	0	DJI_20230630013123_0060_Z.JPG	Footings		['overgrown']	low		
L23	L23_477	S	0	DJI_20230630013335_0088_Z.JPG	Member	131	['bent']	low	4	right
L23	L23_481	S	10	DJI_20230630020101_0039_Z.JPG	Member	144	['bent']	low	1	right
L23	L23_481	S	10	DJI_20230630020101_0039_Z.JPG	Member	144	['bent']	low	3	left
L23	L23_481	S	10	DJI_20230630020132_0049_Z.JPG	Member	144	['bent']	low	1	left
L23	L23_485	S	0	DJI_20230630020831_0128_Z.JPG	Footings		['overgrown']	low		
L23	L23_485	S	0	DJI_20230630020831_0128_Z.JPG	Footings		['overgrown']	low		
L23	L23_485	S	0	DJI_20230630020831_0128_Z.JPG	Footings		['overgrown']	low		
L23	L23_485	S	0	DJI_20230630020831_0128_Z.JPG	Footings		['overgrown']	low		
L23	L23_490	S	0	DJI_20230630201126_0056_Z.JPG	Member	131	['bent']	low	4	right
L23	L23_490	S	0	DJI_20230630201203_0066_Z.JPG	Member	131	['bent']	low	3	left
L23	L23_490	S	0	DJI_20230630201203_0066_Z.JPG	Member	131	['bent']	low	1	right
L23	L23_490	S	0	DJI_20230630201203_0066_Z.JPG	Member	131	['bent']	low	1	left
L23	L23_494	S	0	DJI_20230630202040_0166_Z.JPG	Member	131	['broken']	medium	2	left
L23	L23_496	S	0	DJI_20230630214823_0022_Z.JPG	Member	131	['bent']	low	1	left
L23	L23_496	S	0	DJI_20230630214823_0022_Z.JPG	Footings		['overgrown']	low		
L23	L23_496	S	0	DJI_20230630214823_0022_Z.JPG	Footings		['overgrown']	low		
L23	L23_496	S	0	DJI_20230630214823_0022_Z.JPG	Footings		['overgrown']	low		

Line Number	Structure Identifier	Structure Type	Extension	Image File	Feature	ID	Defect	Severity	Lg	Side
L23	L23_496	S	0	DJI_20230630214823_0022_Z.JPG	Footings		['overgrown']	low		
L23	L23_498	S	0	DJI_20230630215235_0079_Z.JPG	Footings		['fill too high']	low		
L23	L23_498	S	0	DJI_20230630215235_0079_Z.JPG	Footings		['fill too high']	low		
L23	L23_498	S	0	DJI_20230630215235_0079_Z.JPG	Footings		['fill too high']	low		
L23	L23_498	S	0	DJI_20230630215235_0079_Z.JPG	Footings		['fill too high']	low		
L23	L23_499	S	0	DJI_20230630215402_0099_Z.JPG	Member	131	['bent']	low	4	left
L23	L23_503	S	0	DJI_20230630220143_0192_Z.JPG	Member	131	['bent']	low	4	right
L23	L23_503	S	0	DJI_20230630220143_0192_Z.JPG	Footings		['overgrown']	low		
L23	L23_504	S	0	DJI_20230630220715_0023_Z.JPG	Member	131	['bent']	low	3	right
L23	L23_505	C	0	DJI_20230630220851_0044_Z.JPG	Footings		['overgrown']	low		
L23	L23_505	C	0	DJI_20230630220851_0044_Z.JPG	Footings		['overgrown']	low		
L23	L23_505	C	0	DJI_20230630220851_0044_Z.JPG	Footings		['overgrown']	low		
L23	L23_505	C	0	DJI_20230630220851_0044_Z.JPG	Footings		['overgrown']	low		
L23	L23_512	S	0	DJI_20230623202026_0067_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_512	S	0	DJI_20230623202034_0069_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_513	S	10	DJI_20230623201734_0030_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_513	S	10	DJI_20230623201737_0031_Z.JPG	Hardware		['worn hardware']	medium		
L23	L23_513	S	10	DJI_20230623201741_0032_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_514	S	5	DJI_20230623201456_0003_Z.JPG	Footings		['fill too high']	low		
L23	L23_514	S	5	DJI_20230623201456_0003_Z.JPG	Footings		['fill too high']	low		
L23	L23_514	S	5	DJI_20230623201456_0003_Z.JPG	Footings		['fill too high']	low		
L23	L23_514	S	5	DJI_20230623201456_0003_Z.JPG	Footings		['fill too high']	low		
L23	L23_514	S	5	DJI_20230623201504_0006_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_514	S	5	DJI_20230623201509_0007_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_514	S	5	DJI_20230623201513_0008_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_515	S	10	DJI_20230623200320_0110_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_515	S	10	DJI_20230623200323_0111_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_515	S	10	DJI_20230623200330_0113_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_516	S	10	DJI_20230623200113_0082_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_516	S	10	DJI_20230623200119_0084_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_517	S	0	DJI_20230623195901_0052_Z.JPG	Member	131	['bent']	low	4	right
L23	L23_518	S	15	DJI_20230623195651_0028_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_518	S	15	DJI_20230623195701_0030_Z.JPG	Hardware		['worn hardware']	low		
L23	L23_522	S	0	DJI_20230614043419_0140_Z.JPG	Member	131	['bent']	low	1	left
L23	L23_524	S	0	DJI_20230614042539_0052_Z.JPG	Footings		['fill too high']	low		
L23	L23_528	S	5	DJI_20230614040344_0079_Z.JPG	Footings		['fill too high']	low		
L23	L23_528	S	5	DJI_20230614040344_0079_Z.JPG	Footings		['fill too high']	low		
L23	L23_528	S	5	DJI_20230614040344_0079_Z.JPG	Footings		['fill too high']	low		
L23	L23_528	S	5	DJI_20230614040344_0079_Z.JPG	Footings		['fill too high']	low		
L23	L23_536	S	0	DJI_20230614023552_0155_Z.JPG	Footings		['fill too high']	low		
L23	L23_536	S	0	DJI_20230614023552_0155_Z.JPG	Footings		['fill too high']	low		
L23	L23_536	S	0	DJI_20230614023552_0155_Z.JPG	Footings		['fill too high']	low		
L23	L23_536	S	0	DJI_20230614023552_0155_Z.JPG	Footings		['fill too high']	low		
L23	L23_539	S	5	DJI_20230613231001_0093_Z.JPG	Footings		['fill too high']	low		
L23	L23_539	S	5	DJI_20230613231019_0098_Z.JPG	Footings		['fill too high']	low		
L23	L23_539	S	5	DJI_20230613231019_0098_Z.JPG	Footings		['fill too high']	low		
L23	L23_539	S	5	DJI_20230613231019_0098_Z.JPG	Footings		['fill too high']	low		
L23	L23_540	S	0	DJI_20230613230527_0055_Z.JPG	Environmental		['raptor nest']	low		
L23	L23_542	S	0	DJI_20230613225428_0117_Z.JPG	Footings		['fill too high']	medium		
L23	L23_542	S	0	DJI_20230613225428_0117_Z.JPG	Footings		['fill too high']	medium		
L23	L23_542	S	0	DJI_20230613225428_0117_Z.JPG	Footings		['fill too high']	medium		
L23	L23_543	S	0	DJI_20230613225204_0094_Z.JPG	Footings		['fill too high']	medium		
L23	L23_543	S	0	DJI_20230613225206_0095_Z.JPG	Footings		['fill too high']	medium		
L23	L23_543	S	0	DJI_20230613225206_0095_Z.JPG	Footings		['fill too high']	medium		
L23	L23_543	S	0	DJI_20230613225206_0095_Z.JPG	Footings		['fill too high']	medium		
L23	L23_544	S	5	DJI_20230613224621_0042_Z.JPG	Footings		['overgrown']	low		
L23	L23_545	S	5	DJI_20230613200311_0185_Z.JPG	Footings		['overgrown']	low		
L23	L23_545	S	5	DJI_20230613200311_0185_Z.JPG	Footings		['submerged']	low		
L23	L23_545	S	5	DJI_20230613200311_0185_Z.JPG	Footings		['overgrown']	low		
L23	L23_545	S	5	DJI_20230613200500_0210_Z.JPG	Footings		['fill too high']	low		
L23	L23_546	S	0	DJI_20230613195917_0142_Z.JPG	Footings		['submerged']	low		
L23	L23_546	S	0	DJI_20230613195917_0142_Z.JPG	Footings		['submerged']	low		
L23	L23_546	S	0	DJI_20230613195917_0142_Z.JPG	Footings		['submerged']	low		
L23	L23_546	S	0	DJI_20230613195917_0142_Z.JPG	Footings		['submerged']	low		
L23	L23_548	S	0	DJI_20230613195031_0056_Z.JPG	Footings		['submerged']	low		
L23	L23_548	S	0	DJI_20230613195031_0056_Z.JPG	Footings		['overgrown']	low		
L23	L23_548	S	0	DJI_20230613195031_0056_Z.JPG	Footings		['submerged']	low		
L23	L23_548	S	0	DJI_20230613195252_0085_Z.JPG	Footings		['overgrown']	low		
L23	L23_549	S	5	DJI_20230613194605_0010_Z.JPG	Footings		['fill too high']	high		
L23	L23_549	S	5	DJI_20230613194737_0027_Z.JPG	Member	116	['bent']	low	3	left
L23	L23_549	S	5	DJI_20230613194855_0045_Z.JPG	Footings		['fill too high']	high		
L23	L23_549	S	5	DJI_20230613194855_0045_Z.JPG	Footings		['fill too high']	high		

Line Number	Structure Identifier	Structure Type	Extension	Image File	Feature	ID	Defect	Severity	Lg	Side
L23	L23_549	S	5	DJI_20230613194855_0045_Z.JPG	Footings		['fill too high']	high		
L23	L23_550	C	0	DJI_20230613193510_0173_Z.JPG	Footings		['submerged']	low		
L23	L23_550	C	0	DJI_20230613193558_0186_Z.JPG	Footings		['submerged']	low		
L23	L23_550	C	0	DJI_20230613193558_0186_Z.JPG	Footings		['submerged']	low		
L23	L23_550	C	0	DJI_20230613193558_0186_Z.JPG	Footings		['submerged']	low		
L23	L23_552	S	20	DJI_20230613192531_0071_Z.JPG	Footings		['overgrown']	low		
L23	L23_552	S	20	DJI_20230613192531_0071_Z.JPG	Footings		['overgrown']	low		
L23	L23_552	S	20	DJI_20230613192531_0071_Z.JPG	Footings		['overgrown']	low		
L23	L23_553	S	5	DJI_20230613192116_0040_Z.JPG	Footings		['submerged']	low		
L23	L23_553	S	5	DJI_20230613192116_0040_Z.JPG	Footings		['submerged']	medium		
L23	L23_555	S	5	DJI_20230613053551_0077_Z.JPG	Member	127	['bent']	medium	4	right
L23	L23_555	S	5	DJI_20230613053939_0114_Z.JPG	Footings		['fill too high']	medium		
L23	L23_555	S	5	DJI_20230613053939_0114_Z.JPG	Footings		['fill too high']	medium		
L23	L23_555	S	5	DJI_20230613053939_0114_Z.JPG	Footings		['fill too high']	medium		
L23	L23_555	S	5	DJI_20230613053939_0114_Z.JPG	Footings		['fill too high']	medium		
L23	L23_557	T	0	DJI_20230613051214_0201_Z.JPG	Footings		['submerged']	low		
L23	L23_557	T	0	DJI_20230613051219_0202_Z.JPG	Footings		['submerged']	low		
L23	L23_557	T	0	DJI_20230613051219_0202_Z.JPG	Footings		['submerged']	low		
L23	L23_557	T	0	DJI_20230613051219_0202_Z.JPG	Footings		['submerged']	low		
L23	L23_559	S	5	DJI_20230613050311_0095_Z.JPG	Member	136	['bent']	low	4	right
L23	L23_562	S	5	DJI_20230613025325_0159_Z.JPG	Footings		['submerged']	low		
L23	L23_565	T	0	DJI_20230613023746_0020_Z.JPG	Footings		['submerged']	low		
L23	L23_565	T	0	DJI_20230613023920_0036_Z.JPG	Insulator		['broken']	medium		
L23	L23_566	S	5	DJI_20230613015226_0144_Z.JPG	Footings		['submerged']	low		
L23	L23_566	S	5	DJI_20230613015226_0144_Z.JPG	Footings		['submerged']	low		
L23	L23_566	S	5	DJI_20230613015411_0165_Z.JPG	Member	127	['bent']	low	2	right
L23	L23_568	C	10	DJI_20230613013835_0024_Z.JPG	Member	140	['bent']	low	3	left
L23	L23_570	S	0	DJI_20230612223731_0038_Z.JPG	Member	12	['bent']	low		
L23A	L23A_1	RT-DE-70	15	DJI_20230615043020_0136_Z.JPG	Insulator		['porcelain']	low		
L23A	L23A_1	RT-DE-70	15	DJI_20230615043020_0136_Z.JPG	Insulator		['porcelain']	low		
L23A	L23A_1	RT-DE-70	15	DJI_20230615043020_0136_Z.JPG	Insulator		['porcelain']	low		
L23A	L23A_1	RT-DE-70	15	DJI_20230615043020_0136_Z.JPG	Insulator		['porcelain']	low		
L23A	L23A_1	RT-DE-70	15	DJI_20230615043020_0136_Z.JPG	Insulator		['porcelain']	low		
L23A	L23A_1	RT-DE-70	15	DJI_20230615043020_0136_Z.JPG	Insulator		['porcelain']	low		
L23A	L23A_2	RT-0	5	DJI_20230615042222_0057_Z.JPG	Member	167	['bent']	low	2	left
L23A	L23A_2	RT-0	5	DJI_20230615042425_0076_Z.JPG	Insulator		['porcelain']	low		
L23A	L23A_2	RT-0	5	DJI_20230615042425_0076_Z.JPG	Insulator		['porcelain']	low		
L23A	L23A_2	RT-0	5	DJI_20230615042514_0086_Z.JPG	Insulator		['porcelain']	low		
L23A	L23A_3	RT-0	20	DJI_20230615041552_0003_Z.JPG	Insulator		['porcelain']	low		
L23A	L23A_3	RT-0	20	DJI_20230615041921_0031_Z.JPG	Insulator		['porcelain']	low		
L23A	L23A_3	RT-0	20	DJI_20230615041921_0031_Z.JPG	Insulator		['porcelain']	low		
L23A	L23A_3	RT-0	20	DJI_20230615042003_0040_Z.JPG	Member	15	['bent']	low		
L23A	L23A_3	RT-0	20	DJI_20230615042021_0044_Z.JPG	Footings		['fill too low']	low		
L23A	L23A_4	RT-0	0	DJI_20230615035257_0091_Z.JPG	Insulator		['porcelain']	low		
L23A	L23A_4	RT-0	0	DJI_20230615035300_0092_Z.JPG	Insulator		['porcelain']	low		
L23A	L23A_4	RT-0	0	DJI_20230615035300_0092_Z.JPG	Insulator		['porcelain']	low		
L23A	L23A_4	RT-0	0	DJI_20230615035304_0094_Z.JPG	Footings		['fill too high']	low		
L23A	L23A_5	RT-0	20	DJI_20230615034804_0043_Z.JPG	Insulator		['porcelain']	low		
L23A	L23A_5	RT-0	20	DJI_20230615035045_0072_Z.JPG	Insulator		['porcelain']	low		
L23A	L23A_5	RT-0	20	DJI_20230615035045_0072_Z.JPG	Insulator		['porcelain']	low		
L23A	L23A_6	RT-0	15	DJI_20230615034654_0032_Z.JPG	Insulator		['porcelain']	low		
L23A	L23A_7	RT-DE-70	10	DJI_20230615055959_0024_Z.JPG	Footings		['fill too high']	low		
L23A	L23A_7	RT-DE-70	10	DJI_20230615060054_0029_Z.JPG	Insulator		['porcelain']	low		
L23A	L23A_7	RT-DE-70	10	DJI_20230615060054_0029_Z.JPG	Insulator		['porcelain']	low		
L23A	L23A_7	RT-DE-70	10	DJI_20230615060057_0030_Z.JPG	Insulator		['porcelain']	low		
L23A	L23A_7	RT-DE-70	10	DJI_20230615060057_0030_Z.JPG	Insulator		['porcelain']	low		
L23A	L23A_7	RT-DE-70	10	DJI_20230615060058_0031_Z.JPG	Insulator		['porcelain']	low		
L23A	L23A_7	RT-DE-70	10	DJI_20230615060058_0031_Z.JPG	Insulator		['porcelain']	low		
L23A	L23A_7	RT-DE-70	10	DJI_20230615060058_0031_Z.JPG	Insulator		['porcelain']	low		
L23A	L23A_7	RT-DE-70	10	DJI_20230615060058_0031_Z.JPG	Insulator		['porcelain']	low		
L23A	L23A_7	RT-DE-70	10	DJI_20230615060058_0031_Z.JPG	Insulator		['porcelain']	low		
L23A	L23A_8	GV-0	0	DJI_20230615060612_0078_Z.JPG	Footings		['fill too low']	low		
L23A	L23A_8	GV-0	0	DJI_20230615060703_0084_Z.JPG	Insulator		['porcelain']	low		
L23A	L23A_8	GV-0	0	DJI_20230615060703_0084_Z.JPG	Insulator		['porcelain']	low		
L23A	L23A_8	GV-0	0	DJI_20230615060705_0085_Z.JPG	Insulator		['porcelain']	low		
L23A	L23A_9	GV-0	0	DJI_20230615060832_0096_Z.JPG	Footings		['fill too low']	low		
L23A	L23A_9	GV-0	0	DJI_20230615061053_0119_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_9	GV-0	0	DJI_20230615061059_0121_Z.JPG	Insulator		['porcelain']	low		
L23A	L23A_9	GV-0	0	DJI_20230615061059_0121_Z.JPG	Insulator		['porcelain']	low		
L23A	L23A_10	GV-0	0	DJI_20230615061536_0155_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_10	GV-0	0	DJI_20230615061536_0155_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_10	GV-0	0	DJI_20230615061536_0155_W.JPG	Insulator		['porcelain']	low		

Line Number	Structure Identifier	Structure Type	Extension	Image File	Feature	ID	Defect	Severity	Lg	Side
L23A	L23A_11	GV-0	0	DJI_20230615201348_0028_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_11	GV-0	0	DJI_20230615201348_0028_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_11	GV-0	0	DJI_20230615201348_0028_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_12	GV-0	0	DJI_20230615201610_0048_W.JPG	Insulator		['not plomb']	medium		
L23A	L23A_12	GV-0	0	DJI_20230615201610_0048_W.JPG	Insulator		['not plomb']	medium		
L23A	L23A_12	GV-0	0	DJI_20230615201610_0048_W.JPG	Insulator		['not plomb']	low		
L23A	L23A_12	GV-0	0	DJI_20230615201727_0065_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_12	GV-0	0	DJI_20230615201727_0065_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_12	GV-0	0	DJI_20230615201727_0065_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_12	GV-0	0	DJI_20230615201729_0066_Z.JPG	Footings		['fill too low']	low		
L23A	L23A_13	GV-0	0	DJI_20230615201949_0086_W.JPG	Insulator		['not plumb']	medium		
L23A	L23A_13	GV-0	0	DJI_20230615201949_0086_W.JPG	Insulator		['not plumb']	medium		
L23A	L23A_13	GV-0	0	DJI_20230615201949_0086_W.JPG	Insulator		['not plumb']	medium		
L23A	L23A_13	GV-0	0	DJI_20230615202040_0096_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_13	GV-0	0	DJI_20230615202040_0096_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_13	GV-0	0	DJI_20230615202040_0096_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_14	GV-0	0	DJI_20230615202159_0102_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_14	GV-0	0	DJI_20230615202159_0102_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_14	GV-0	0	DJI_20230615202159_0102_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_15	GV-0	0	DJI_20230615202716_0148_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_15	GV-0	0	DJI_20230615202716_0148_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_15	GV-0	0	DJI_20230615202716_0148_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_16	GV-0	0	DJI_20230615210034_0002_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_16	GV-0	0	DJI_20230615210034_0002_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_16	GV-0	0	DJI_20230615210034_0002_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_17	GV-0	0	DJI_20230615210728_0012_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_17	GV-0	0	DJI_20230615210728_0012_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_17	GV-0	0	DJI_20230615210728_0012_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_18	GV-0	0	DJI_20230615211137_0045_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_18	GV-0	0	DJI_20230615211137_0045_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_18	GV-0	0	DJI_20230615211137_0045_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_19	GV-0	0	DJI_20230615211503_0078_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_19	GV-0	0	DJI_20230615211503_0078_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_19	GV-0	0	DJI_20230615211503_0078_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_20	GV-0	0	DJI_20230617045900_0018_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_20	GV-0	0	DJI_20230617045900_0018_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_20	GV-0	0	DJI_20230617045900_0018_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_21	GV-0	0	DJI_20230617050301_0060_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_21	GV-0	0	DJI_20230617050301_0060_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_21	GV-0	0	DJI_20230617050301_0060_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_22	GV-0	0	DJI_20230616211622_0205_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_22	GV-0	0	DJI_20230616211622_0205_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_22	GV-0	0	DJI_20230616211622_0205_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_23	GV-0	0	DJI_20230616211508_0198_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_23	GV-0	0	DJI_20230616211508_0198_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_23	GV-0	0	DJI_20230616211508_0198_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_24	GV-0	0	DJI_20230616211207_0162_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_24	GV-0	0	DJI_20230616211207_0162_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_24	GV-0	0	DJI_20230616211207_0162_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_25	GV-0	0	DJI_20230616210824_0115_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_25	GV-0	0	DJI_20230616210824_0115_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_25	GV-0	0	DJI_20230616210824_0115_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_26	GV-0	0	DJI_20230616210518_0082_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_26	GV-0	0	DJI_20230616210518_0082_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_26	GV-0	0	DJI_20230616210518_0082_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_27	GV-0	0	DJI_20230616210230_0049_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_27	GV-0	0	DJI_20230616210230_0049_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_27	GV-0	0	DJI_20230616210230_0049_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_28	GV-0	0	DJI_20230616205946_0015_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_28	GV-0	0	DJI_20230616205946_0015_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_28	GV-0	0	DJI_20230616205946_0015_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_29	GV-0	0	DJI_20230616222242_0019_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_29	GV-0	0	DJI_20230616222242_0019_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_29	GV-0	0	DJI_20230616222242_0019_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_30	GV-0	0	DJI_20230616222540_0053_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_30	GV-0	0	DJI_20230616222540_0053_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_31	GV-0	0	DJI_20230616222732_0070_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_31	GV-0	0	DJI_20230616222732_0070_W.JPG	Insulator		['porcelain']	medium		
L23A	L23A_31	GV-0	0	DJI_20230616222732_0070_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_31	GV-0	0	DJI_20230616222902_0096_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_31	GV-0	0	DJI_20230616222902_0096_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_31	GV-0	0	DJI_20230616222902_0096_W.JPG	Insulator		['porcelain']	low		

Line Number	Structure Identifier	Structure Type	Extension	Image File	Feature	ID	Defect	Severity	Lg	Side
L23A	L23A_32	GV-0	0	DJI_20230616223003_0102_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_32	GV-0	0	DJI_20230616223003_0102_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_32	GV-0	0	DJI_20230616223003_0102_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_33	GV-0	0	DJI_20230616223246_0133_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_33	GV-0	0	DJI_20230616223246_0133_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_33	GV-0	0	DJI_20230616223246_0133_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_34	GV-0	0	DJI_20230616231716_0024_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_34	GV-0	0	DJI_20230616231716_0024_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_34	GV-0	0	DJI_20230616231716_0024_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_35	GV-0	0	DJI_20230616231821_0029_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_35	GV-0	0	DJI_20230616231821_0029_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_35	GV-0	0	DJI_20230616231821_0029_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_35	GV-0	0	DJI_20230616231839_0033_Z.JPG	Environmental		['raptor nest']	low		
L23A	L23A_36	GV-0	0	DJI_20230616232123_0058_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_36	GV-0	0	DJI_20230616232123_0058_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_36	GV-0	0	DJI_20230616232123_0058_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_37	GV-0	0	DJI_20230617010010_0050_Z.JPG	Footings		['overgrown']	low		
L23A	L23A_37	GV-0	0	DJI_20230617010051_0058_W.JPG	Insulator		['old', 'porcelain']	low		
L23A	L23A_37	GV-0	0	DJI_20230617010051_0058_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_37	GV-0	0	DJI_20230617010051_0058_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_38	GV-0	0	DJI_20230617005818_0027_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_38	GV-0	0	DJI_20230617005818_0027_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_38	GV-0	0	DJI_20230617005818_0027_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_39	GV-0	0	DJI_20230617005015_0207_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_39	GV-0	0	DJI_20230617005015_0207_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_39	GV-0	0	DJI_20230617005015_0207_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_40	GV-0	0	DJI_20230617004709_0176_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_40	GV-0	0	DJI_20230617004709_0176_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_41	GV-0	0	DJI_20230617004247_0132_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_41	GV-0	0	DJI_20230617004247_0132_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_41	GV-0	0	DJI_20230617004247_0132_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_42	GV-0	0	DJI_20230617003928_0103_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_42	GV-0	0	DJI_20230617003928_0103_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_42	GV-0	0	DJI_20230617003928_0103_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_43	GV-0	0	DJI_20230617003704_0080_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_43	GV-0	0	DJI_20230617003704_0080_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_43	GV-0	0	DJI_20230617003704_0080_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_44	GV-0	0	DJI_20230617003251_0031_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_44	GV-0	0	DJI_20230617003251_0031_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_44	GV-0	0	DJI_20230617003251_0031_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_45	GV-0	0	DJI_20230617012953_0003_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_45	GV-0	0	DJI_20230617012953_0003_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_45	GV-0	0	DJI_20230617012953_0003_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_46	GV-0	0	DJI_20230617021523_0053_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_46	GV-0	0	DJI_20230617021523_0053_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_46	GV-0	0	DJI_20230617021523_0053_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_46	GV-0	0	DJI_20230617021715_0082_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_46	GV-0	0	DJI_20230617021715_0082_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_46	GV-0	0	DJI_20230617021715_0082_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_47	GV-0	0	DJI_20230617021310_0034_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_47	GV-0	0	DJI_20230617021310_0034_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_47	GV-0	0	DJI_20230617021310_0034_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_48	GV-0	0	DJI_20230617022435_0148_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_48	GV-0	0	DJI_20230617022435_0148_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_48	GV-0	0	DJI_20230617022435_0148_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_49	GV-0	0	DJI_20230617022720_0173_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_49	GV-0	0	DJI_20230617022720_0173_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_49	GV-0	0	DJI_20230617022720_0173_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_50	GV-0	0	DJI_20230617023028_0207_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_50	GV-0	0	DJI_20230617023028_0207_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_50	GV-0	0	DJI_20230617023028_0207_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_51	GV-0	0	DJI_20230617024043_0072_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_51	GV-0	0	DJI_20230617024043_0072_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_51	GV-0	0	DJI_20230617024043_0072_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_52	GV-0	0	DJI_20230617023739_0037_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_52	GV-0	0	DJI_20230617023739_0037_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_52	GV-0	0	DJI_20230617023739_0037_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_53	GV-0	0	DJI_20230619212242_0002_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_53	GV-0	0	DJI_20230619212242_0002_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_53	GV-0	0	DJI_20230619212242_0002_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_54	GV-0	0	DJI_20230619212627_0043_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_54	GV-0	0	DJI_20230619212627_0043_W.JPG	Insulator		['porcelain']	low		

Line Number	Structure Identifier	Structure Type	Extension	Image File	Feature	ID	Defect	Severity	Lg	Side
L23A	L23A_54	GV-0	0	DJI_20230619212627_0043_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_55	GV-0	0	DJI_20230619212823_0058_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_55	GV-0	0	DJI_20230619212823_0058_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_55	GV-0	0	DJI_20230619212823_0058_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_56	GV-0	0	DJI_20230619213057_0085_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_56	GV-0	0	DJI_20230619213057_0085_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_56	GV-0	0	DJI_20230619213057_0085_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_57	GV-0	0	DJI_20230619213337_0111_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_57	GV-0	0	DJI_20230619213337_0111_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_57	GV-0	0	DJI_20230619213337_0111_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_58	GV-0	0	DJI_20230619213610_0139_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_58	GV-0	0	DJI_20230619213610_0139_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_58	GV-0	0	DJI_20230619213610_0139_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_59	GV-0	0	DJI_20230619213900_0169_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_59	GV-0	0	DJI_20230619213900_0169_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_59	GV-0	0	DJI_20230619213900_0169_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_60	GV-0	0	DJI_20230619214054_0183_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_60	GV-0	0	DJI_20230619214054_0183_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_60	GV-0	0	DJI_20230619214054_0183_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_61	GV-0	0	DJI_20230619233908_0001_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_61	GV-0	0	DJI_20230619233908_0001_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_61	GV-0	0	DJI_20230619233908_0001_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_61	GV-0	0	DJI_20230619234048_0027_Z.JPG	Footings		['fill too low']	low		
L23A	L23A_62	GV-0	0	DJI_20230619234205_0033_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_62	GV-0	0	DJI_20230619234205_0033_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_62	GV-0	0	DJI_20230619234205_0033_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_63	GV-0	0	DJI_20230619234422_0061_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_63	GV-0	0	DJI_20230619234422_0061_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_63	GV-0	0	DJI_20230619234422_0061_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_64	GV-0	0	DJI_20230619234602_0074_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_64	GV-0	0	DJI_20230619234602_0074_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_64	GV-0	0	DJI_20230619234602_0074_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_64	GV-0	0	DJI_20230619234724_0094_Z.JPG	Environmental		['raptor']	low		
L23A	L23A_65	GV-0	0	DJI_20230619235701_0002_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_65	GV-0	0	DJI_20230619235701_0002_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_65	GV-0	0	DJI_20230619235701_0002_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_66	GV-0	0	DJI_20230619235924_0027_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_66	GV-0	0	DJI_20230619235924_0027_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_66	GV-0	0	DJI_20230619235924_0027_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_67	GV-0	0	DJI_20230620000210_0055_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_67	GV-0	0	DJI_20230620000210_0055_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_67	GV-0	0	DJI_20230620000210_0055_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_68	GV-0	0	DJI_20230620000444_0083_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_68	GV-0	0	DJI_20230620000444_0083_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_68	GV-0	0	DJI_20230620000444_0083_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_69	GV-0	0	DJI_20230619235042_0102_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_69	GV-0	0	DJI_20230619235042_0102_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_69	GV-0	0	DJI_20230619235042_0102_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_70	GV-0	0	DJI_20230620000849_0131_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_70	GV-0	0	DJI_20230620000849_0131_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_70	GV-0	0	DJI_20230620000849_0131_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_71	GV-0	0	DJI_20230620000953_0136_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_71	GV-0	0	DJI_20230620000953_0136_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_71	GV-0	0	DJI_20230620000953_0136_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_72	GV-0	0	DJI_20230620001220_0163_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_72	GV-0	0	DJI_20230620001220_0163_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_72	GV-0	0	DJI_20230620001220_0163_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_73	GV-0	0	DJI_20230620001959_0001_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_73	GV-0	0	DJI_20230620001959_0001_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_73	GV-0	0	DJI_20230620001959_0001_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_74	GV-0	0	DJI_20230620002233_0030_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_74	GV-0	0	DJI_20230620002233_0030_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_74	GV-0	0	DJI_20230620002233_0030_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_75	GV-0	0	DJI_20230620005026_0001_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_75	GV-0	0	DJI_20230620005026_0001_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_75	GV-0	0	DJI_20230620005026_0001_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_76	GV-0	0	DJI_20230620005329_0027_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_76	GV-0	0	DJI_20230620005329_0027_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_76	GV-0	0	DJI_20230620005329_0027_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_77	GV-0	0	DJI_20230620005724_0066_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_77	GV-0	0	DJI_20230620005724_0066_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_77	GV-0	0	DJI_20230620005724_0066_W.JPG	Insulator		['porcelain']	low		

Line Number	Structure Identifier	Structure Type	Extension	Image File	Feature	ID	Defect	Severity	Lg	Side
L23A	L23A_78	GV-0	0	DJI_20230620005941_0080_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_78	GV-0	0	DJI_20230620005941_0080_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_78	GV-0	0	DJI_20230620005941_0080_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_79	GV-0	0	DJI_20230620010404_0116_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_79	GV-0	0	DJI_20230620010404_0116_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_79	GV-0	0	DJI_20230620010404_0116_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_80	RT-DE-70	0	DJI_20230620010710_0141_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_80	RT-DE-70	0	DJI_20230620010710_0141_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_80	RT-DE-70	0	DJI_20230620010710_0141_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_81	GV-0	0	DJI_20230620032443_0002_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_81	GV-0	0	DJI_20230620032443_0002_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_81	GV-0	0	DJI_20230620032443_0002_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_82	GV-0	0	DJI_20230620032749_0031_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_82	GV-0	0	DJI_20230620032749_0031_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_82	GV-0	0	DJI_20230620032749_0031_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_83	GV-0	0	DJI_20230620033035_0061_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_83	GV-0	0	DJI_20230620033035_0061_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_83	GV-0	0	DJI_20230620033035_0061_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_84	GV-0	0	DJI_20230620033444_0106_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_84	GV-0	0	DJI_20230620033444_0106_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_84	GV-0	0	DJI_20230620033444_0106_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_85	GV-0	0	DJI_20230620033844_0154_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_85	GV-0	0	DJI_20230620033844_0154_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_85	GV-0	0	DJI_20230620033844_0154_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_86	GV-0	0	DJI_20230620034843_0002_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_86	GV-0	0	DJI_20230620034843_0002_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_86	GV-0	0	DJI_20230620034843_0002_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_87	GV-0	0	DJI_20230620035316_0062_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_87	GV-0	0	DJI_20230620035316_0062_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_87	GV-0	0	DJI_20230620035316_0062_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_88	RT-DE-70	0	DJI_20230620035633_0097_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_88	RT-DE-70	0	DJI_20230620035633_0097_W.JPG	Insulator		['porcelain']	low		
L23A	L23A_88	RT-DE-70	0	DJI_20230620035633_0097_W.JPG	Insulator		['porcelain']	low		
L24	L24_4	H	20	DJI_20230620063658_0012_Z.JPG	Member	124	['bent']	low	1	right
L24	L24_4	H	20	DJI_20230620063658_0012_Z.JPG	Member/126	25/12	['bent']	low	1	right
L24	L24_4	H	20	DJI_20230620063758_0029_Z.JPG	Member	107	['bent']	low	3	right
L24	L24_4	H	20	DJI_20230620063758_0029_Z.JPG	Member	106	['bent']	medium	1	left
L24	L24_4	H	20	DJI_20230620063802_0030_Z.JPG	Conductor		['missing jumper']	low		
L24	L24_4	H	20	DJI_20230620063804_0031_Z.JPG	Conductor		['missing jumper']	low		
L24	L24_4	H	20	DJI_20230620063804_0031_Z.JPG	Conductor		['missing jumper']	low		
L24	L24_6	B	10	DJI_20230620064141_0066_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_6	B	10	DJI_20230620064148_0068_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_7	B	20	DJI_20230620064431_0097_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_8	H	0	DJI_20230620064953_0143_Z.JPG	Footings		['fill too high']	low		
L24	L24_8	H	0	DJI_20230620064953_0143_Z.JPG	Footings		['fill too high']	low		
L24	L24_8	H	0	DJI_20230620064953_0143_Z.JPG	Footings		['fill too high']	low		
L24	L24_8	H	0	DJI_20230620064953_0143_Z.JPG	Footings		['fill too high']	low		
L24	L24_10	BB	10	DJI_20230621205151_0055_Z.JPG	Member/278	77/27	['bent']	low	4	right
L24	L24_10	BB	10	DJI_20230621205151_0055_Z.JPG	Member	277	['bent']	low	1	right
L24	L24_15	BB	0	DJI_20230621225354_0161_Z.JPG	Structure		['rusted']	low		
L24	L24_15	BB	0	DJI_20230621225359_0162_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_15	BB	0	DJI_20230621225524_0178_Z.JPG	Footings		['fill too high']	low		
L24	L24_15	BB	0	DJI_20230621225524_0178_Z.JPG	Footings		['fill too high']	low		
L24	L24_15	BB	0	DJI_20230621225524_0178_Z.JPG	Footings		['fill too high']	low		
L24	L24_15	BB	0	DJI_20230621225524_0178_Z.JPG	Footings		['fill too high']	low		
L24	L24_24	BB	0	DJI_20230620020903_0137_Z.JPG	Member/228	27/22	['bent']	low	2	left
L24	L24_24	BB	0	DJI_20230620020942_0146_Z.JPG	Member/228	27/22	['bent']	low	1	right
L24	L24_24	BB	0	DJI_20230620021036_0161_Z.JPG	Member/228	27/22	['bent']	low	1	left
L24	L24_24	BB	0	DJI_20230620021036_0161_Z.JPG	Member	232	['bent']	low	1	right
L24	L24_26	BB	0	DJI_20230620211854_0145_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_26	BB	0	DJI_20230620211903_0147_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_28	BB	15	DJI_20230620211500_0101_Z.JPG	Footings		['overgrown']	low		
L24	L24_28	BB	15	DJI_20230620211500_0101_Z.JPG	Footings		['overgrown']	low		
L24	L24_28	BB	15	DJI_20230620211500_0101_Z.JPG	Footings		['overgrown']	low		
L24	L24_28	BB	15	DJI_20230620211500_0101_Z.JPG	Footings		['overgrown']	low		
L24	L24_29	BB	5	DJI_20230620211324_0083_Z.JPG	Member	252	['bent']	low	2	left
L24	L24_33	BB	20	DJI_20230622040240_0266_Z.JPG	Member	63	['bent']	low	2	right
L24	L24_35	BB	0	DJI_20230622035744_0195_Z.JPG	Member	228	['bent']	low	3	left
L24	L24_35	BB	0	DJI_20230622035830_0208_Z.JPG	Member	228	['bent']	low	3	right
L24	L24_36	BB	5	DJI_20230622035629_0179_Z.JPG	Environmental		['raptor nest']	low		
L24	L24_36	BB	5	DJI_20230622035641_0182_Z.JPG	Member	228	['bent']	low	2	right
L24	L24_38	BB	0	DJI_20230622035102_0106_Z.JPG	Footings		['fill too high']	low		

Line Number	Structure Identifier	Structure Type	Extension	Image File	Feature	ID	Defect	Severity	Lg	Side
L24	L24_38	BB	0	DJI_20230622035102_0106_Z.JPG	Footings		['fill too high']	low		
L24	L24_38	BB	0	DJI_20230622035102_0106_Z.JPG	Footings		['fill too high']	low		
L24	L24_38	BB	0	DJI_20230622035102_0106_Z.JPG	Footings		['fill too high']	low		
L24	L24_39	BB	5	DJI_20230622035014_0099_Z.JPG	Footings		['overgrown']	low		
L24	L24_39	BB	5	DJI_20230622035014_0099_Z.JPG	Footings		['overgrown']	low		
L24	L24_39	BB	5	DJI_20230622035014_0099_Z.JPG	Footings		['overgrown']	low		
L24	L24_39	BB	5	DJI_20230622035023_0102_Z.JPG	Environmental		['raptor']	low		
L24	L24_40	BB	5	DJI_20230622034623_0045_W.JPG	Structure		['leaning']	low		
L24	L24_40	BB	5	DJI_20230622034651_0052_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_40	BB	5	DJI_20230622034700_0054_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_40	BB	5	DJI_20230622034738_0063_Z.JPG	Member	236	['bent']	low	4	left
L24	L24_40	BB	5	DJI_20230622034805_0071_Z.JPG	Member	237	['bent']	low	3	right
L24	L24_42	BB	0	DJI_20230622030150_0031_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_43	BB	0	DJI_20230622030014_0008_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_43	BB	0	DJI_20230622030101_0021_Z.JPG	Footings		['fill too high']	low		
L24	L24_43	BB	0	DJI_20230622030101_0021_Z.JPG	Footings		['fill too high']	low		
L24	L24_43	BB	0	DJI_20230622030101_0021_Z.JPG	Footings		['fill too high']	low		
L24	L24_43	BB	0	DJI_20230622030101_0021_Z.JPG	Footings		['fill too high']	low		
L24	L24_44	BB	15	DJI_20230622022301_0146_W.JPG	Structure		['leaning']	low		
L24	L24_44	BB	15	DJI_20230622022320_0151_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_45	BB	20	DJI_20230622022143_0136_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_47	BB	20	DJI_20230622021607_0065_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_48	BB	10	DJI_20230622021431_0041_Z.JPG	Footings		['fill too high']	low		
L24	L24_48	BB	10	DJI_20230622021431_0041_Z.JPG	Footings		['fill too high']	low		
L24	L24_48	BB	10	DJI_20230622021431_0041_Z.JPG	Footings		['fill too high']	low		
L24	L24_48	BB	10	DJI_20230622021431_0041_Z.JPG	Footings		['fill too high']	low		
L24	L24_50	BB	5	DJI_20230622004038_0184_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_50	BB	5	DJI_20230622004043_0186_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_50	BB	5	DJI_20230622004052_0187_W.JPG	Structure		['leaning']	low		
L24	L24_51	BB	5	DJI_20230622003822_0156_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_51	BB	5	DJI_20230622003906_0167_Z.JPG	Member	252	['bent']	low	2	right
L24	L24_51	BB	5	DJI_20230622003906_0167_Z.JPG	Member	252	['bent']	low	4	left
L24	L24_52	BB	5	DJI_20230622003618_0128_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_52	BB	5	DJI_20230622003621_0129_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_52	BB	5	DJI_20230622003624_0130_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_52	BB	5	DJI_20230622003653_0137_W.JPG	Structure		['leaning']	low		
L24	L24_52	BB	5	DJI_20230622003724_0145_Z.JPG	Footings		['fill too high']	low		
L24	L24_52	BB	5	DJI_20230622003724_0145_Z.JPG	Footings		['fill too high']	low		
L24	L24_53	BB	10	DJI_20230622003509_0119_Z.JPG	Footings		['overgrown']	low		
L24	L24_53	BB	10	DJI_20230622003509_0119_Z.JPG	Footings		['overgrown']	low		
L24	L24_53	BB	10	DJI_20230622003509_0119_Z.JPG	Footings		['overgrown']	low		
L24	L24_54	BB	5	DJI_20230622003221_0082_W.JPG	Structure		['leaning']	low		
L24	L24_54	BB	5	DJI_20230622003306_0095_Z.JPG	Footings		['fill too high']	low		
L24	L24_54	BB	5	DJI_20230622003306_0095_Z.JPG	Footings		['fill too high']	low		
L24	L24_54	BB	5	DJI_20230622003306_0095_Z.JPG	Footings		['fill too high']	low		
L24	L24_54	BB	5	DJI_20230622003306_0095_Z.JPG	Footings		['fill too high']	low		
L24	L24_55	BB	5	DJI_20230622003011_0059_Z.JPG	Footings		['fill too high']	low		
L24	L24_55	BB	5	DJI_20230622003011_0059_Z.JPG	Footings		['fill too high']	low		
L24	L24_55	BB	5	DJI_20230622003011_0059_Z.JPG	Footings		['fill too high']	low		
L24	L24_55	BB	5	DJI_20230622003011_0059_Z.JPG	Footings		['fill too high']	low		
L24	L24_57	BB	5	DJI_20230622002609_0018_Z.JPG	Member	253	['bent']	low	1	left
L24	L24_57	BB	5	DJI_20230622002609_0018_Z.JPG	Member	252	['bent']	low	3	left
L24	L24_57	BB	5	DJI_20230622002609_0018_Z.JPG	Member	252	['bent']	low	2	right
L24	L24_60	BB	0	DJI_20230620215208_0072_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_60	BB	0	DJI_20230620215214_0074_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_62	BB	5	DJI_20230620214535_0027_Z.JPG	Footings		['fill too high']	low		
L24	L24_62	BB	5	DJI_20230620214535_0027_Z.JPG	Footings		['fill too high']	low		
L24	L24_62	BB	5	DJI_20230620214535_0027_Z.JPG	Footings		['fill too high']	low		
L24	L24_62	BB	5	DJI_20230620214535_0027_Z.JPG	Footings		['fill too high']	low		
L24	L24_63	BB	15	DJI_20230620220032_0149_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_65	BB	10	DJI_20230620221522_0098_W.JPG	Structure		['leaning']	low		
L24	L24_65	BB	10	DJI_20230620221535_0103_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_66	BB	10	DJI_20230620221318_0076_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_67	BB	0	DJI_20230620220937_0032_Z.JPG	Footings		['overgrown']	low		
L24	L24_67	BB	0	DJI_20230620220937_0032_Z.JPG	Footings		['overgrown']	low		
L24	L24_67	BB	0	DJI_20230620220937_0032_Z.JPG	Footings		['fill too high']	low		
L24	L24_67	BB	0	DJI_20230620220937_0032_Z.JPG	Footings		['fill too high']	low		
L24	L24_67	BB	0	DJI_20230620221008_0040_Z.JPG	Member	75	['missing bolt']	medium	2	left
L24	L24_70	BB	10	DJI_20230621001814_0035_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_70	BB	10	DJI_20230621001851_0046_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_71	BB	0	DJI_20230621002120_0064_Z.JPG	Footings		['fill too high']	low		
L24	L24_71	BB	0	DJI_20230621002120_0064_Z.JPG	Footings		['fill too high']	low		

Line Number	Structure Identifier	Structure Type	Extension	Image File	Feature	ID	Defect	Severity	Lg	Side
L24	L24_71	BB	0	DJI_20230621002120_0064_Z.JPG	Footings		['fill too high']	low		
L24	L24_71	BB	0	DJI_20230621002120_0064_Z.JPG	Footings		['fill too high']	low		
L24	L24_73	BB	0	DJI_20230621002458_0103_Z.JPG	Member	75	['broken']	low	1	right
L24	L24_73	BB	0	DJI_20230621002551_0116_Z.JPG	Member	227	['bent']	low	4	left
L24	L24_74	BB	0	DJI_20230621002815_0144_Z.JPG	Footings		['fill too low']	low		
L24	L24_74	BB	0	DJI_20230621002815_0144_Z.JPG	Footings		['fill too low']	low		
L24	L24_74	BB	0	DJI_20230621002815_0144_Z.JPG	Footings		['fill too low']	low		
L24	L24_75	BB	0	DJI_20230621003103_0183_Z.JPG	Member	228	['bent']	low	3	right
L24	L24_76	BB	0	DJI_20230621004654_0099_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_78	BB	5	DJI_20230621004055_0036_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_78	BB	5	DJI_20230621004100_0037_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_78	BB	5	DJI_20230621004104_0038_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_79	BB	5	DJI_20230621003805_0019_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_79	BB	5	DJI_20230621003820_0022_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_80	BB	5	DJI_20230621011303_0030_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_80	BB	5	DJI_20230621011307_0031_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_80	BB	5	DJI_20230621011309_0032_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_81	BB	5	DJI_20230621011053_0007_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_81	BB	5	DJI_20230621011056_0008_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_81	BB	5	DJI_20230621011133_0013_Z.JPG	Member	257	['bent']	low	4	right
L24	L24_83	BB	5	DJI_20230621011909_0085_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_83	BB	5	DJI_20230621012014_0099_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_84	BB	10	DJI_20230621012206_0121_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_84	BB	10	DJI_20230621012237_0130_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_85	BB	5	DJI_20230616000343_0155_Z.JPG	Environmental		['raptor nest']	low		
L24	L24_87	EE	0	DJI_20230615235605_0098_Z.JPG	Insulator		['broken']	low		
L24	L24_93	BB	5	DJI_20230616002213_0094_Z.JPG	Member	252	['bent']	low	2	left
L24	L24_96	BB	10	DJI_20230616003130_0169_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_97	BB	5	DJI_20230616042501_0024_Z.JPG	Footings		['fill too high']	low		
L24	L24_97	BB	5	DJI_20230616042501_0024_Z.JPG	Footings		['fill too high']	low		
L24	L24_97	BB	5	DJI_20230616042501_0024_Z.JPG	Footings		['fill too high']	low		
L24	L24_100	BB	5	DJI_20230616043251_0067_Z.JPG	Member	252	['bent']	low	4	right
L24	L24_103	BB	10	DJI_20230616060545_0034_W.JPG	Structure		['leaning']	medium		
L24	L24_105	EE	20	DJI_20230616061135_0082_Z.JPG	Insulator		['porcelain']	low		
L24	L24_105	EE	20	DJI_20230616061150_0084_Z.JPG	Insulator		['porcelain']	low		
L24	L24_105	EE	20	DJI_20230616061259_0095_Z.JPG	Insulator		['porcelain']	low		
L24	L24_106	BB	20	DJI_20230616061507_0111_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_106	BB	20	DJI_20230616061525_0112_W.JPG	Structure		['leaning']	low		
L24	L24_107	BB	5	DJI_20230616061920_0137_Z.JPG	Member	234	['bent']	low	2	left
L24	L24_107	BB	5	DJI_20230616061956_0141_Z.JPG	Member	234	['bent']	low	2	right
L24	L24_107	BB	5	DJI_20230616062030_0146_Z.JPG	Footings		['fill too high']	low		
L24	L24_107	BB	5	DJI_20230616062030_0146_Z.JPG	Footings		['fill too high']	low		
L24	L24_114	BB	20	DJI_20230617195223_0074_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_114	BB	20	DJI_20230617195229_0076_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_116	BB	5	DJI_20230617195933_0143_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_117	BB	0	DJI_20230617200114_0160_Z.JPG	Member	228	['bent']	low	3	left
L24	L24_120	BB	0	DJI_20230617212441_0016_Z.JPG	Footings		['overgrown']	low		
L24	L24_120	BB	0	DJI_20230617212441_0016_Z.JPG	Footings		['overgrown']	low		
L24	L24_120	BB	0	DJI_20230617212441_0016_Z.JPG	Footings		['overgrown']	low		
L24	L24_120	BB	0	DJI_20230617212441_0016_Z.JPG	Footings		['overgrown']	low		
L24	L24_120	BB	0	DJI_20230617212444_0018_Z.JPG	Environmental		['raptor nest']	low		
L24	L24_121	EE	5	DJI_20230617212910_0057_Z.JPG	Member	175	['bent']	low	3	center
L24	L24_125	BB	5	DJI_20230617224227_0050_Z.JPG	Footings		['fill too high']	low		
L24	L24_125	BB	5	DJI_20230617224227_0050_Z.JPG	Footings		['fill too high']	low		
L24	L24_125	BB	5	DJI_20230617224227_0050_Z.JPG	Footings		['fill too high']	low		
L24	L24_125	BB	5	DJI_20230617224227_0050_Z.JPG	Footings		['fill too high']	low		
L24	L24_126	BB	5	DJI_20230617224336_0056_Z.JPG	Structure		['leaning']	low		
L24	L24_126	BB	5	DJI_20230617224351_0061_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_126	BB	5	DJI_20230617224412_0065_Z.JPG	Hardware		['worn hardware']	medium		
L24	L24_129	BB	10	DJI_20230617225256_0150_Z.JPG	Member	278	['bent']	low	4	right
L24	L24_129	BB	10	DJI_20230617225356_0161_Z.JPG	Member	277	['bent']	low	1	left
L24	L24_130	EE	5	DJI_20230617225626_0183_Z.JPG	Footings		['fill too high']	low		
L24	L24_130	EE	5	DJI_20230617225626_0183_Z.JPG	Footings		['overgrown']	low		
L24	L24_130	EE	5	DJI_20230617225626_0183_Z.JPG	Footings		['fill too high']	low		
L24	L24_130	EE	5	DJI_20230617225626_0183_Z.JPG	Footings		['overgrown']	low		
L24	L24_130	EE	5	DJI_20230617225641_0187_Z.JPG	Member	101	['bent']	low		
L24	L24_131	BB	0	DJI_20230618002419_0017_Z.JPG	Member	228	['bent']	low	2	right
L24	L24_131	BB	0	DJI_20230618002503_0027_Z.JPG	Member	231	['altered member']	medium	4	left
L24	L24_131	BB	0	DJI_20230618002503_0027_Z.JPG	Member	228	['altered member']	low	1	left
L24	L24_131	BB	0	DJI_20230618002503_0027_Z.JPG	Member	228	['bent']	low	3	right
L24	L24_131	BB	0	DJI_20230618002503_0027_Z.JPG	Member	228	['bent']	low	1	right
L24	L24_131	BB	0	DJI_20230618002503_0027_Z.JPG	Member	231	['bent']	low	4	right

Line Number	Structure Identifier	Structure Type	Extension	Image File	Feature	ID	Defect	Severity	Lg	Side
L24	L24_131	BB	0	DJI_20230618002503_0027_Z.JPG	Member	228	['bent']	low	4	left
L24	L24_132	BB	20	DJI_20230618002651_0040_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_134	BB	5	DJI_20230618003539_0116_Z.JPG	Member	236	['bent']	low	3	left
L24	L24_134	BB	5	DJI_20230618003624_0124_Z.JPG	Member	75	['bent']	low	3	center
L24	L24_134	BB	5	DJI_20230618003624_0124_Z.JPG	Member	75	['bent']	low	4	center
L24	L24_134	BB	5	DJI_20230618003624_0124_Z.JPG	Member	75	['missing']	medium	2	center
L24	L24_134	BB	5	DJI_20230618003624_0124_Z.JPG	Member	75	['bent']	low	1	center
L24	L24_134	BB	5	DJI_20230618003642_0127_Z.JPG	Environmental		['raptor nest']	low		
L24	L24_136	BB	20	DJI_20230618004203_0180_Z.JPG	Environmental		['raptor nest']	low		
L24	L24_137	BB	0	DJI_20230618013422_0004_Z.JPG	Member	228	['bent']	low	2	left
L24	L24_138	BB	5	DJI_20230618013813_0042_Z.JPG	Environmental		['raptor nest']	low		
L24	L24_147	BB	10	DJI_20230621030013_0213_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_147	BB	10	DJI_20230621030017_0214_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_147	BB	10	DJI_20230621030021_0215_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_149	BB	5	DJI_20230622223916_0031_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_149	BB	5	DJI_20230622223925_0033_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_149	BB	5	DJI_20230622223957_0041_Z.JPG	Footings		['overgrown']	low		
L24	L24_149	BB	5	DJI_20230622223957_0041_Z.JPG	Footings		['overgrown']	low		
L24	L24_149	BB	5	DJI_20230622223957_0041_Z.JPG	Footings		['overgrown']	low		
L24	L24_149	BB	5	DJI_20230622223957_0041_Z.JPG	Footings		['overgrown']	low		
L24	L24_149	BB	5	DJI_20230622224022_0047_Z.JPG	Footings		['overgrown']	low		
L24	L24_149	BB	5	DJI_20230622224022_0047_Z.JPG	Footings		['overgrown']	low		
L24	L24_151	BB	0	DJI_20230622224458_0082_Z.JPG	Footings		['overgrown']	low		
L24	L24_151	BB	0	DJI_20230622224458_0082_Z.JPG	Member	226	['bent']	medium	1	center
L24	L24_151	BB	0	DJI_20230622224458_0082_Z.JPG	Member	227	['bent']	low	1	left
L24	L24_151	BB	0	DJI_20230622224458_0082_Z.JPG	Member	228	['bent']	low	1	right
L24	L24_151	BB	0	DJI_20230622224458_0082_Z.JPG	Member	228	['bent']	low	3	left
L24	L24_151	BB	0	DJI_20230622224633_0104_Z.JPG	Member	228	['bent']	low	3	right
L24	L24_152	BB	5	DJI_20230622224759_0115_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_154	BB	5	DJI_20230622231607_0006_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_154	BB	5	DJI_20230622231610_0007_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_154	BB	5	DJI_20230622231617_0008_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_156	BB	10	DJI_20230622232136_0062_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_156	BB	10	DJI_20230622232144_0064_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_157	BB	20	DJI_20230622232326_0081_W.JPG	Structure		['leaning']	low		
L24	L24_157	BB	20	DJI_20230622232354_0087_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_157	BB	20	DJI_20230622232404_0089_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_158	BB	5	DJI_20230622232616_0113_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_158	BB	5	DJI_20230622232629_0115_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_159	BB	20	DJI_20230622232835_0137_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_159	BB	20	DJI_20230622232843_0139_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_160	BB	10	DJI_20230622233102_0164_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_160	BB	10	DJI_20230622233108_0166_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_160	BB	10	DJI_20230622233116_0167_W.JPG	Structure		['leaning']	low		
L24	L24_162	BB	0	DJI_20230623010116_0006_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_162	BB	0	DJI_20230623010119_0007_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_162	BB	0	DJI_20230623010122_0008_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_163	BB	5	DJI_20230623010406_0042_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_163	BB	5	DJI_20230623010414_0044_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_164	BB	0	DJI_20230623010945_0082_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_164	BB	0	DJI_20230623010953_0084_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_165	BB	5	DJI_20230623011144_0107_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_165	BB	5	DJI_20230623011208_0110_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_165	BB	5	DJI_20230623011250_0123_Z.JPG	Footings		['overgrown']	low		
L24	L24_166	BB	15	DJI_20230623011357_0132_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_167	BB	20	DJI_20230623011604_0159_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_167	BB	20	DJI_20230623011622_0161_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_169	BB	10	DJI_20230623012045_0210_Z.JPG	Member	277	['bent']	low	1	left
L24	L24_169	BB	10	DJI_20230623012045_0210_Z.JPG	Member	278	['bent']	low	4	right
L24	L24_169	BB	10	DJI_20230623012101_0216_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_169	BB	10	DJI_20230623012113_0219_Z.JPG	Member	277	['bent']	low	3	left
L24	L24_169	BB	10	DJI_20230623012113_0219_Z.JPG	Member	295	['bent']	low	1	right
L24	L24_171	BB	5	DJI_20230623014319_0056_Z.JPG	Member	237	['bent']	low	4	right
L24	L24_176	BB	5	DJI_20230623015703_0198_Z.JPG	Member	253	['bent']	low	1	left
L24	L24_182	BB	0	DJI_20230623030649_0151_Z.JPG	Footings		['overgrown']	low		
L24	L24_182	BB	0	DJI_20230623030657_0155_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_182	BB	0	DJI_20230623030705_0157_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_182	BB	0	DJI_20230623030750_0174_Z.JPG	Insulator		['porcelain']	low		
L24	L24_185	BB	5	DJI_20230624221045_0049_Z.JPG	Footings		['overgrown']	low		
L24	L24_185	BB	5	DJI_20230624221045_0049_Z.JPG	Footings		['overgrown']	low		
L24	L24_185	BB	5	DJI_20230624221045_0049_Z.JPG	Footings		['overgrown']	low		
L24	L24_186	EE	0	DJI_20230624221139_0057_Z.JPG	Member	199	['bent']	low	2	left

Line Number	Structure Identifier	Structure Type	Extension	Image File	Feature	ID	Defect	Severity	Lg	Side
L24	L24_186	EE	0	DJI_20230624221211_0065_Z.JPG	Member	200	['bent']	low	1	right
L24	L24_186	EE	0	DJI_20230624221249_0077_Z.JPG	Member	200	['bent']	low	3	right
L24	L24_186	EE	0	DJI_20230624221249_0077_Z.JPG	Member	199	['bent']	low	1	left
L24	L24_192	BB	5	DJI_20230624222428_0229_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_192	BB	5	DJI_20230624222435_0231_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_194	BB	5	DJI_20230624223150_0037_W.JPG	Structure		['leaning']	low		
L24	L24_198	BB	0	DJI_20230624230520_0019_Z.JPG	Footings		['overgrown']	low		
L24	L24_198	BB	0	DJI_20230624230520_0019_Z.JPG	Footings		['overgrown']	low		
L24	L24_198	BB	0	DJI_20230624230520_0019_Z.JPG	Footings		['overgrown']	low		
L24	L24_198	BB	0	DJI_20230624230520_0019_Z.JPG	Footings		['overgrown']	low		
L24	L24_199	BB	0	DJI_20230624230755_0045_Z.JPG	Footings		['overgrown']	low		
L24	L24_199	BB	0	DJI_20230624230755_0045_Z.JPG	Footings		['overgrown']	low		
L24	L24_199	BB	0	DJI_20230624230755_0045_Z.JPG	Footings		['overgrown']	low		
L24	L24_199	BB	0	DJI_20230624230755_0045_Z.JPG	Footings		['overgrown']	low		
L24	L24_200	BB	0	DJI_20230624230940_0069_Z.JPG	Footings		['overgrown']	low		
L24	L24_200	BB	0	DJI_20230624230940_0069_Z.JPG	Footings		['overgrown']	low		
L24	L24_200	BB	0	DJI_20230624230940_0069_Z.JPG	Footings		['overgrown']	low		
L24	L24_200	BB	0	DJI_20230624230940_0069_Z.JPG	Footings		['overgrown']	low		
L24	L24_202	BB	0	DJI_20230624231320_0118_Z.JPG	Footings		['overgrown']	low		
L24	L24_202	BB	0	DJI_20230624231320_0118_Z.JPG	Footings		['overgrown']	low		
L24	L24_202	BB	0	DJI_20230624231320_0118_Z.JPG	Footings		['overgrown']	low		
L24	L24_202	BB	0	DJI_20230624231320_0118_Z.JPG	Footings		['overgrown']	low		
L24	L24_203	BB	5	DJI_20230624231416_0128_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_203	BB	5	DJI_20230624231419_0129_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_203	BB	5	DJI_20230624231422_0130_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_203	BB	5	DJI_20230624231507_0145_Z.JPG	Footings		['overgrown']	low		
L24	L24_203	BB	5	DJI_20230624231507_0145_Z.JPG	Footings		['overgrown']	low		
L24	L24_203	BB	5	DJI_20230624231507_0145_Z.JPG	Footings		['overgrown']	low		
L24	L24_203	BB	5	DJI_20230624231507_0145_Z.JPG	Footings		['overgrown']	low		
L24	L24_204	BB	10	DJI_20230624231609_0156_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_205	BB	5	DJI_20230624231803_0182_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_205	BB	5	DJI_20230624231809_0184_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_206	BB	5	DJI_20230624231950_0209_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_208	BB	5	DJI_20230624232707_0039_Z.JPG	Footings		['overgrown']	low		
L24	L24_208	BB	5	DJI_20230624232707_0039_Z.JPG	Footings		['overgrown']	low		
L24	L24_210	BB	20	DJI_20230624233007_0085_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_210	BB	20	DJI_20230624233046_0100_Z.JPG	Footings		['overgrown']	low		
L24	L24_210	BB	20	DJI_20230624233046_0100_Z.JPG	Footings		['overgrown']	low		
L24	L24_210	BB	20	DJI_20230624233046_0100_Z.JPG	Footings		['overgrown']	low		
L24	L24_211	BB	5	DJI_20230624233204_0111_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_214	BB	5	DJI_20230624233811_0191_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_219	BB	5	DJI_20230625013744_0109_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_219	BB	5	DJI_20230625013751_0111_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_219	BB	5	DJI_20230625013830_0124_Z.JPG	Footings		['overgrown']	low		
L24	L24_219	BB	5	DJI_20230625013830_0124_Z.JPG	Footings		['overgrown']	low		
L24	L24_222	BB	0	DJI_20230625014717_0060_Z.JPG	Member	227	['bent']	low	2	left
L24	L24_222	BB	0	DJI_20230625014746_0069_Z.JPG	Member	228	['bent']	low	3	left
L24	L24_226	BB	5	DJI_20230625015748_0009_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_226	BB	5	DJI_20230625015758_0011_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_227	BB	20	DJI_20230625015942_0035_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_227	BB	20	DJI_20230625015949_0037_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_228	BB	20	DJI_20230625020215_0066_Z.JPG	Hardware		['worn hardware']	medium		
L24	L24_228	BB	20	DJI_20230625020221_0068_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_229	BB	0	DJI_20230625020353_0090_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_229	BB	0	DJI_20230625020358_0092_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_231	BB	20	DJI_20230625022331_0051_Z.JPG	Member	53	['bent']	low	1	right
L24	L24_235	BB	5	DJI_20230625022917_0137_Z.JPG	Member	237	['bent']	low	1	right
L24	L24_235	BB	5	DJI_20230625022917_0137_Z.JPG	Member	236	['bent']	low	3	left
L24	L24_236	BB	0	DJI_20230625213706_0019_Z.JPG	Member	227	['bent']	low	2	left
L24	L24_238	BB	5	DJI_20230625214004_0059_Z.JPG	Hardware		['worn hardware']	medium		
L24	L24_240	BB	5	DJI_20230625214420_0117_Z.JPG	Environmental		['raptor nest']	low		
L24	L24_241	BB	5	DJI_20230625214619_0150_Z.JPG	Footings		['fill too high']	low		
L24	L24_241	BB	5	DJI_20230625214619_0150_Z.JPG	Footings		['fill too high']	low		
L24	L24_241	BB	5	DJI_20230625214619_0150_Z.JPG	Footings		['fill too high']	low		
L24	L24_241	BB	5	DJI_20230625214619_0150_Z.JPG	Footings		['fill too high']	low		
L24	L24_247	BB	5	DJI_20230625222050_0085_Z.JPG	Footings		['overgrown']	low		
L24	L24_247	BB	5	DJI_20230625222114_0095_Z.JPG	Member	252	['bent']	low	1	left
L24	L24_250	BB	0	DJI_20230625222630_0169_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_251	BB	5	DJI_20230625222841_0190_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_251	BB	5	DJI_20230625222847_0192_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_257	BB	10	DJI_20230625224348_0129_Z.JPG	Hardware		['worn hardware']	medium		
L24	L24_257	BB	10	DJI_20230625224355_0131_Z.JPG	Hardware		['worn hardware']	low		

Line Number	Structure Identifier	Structure Type	Extension	Image File	Feature	ID	Defect	Severity	Lg	Side
L24	L24_258	BB	20	DJI_20230625224532_0153_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_258	BB	20	DJI_20230625224538_0155_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_261	BB	10	DJI_20230626004258_0054_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_265	BB	5	DJI_20230626005021_0157_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_265	BB	5	DJI_20230626005027_0159_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_266	BB	0	DJI_20230626005201_0182_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_266	BB	0	DJI_20230626005207_0184_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_266	BB	0	DJI_20230626005247_0197_Z.JPG	Footings		['fill too high']	low		
L24	L24_266	BB	0	DJI_20230626005247_0197_Z.JPG	Footings		['fill too high']	low		
L24	L24_266	BB	0	DJI_20230626005247_0197_Z.JPG	Footings		['overgrown']	low		
L24	L24_266	BB	0	DJI_20230626005247_0197_Z.JPG	Footings		['fill too high']	low		
L24	L24_267	BB	0	DJI_20230626005755_0023_Z.JPG	Footings		['fill too high']	low		
L24	L24_267	BB	0	DJI_20230626005755_0023_Z.JPG	Footings		['fill too high']	low		
L24	L24_267	BB	0	DJI_20230626005755_0023_Z.JPG	Footings		['fill too high']	low		
L24	L24_267	BB	0	DJI_20230626005755_0023_Z.JPG	Footings		['fill too high']	low		
L24	L24_269	BB	0	DJI_20230626010054_0058_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_269	BB	0	DJI_20230626010140_0074_Z.JPG	Footings		['fill too high']	low		
L24	L24_269	BB	0	DJI_20230626010140_0074_Z.JPG	Footings		['fill too high']	low		
L24	L24_269	BB	0	DJI_20230626010140_0074_Z.JPG	Footings		['fill too high']	low		
L24	L24_269	BB	0	DJI_20230626010140_0074_Z.JPG	Footings		['fill too high']	low		
L24	L24_272	BB	0	DJI_20230626010640_0127_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_272	BB	0	DJI_20230626010647_0129_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_272	BB	0	DJI_20230626010726_0142_Z.JPG	Footings		['fill too high']	low		
L24	L24_272	BB	0	DJI_20230626010726_0142_Z.JPG	Footings		['fill too high']	low		
L24	L24_272	BB	0	DJI_20230626010726_0142_Z.JPG	Footings		['fill too high']	low		
L24	L24_272	BB	0	DJI_20230626010726_0142_Z.JPG	Footings		['fill too high']	low		
L24	L24_274	BB	5	DJI_20230626011037_0178_Z.JPG	Hardware		['worn hardware']	medium		
L24	L24_274	BB	5	DJI_20230626011044_0180_Z.JPG	Hardware		['worn hardware']	medium		
L24	L24_277	BB	5	DJI_20230626014142_0081_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_278	BB	5	DJI_20230626014404_0110_Z.JPG	Member	252	['bent']	low	2	left
L24	L24_281	BB	0	DJI_20230626014930_0178_Z.JPG	Member	75	['missing']	medium	3	center
L24	L24_281	BB	0	DJI_20230626014930_0178_Z.JPG	Member	75	['missing']	medium	4	center
L24	L24_281	BB	0	DJI_20230626014930_0178_Z.JPG	Member	75	['missing']	medium	1	center
L24	L24_281	BB	0	DJI_20230626014930_0178_Z.JPG	Member	75	['missing']	medium	2	center
L24	L24_283	BB	0	DJI_20230626015247_0223_Z.JPG	Footings		['overgrown']	low		
L24	L24_283	BB	0	DJI_20230626015247_0223_Z.JPG	Footings		['fill too high']	low		
L24	L24_283	BB	0	DJI_20230626015247_0223_Z.JPG	Footings		['overgrown']	low		
L24	L24_284	BB	0	DJI_20230626015813_0007_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_284	BB	0	DJI_20230626015919_0022_Z.JPG	Footings		['fill too high']	low		
L24	L24_284	BB	0	DJI_20230626015919_0022_Z.JPG	Footings		['overgrown']	low		
L24	L24_284	BB	0	DJI_20230626015919_0022_Z.JPG	Footings		['fill too high']	low		
L24	L24_284	BB	0	DJI_20230626015919_0022_Z.JPG	Footings		['fill too high']	low		
L24	L24_285	BB	5	DJI_20230626020017_0031_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_285	BB	5	DJI_20230626020023_0033_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_285	BB	5	DJI_20230626020041_0037_Z.JPG	Member	237	['bent']	low	1	right
L24	L24_285	BB	5	DJI_20230626020056_0042_Z.JPG	Member	235	['bent']	low	4	left
L24	L24_285	BB	5	DJI_20230626020056_0042_Z.JPG	Member	234	['bent']	low	4	right
L24	L24_285	BB	5	DJI_20230626020110_0047_Z.JPG	Footings		['overgrown']	low		
L24	L24_285	BB	5	DJI_20230626020110_0047_Z.JPG	Footings		['overgrown']	low		
L24	L24_285	BB	5	DJI_20230626020110_0047_Z.JPG	Footings		['overgrown']	low		
L24	L24_285	BB	5	DJI_20230626020110_0047_Z.JPG	Footings		['overgrown']	low		
L24	L24_286	BB	0	DJI_20230626020227_0057_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_286	BB	0	DJI_20230626020232_0059_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_287	BB	5	DJI_20230626020404_0082_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_290	BB	10	DJI_20230626214749_0045_Z.JPG	Member	278	['bent']	low	2	right
L24	L24_291	BB	10	DJI_20230626215014_0079_Z.JPG	Member	278	['bent']	low	3	right
L24	L24_292	BB	5	DJI_20230626215116_0089_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_294	BB	0	DJI_20230626220134_0007_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_294	BB	0	DJI_20230626220136_0008_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_294	BB	0	DJI_20230626220139_0009_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_294	BB	0	DJI_20230626220211_0017_Z.JPG	Member	227	['bent']	low	4	left
L24	L24_294	BB	0	DJI_20230626220211_0017_Z.JPG	Member	227	['bent']	low	1	left
L24	L24_295	BB	20	DJI_20230626220428_0043_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_296	BB	5	DJI_20230626220613_0067_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_298	BB	0	DJI_20230626221007_0119_Z.JPG	Footings		['overgrown']	low		
L24	L24_298	BB	0	DJI_20230626221007_0119_Z.JPG	Footings		['fill too high']	low		
L24	L24_298	BB	0	DJI_20230626221007_0119_Z.JPG	Footings		['fill too high']	low		
L24	L24_298	BB	0	DJI_20230626221007_0119_Z.JPG	Footings		['overgrown']	low		
L24	L24_302	BB	5	DJI_20230626221815_0237_Z.JPG	Footings		['fill too high']	low		
L24	L24_302	BB	5	DJI_20230626221815_0237_Z.JPG	Footings		['fill too high']	low		
L24	L24_304	BB	5	DJI_20230626224520_0036_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_305	BB	5	DJI_20230626224739_0073_Z.JPG	Footings		['fill too high']	low		

Line Number	Structure Identifier	Structure Type	Extension	Image File	Feature	ID	Defect	Severity	Lg	Side
L24	L24_305	BB	5	DJI_20230626224739_0073_Z.JPG	Footings		['fill too high']	low		
L24	L24_305	BB	5	DJI_20230626224739_0073_Z.JPG	Footings		['fill too high']	low		
L24	L24_305	BB	5	DJI_20230626224739_0073_Z.JPG	Footings		['fill too high']	low		
L24	L24_306	BB	5	DJI_20230626224840_0084_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_306	BB	5	DJI_20230626224905_0092_Z.JPG	Footings		['fill too high']	low		
L24	L24_306	BB	5	DJI_20230626224905_0092_Z.JPG	Footings		['fill too high']	low		
L24	L24_306	BB	5	DJI_20230626224905_0092_Z.JPG	Footings		['fill too high']	low		
L24	L24_306	BB	5	DJI_20230626224905_0092_Z.JPG	Footings		['fill too high']	low		
L24	L24_306	BB	5	DJI_20230626224918_0097_Z.JPG	Member	23	['loose nut']	low		
L24	L24_307	BB	5	DJI_20230626225022_0107_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_307	BB	5	DJI_20230626225024_0108_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_309	BB	5	DJI_20230626225444_0164_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_310	BB	5	DJI_20230626225618_0188_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_310	BB	5	DJI_20230626225627_0190_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_310	BB	5	DJI_20230626225704_0205_Z.JPG	Environmental		['raptor nest']	low		
L24	L24_312	BB	0	DJI_20230626230354_0006_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_312	BB	0	DJI_20230626230400_0008_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_312	BB	0	DJI_20230626230444_0022_Z.JPG	Footings		['overgrown']	low		
L24	L24_312	BB	0	DJI_20230626230444_0022_Z.JPG	Footings		['overgrown']	low		
L24	L24_312	BB	0	DJI_20230626230444_0022_Z.JPG	Footings		['overgrown']	low		
L24	L24_312	BB	0	DJI_20230626230444_0022_Z.JPG	Footings		['overgrown']	low		
L24	L24_319	BB	5	DJI_20230627012110_0010_W.JPG	Structure		['leaning']	low		
L24	L24_320	BB	10	DJI_20230627012314_0037_Z.JPG	Member	277	['bent']	low	4	left
L24	L24_320	BB	10	DJI_20230627012354_0047_Z.JPG	Member	277	['bent']	low	1	left
L24	L24_324	BB	5	DJI_20230627013152_0142_Z.JPG	Environmental		['raptor nest']	low		
L24	L24_328	BB	5	DJI_20230627014059_0011_Z.JPG	Footings		['overgrown']	low		
L24	L24_328	BB	5	DJI_20230627014059_0011_Z.JPG	Footings		['fill too high']	low		
L24	L24_328	BB	5	DJI_20230627014059_0011_Z.JPG	Footings		['overgrown']	low		
L24	L24_328	BB	5	DJI_20230627014059_0011_Z.JPG	Footings		['overgrown']	low		
L24	L24_329	BB	10	DJI_20230627014420_0061_Z.JPG	Member	278	['bent']	low	3	right
L24	L24_329	BB	10	DJI_20230627014420_0061_Z.JPG	Member	277	['bent']	low	2	left
L24	L24_330	BB	0	DJI_20230627014517_0071_Z.JPG	Environmental		['raptor nest']	low		
L24	L24_330	BB	0	DJI_20230627014557_0080_Z.JPG	Footings		['overgrown']	low		
L24	L24_330	BB	0	DJI_20230627014557_0080_Z.JPG	Footings		['overgrown']	low		
L24	L24_330	BB	0	DJI_20230627014557_0080_Z.JPG	Footings		['overgrown']	low		
L24	L24_330	BB	0	DJI_20230627014557_0080_Z.JPG	Footings		['overgrown']	low		
L24	L24_334	BB	10	DJI_20230627015247_0180_Z.JPG	Member	277	['bent']	low	4	left
L24	L24_336	BB	20	DJI_20230627021516_0039_Z.JPG	Member	52	['bent']	low	1	right
L24	L24_337	BB	5	DJI_20230627021754_0078_Z.JPG	Member	253	['bent']	low	2	right
L24	L24_337	BB	5	DJI_20230627021754_0078_Z.JPG	Member	252	['bent']	low	1	left
L24	L24_338	BB	5	DJI_20230627022025_0108_Z.JPG	Member	253	['bent']	low	3	right
L24	L24_338	BB	5	DJI_20230627022025_0108_Z.JPG	Member	252	['bent']	low	1	left
L24	L24_338	BB	5	DJI_20230627022025_0108_Z.JPG	Member	253	['bent']	low	1	right
L24	L24_338	BB	5	DJI_20230627022025_0108_Z.JPG	Member	252	['bent']	low	2	left
L24	L24_339	BB	5	DJI_20230627022233_0134_Z.JPG	Footings		['fill too high']	low		
L24	L24_339	BB	5	DJI_20230627022233_0134_Z.JPG	Footings		['fill too high']	low		
L24	L24_339	BB	5	DJI_20230627022233_0134_Z.JPG	Footings		['fill too high']	low		
L24	L24_339	BB	5	DJI_20230627022233_0134_Z.JPG	Footings		['fill too high']	low		
L24	L24_340	BB	5	DJI_20230627022341_0148_Z.JPG	Footings		['fill too high']	low		
L24	L24_340	BB	5	DJI_20230627022341_0148_Z.JPG	Footings		['fill too high']	low		
L24	L24_340	BB	5	DJI_20230627022341_0148_Z.JPG	Footings		['fill too high']	low		
L24	L24_340	BB	5	DJI_20230627022341_0148_Z.JPG	Footings		['fill too high']	low		
L24	L24_343	BB	5	DJI_20230627222642_0060_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_343	BB	5	DJI_20230627222648_0062_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_343	BB	5	DJI_20230627222731_0075_Z.JPG	Footings		['fill too high']	low		
L24	L24_343	BB	5	DJI_20230627222731_0075_Z.JPG	Footings		['fill too high']	low		
L24	L24_343	BB	5	DJI_20230627222731_0075_Z.JPG	Footings		['fill too high']	low		
L24	L24_343	BB	5	DJI_20230627222731_0075_Z.JPG	Footings		['fill too high']	low		
L24	L24_344	BB	5	DJI_20230627222904_0098_Z.JPG	Member	75	['missing']	medium	4	center
L24	L24_344	BB	5	DJI_20230627222904_0098_Z.JPG	Member	75	['missing']	medium	2	center
L24	L24_344	BB	5	DJI_20230627222904_0098_Z.JPG	Member	75	['missing']	medium	1	center
L24	L24_344	BB	5	DJI_20230627222904_0098_Z.JPG	Member	75	['missing']	medium	3	center
L24	L24_344	BB	5	DJI_20230627222904_0098_Z.JPG	Footings		['fill too high']	low		
L24	L24_344	BB	5	DJI_20230627222904_0098_Z.JPG	Footings		['overgrown']	low		
L24	L24_344	BB	5	DJI_20230627222904_0098_Z.JPG	Footings		['fill too high']	low		
L24	L24_344	BB	5	DJI_20230627222904_0098_Z.JPG	Footings		['fill too high']	low		
L24	L24_346	BB	5	DJI_20230627223201_0137_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_346	BB	5	DJI_20230627223207_0139_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_347	BB	5	DJI_20230627223417_0172_Z.JPG	Member	252	['bent']	low	3	left
L24	L24_347	BB	5	DJI_20230627223417_0172_Z.JPG	Member	253	['bent']	low	1	right
L24	L24_347	BB	5	DJI_20230627223500_0183_Z.JPG	Member	253	['bent']	low	3	right
L24	L24_347	BB	5	DJI_20230627223500_0183_Z.JPG	Member	252	['bent']	low	2	left

Line Number	Structure Identifier	Structure Type	Extension	Image File	Feature	ID	Defect	Severity	Lg	Side
L24	L24_347	BB	5	DJI_20230627223500_0183_Z.JPG	Member	252	['bent']	low	1	left
L24	L24_349	BB	15	DJI_20230627214305_0051_Z.JPG	Member	253	['bent']	low	4	right
L24	L24_349	BB	15	DJI_20230627214305_0051_Z.JPG	Member	252	['bent']	low	3	left
L24	L24_349	BB	15	DJI_20230627214305_0051_Z.JPG	Member	253	['bent']	low	1	right
L24	L24_349	BB	15	DJI_20230627214343_0061_Z.JPG	Member	312	['bent']	low	1	left
L24	L24_350	BB	10	DJI_20230627214456_0070_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_350	BB	10	DJI_20230627214502_0072_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_351	BB	5	DJI_20230627214843_0115_Z.JPG	Member	253	['bent']	low	2	right
L24	L24_351	BB	5	DJI_20230627214843_0115_Z.JPG	Member	253	['bent']	low	3	right
L24	L24_351	BB	5	DJI_20230627214843_0115_Z.JPG	Member	253	['bent']	low	1	right
L24	L24_351	BB	5	DJI_20230627214843_0115_Z.JPG	Member	252	['bent']	low	1	left
L24	L24_351	BB	5	DJI_20230627214843_0115_Z.JPG	Member	253	['bent']	low	4	right
L24	L24_351	BB	5	DJI_20230627214843_0115_Z.JPG	Member	252	['bent']	low	2	left
L24	L24_352	BB	0	DJI_20230627214938_0124_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_352	BB	0	DJI_20230627214945_0126_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_353	BB	0	DJI_20230627215133_0148_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_353	BB	0	DJI_20230627215141_0150_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_353	BB	0	DJI_20230627215156_0153_Z.JPG	Footings		['fill too high']	low		
L24	L24_353	BB	0	DJI_20230627215156_0153_Z.JPG	Footings		['fill too high']	low		
L24	L24_353	BB	0	DJI_20230627215156_0153_Z.JPG	Footings		['fill too high']	low		
L24	L24_353	BB	0	DJI_20230627215156_0153_Z.JPG	Footings		['fill too high']	low		
L24	L24_354	BB	5	DJI_20230627215329_0172_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_354	BB	5	DJI_20230627215334_0174_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_355	BB	5	DJI_20230627215518_0200_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_362	BB	5	DJI_20230627230630_0169_Z.JPG	Member	252	['bent']	low	4	left
L24	L24_362	BB	5	DJI_20230627230630_0169_Z.JPG	Member	252	['bent']	low	3	left
L24	L24_363	BB	0	DJI_20230627230808_0194_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_363	BB	0	DJI_20230627230841_0204_Z.JPG	Footings		['overgrown']	low		
L24	L24_363	BB	0	DJI_20230627230841_0204_Z.JPG	Footings		['overgrown']	low		
L24	L24_363	BB	0	DJI_20230627230841_0204_Z.JPG	Footings		['overgrown']	low		
L24	L24_363	BB	0	DJI_20230627230841_0204_Z.JPG	Footings		['overgrown']	low		
L24	L24_364	BB	5	DJI_20230627231039_0234_Z.JPG	Member	236	['bent']	low	4	left
L24	L24_364	BB	5	DJI_20230627231039_0234_Z.JPG	Member	237	['bent']	low	3	right
L24	L24_367	BB	5	DJI_20230627232221_0089_Z.JPG	Footings		['overgrown']	low		
L24	L24_367	BB	5	DJI_20230627232221_0089_Z.JPG	Footings		['overgrown']	low		
L24	L24_367	BB	5	DJI_20230627232221_0089_Z.JPG	Footings		['overgrown']	low		
L24	L24_371	BB	5	DJI_20230624033519_0017_Z.JPG	Member	237	['bent']	low	2	right
L24	L24_371	BB	5	DJI_20230624033552_0025_Z.JPG	Member	237	['bent']	low	4	right
L24	L24_371	BB	5	DJI_20230624033552_0025_Z.JPG	Member	236	['bent']	low	4	left
L24	L24_371	BB	5	DJI_20230624033552_0025_Z.JPG	Member	237	['bent']	low	3	right
L24	L24_373	BB	10	DJI_20230624033918_0059_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_373	BB	10	DJI_20230624033923_0061_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_373	BB	10	DJI_20230624034042_0074_Z.JPG	Footings		['overgrown']	low		
L24	L24_374	BB	15	DJI_20230624034155_0082_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_377	BB	0	DJI_20230624034848_0162_Z.JPG	Member	228	['bent']	low	1	right
L24	L24_377	BB	0	DJI_20230624034848_0162_Z.JPG	Member	228	['bent']	low	4	right
L24	L24_378	BB	0	DJI_20230624035534_0011_Z.JPG	Member	228	['bent']	low	3	left
L24	L24_379	BB	10	DJI_20230624035812_0038_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_379	BB	10	DJI_20230624035819_0040_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_379	BB	10	DJI_20230624035833_0043_Z.JPG	Member	277	['bent']	low	3	left
L24	L24_379	BB	10	DJI_20230624035951_0057_Z.JPG	Member	277	['bent']	low	4	left
L24	L24_379	BB	10	DJI_20230624035951_0057_Z.JPG	Member	278	['bent']	low	4	right
L24	L24_379	BB	10	DJI_20230624035951_0057_Z.JPG	Member	277	['bent']	low	1	left
L24	L24_379	BB	10	DJI_20230624035951_0057_Z.JPG	Member	278	['bent']	low	3	right
L24	L24_379	BB	10	DJI_20230624035951_0057_Z.JPG	Member	278	['bent']	low	1	right
L24	L24_379	BB	10	DJI_20230624035951_0057_Z.JPG	Member	277	['bent']	low	2	left
L24	L24_379	BB	10	DJI_20230624035951_0057_Z.JPG	Member	278	['bent']	low	2	right
L24	L24_380	BB	5	DJI_20230624040803_0007_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_380	BB	5	DJI_20230624040857_0022_Z.JPG	Member	75	['missing']	medium	2	center
L24	L24_380	BB	5	DJI_20230624040857_0022_Z.JPG	Member	75	['missing']	medium	4	center
L24	L24_380	BB	5	DJI_20230624040857_0022_Z.JPG	Member	75	['missing']	medium	3	center
L24	L24_380	BB	5	DJI_20230624040857_0022_Z.JPG	Member	75	['missing']	medium	1	center
L24	L24_381	BB	15	DJI_20230624040955_0031_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_381	BB	15	DJI_20230624041001_0033_Z.JPG	Hardware		['worn hardware']	medium		
L24	L24_382	BB	0	DJI_20230624041151_0055_Z.JPG	Hardware		['worn hardware']	medium		
L24	L24_387	BB	5	DJI_20230628232214_0128_Z.JPG	Member	75	['missing']	medium	3	center
L24	L24_387	BB	5	DJI_20230628232214_0128_Z.JPG	Member	75	['missing']	medium	1	center
L24	L24_387	BB	5	DJI_20230628232214_0128_Z.JPG	Member	75	['missing']	medium	2	center
L24	L24_387	BB	5	DJI_20230628232214_0128_Z.JPG	Member	75	['missing']	medium	4	center
L24	L24_389	BB	5	DJI_20230628231646_0058_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_390	BB	10	DJI_20230628231458_0030_Z.JPG	Member	278	['bent']	low	3	right
L24	L24_394	BB	0	DJI_20230628230335_0125_Z.JPG	Member	227	['bent']	low	3	left

Line Number	Structure Identifier	Structure Type	Extension	Image File	Feature	ID	Defect	Severity	Lg	Side
L24	L24_395	BB	10	DJI_20230628230042_0088_Z.JPG	Member	278	['bent']	low	4	right
L24	L24_399	BB	5	DJI_20230628013708_0016_Z.JPG	Footings		['overgrown']	low		
L24	L24_399	BB	5	DJI_20230628013708_0016_Z.JPG	Member	236	['bent']	low	4	left
L24	L24_399	BB	5	DJI_20230628013708_0016_Z.JPG	Footings		['overgrown']	low		
L24	L24_399	BB	5	DJI_20230628013734_0023_Z.JPG	Member	234	['missing']	low	2	right
L24	L24_399	BB	5	DJI_20230628013734_0023_Z.JPG	Member	234	['missing']	low	1	left
L24	L24_403	BB	5	DJI_20230628014511_0112_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_403	BB	5	DJI_20230628014516_0114_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_404	BB	10	DJI_20230628014719_0141_Z.JPG	Member	278	['bent']	low	1	right
L24	L24_405	HH	5	DJI_20230628014910_0167_Z.JPG	Guy		['not standard practice']	high		
L24	L24_405	HH	5	DJI_20230628015010_0178_Z.JPG	Guy		['not standard practice']	high		
L24	L24_406	BB	10	DJI_20230628015150_0200_Z.JPG	Member	278	['bent']	low	3	right
L24	L24_406	BB	10	DJI_20230628015150_0200_Z.JPG	Member	277	['bent']	low	1	left
L24	L24_406	BB	10	DJI_20230628015150_0200_Z.JPG	Member	278	['bent']	low	1	right
L24	L24_406	BB	10	DJI_20230628015210_0208_Z.JPG	Member	277	['bent']	low	2	left
L24	L24_406	BB	10	DJI_20230628015210_0208_Z.JPG	Member	277	['bent']	low	3	left
L24	L24_406	BB	10	DJI_20230628015210_0208_Z.JPG	Member	278	['bent']	low	4	right
L24	L24_406	BB	10	DJI_20230628015210_0208_Z.JPG	Member	277	['bent']	low	4	left
L24	L24_406	BB	10	DJI_20230628015210_0208_Z.JPG	Member	278	['bent']	low	2	right
L24	L24_410	HH	5	DJI_20230628020227_0086_Z.JPG	Member	22	['bent']	low	4	right
L24	L24_410	HH	5	DJI_20230628020227_0086_Z.JPG	Member	22	['bent']	low	3	right
L24	L24_410	HH	5	DJI_20230628020227_0086_Z.JPG	Member	22	['bent']	low	3	left
L24	L24_410	HH	5	DJI_20230628020314_0096_Z.JPG	Guy		['not standard practice']	high		
L24	L24_411	BB	5	DJI_20230628020536_0133_Z.JPG	Footings		['overgrown']	low		
L24	L24_411	BB	5	DJI_20230628020536_0133_Z.JPG	Footings		['overgrown']	low		
L24	L24_411	BB	5	DJI_20230628020536_0133_Z.JPG	Footings		['overgrown']	low		
L24	L24_411	BB	5	DJI_20230628020536_0133_Z.JPG	Footings		['overgrown']	low		
L24	L24_412	BB	5	DJI_20230628022425_0011_Z.JPG	Footings		['overgrown']	low		
L24	L24_412	BB	5	DJI_20230628022425_0011_Z.JPG	Footings		['overgrown']	low		
L24	L24_412	BB	5	DJI_20230628022546_0031_Z.JPG	Member	258	['bent']	low	1	left
L24	L24_414	BB	10	DJI_20230628022915_0071_Z.JPG	Environmental		['raptor nest']	low		
L24	L24_415	EE	5	DJI_20230628023029_0084_W.JPG	Structure		['many broken members']	high		
L24	L24_415	EE	5	DJI_20230628023038_0088_Z.JPG	Member	201	['broken']	medium	4	right
L24	L24_415	EE	5	DJI_20230628023038_0088_Z.JPG	Member	175	['bent']	low	3	center
L24	L24_415	EE	5	DJI_20230628023038_0088_Z.JPG	Member	201	['bent']	low	4	left
L24	L24_415	EE	5	DJI_20230628023133_0100_Z.JPG	Member	207	['bent']	low	1	right
L24	L24_415	EE	5	DJI_20230628023133_0100_Z.JPG	Member	207	['bent']	low	1	left
L24	L24_415	EE	5	DJI_20230628023133_0100_Z.JPG	Member	201	['bent']	low	1	right
L24	L24_415	EE	5	DJI_20230628023133_0100_Z.JPG	Member	207	['bent']	low	2	left
L24	L24_415	EE	5	DJI_20230628023133_0100_Z.JPG	Member	207	['bent']	low	4	left
L24	L24_415	EE	5	DJI_20230628023148_0106_Z.JPG	Member	201	['bent']	low	2	right
L24	L24_416	EE	5	DJI_20230628023315_0113_W.JPG	Structure		['many broken members']	medium		
L24	L24_416	EE	5	DJI_20230628023330_0119_Z.JPG	Member	201	['bent']	low	4	right
L24	L24_416	EE	5	DJI_20230628023330_0119_Z.JPG	Member	201	['bent']	low	4	left
L24	L24_416	EE	5	DJI_20230628023330_0119_Z.JPG	Member	207	['bent']	low	4	right
L24	L24_416	EE	5	DJI_20230628023447_0140_Z.JPG	Member	201	['altered member']	low	1	right
L24	L24_416	EE	5	DJI_20230628023447_0140_Z.JPG	Member	201	['bent']	low	1	left
L24	L24_416	EE	5	DJI_20230628023447_0140_Z.JPG	Member	201	['bent']	low	2	right
L24	L24_416	EE	5	DJI_20230628023447_0140_Z.JPG	Member	207	['bent']	low	2	left
L24	L24_416	EE	5	DJI_20230628023447_0140_Z.JPG	Member	201	['bent']	low	2	left
L24	L24_416	EE	5	DJI_20230628023447_0140_Z.JPG	Member	201	['bent']	low	3	left
L24	L24_416	EE	5	DJI_20230628023447_0140_Z.JPG	Member	207	['bent']	low	3	right
L24	L24_416	EE	5	DJI_20230628023447_0140_Z.JPG	Member	201	['bent']	low	3	right
L24	L24_417	BB	5	DJI_20230629211033_0016_Z.JPG	Member	236	['broken']	medium	1	right
L24	L24_417	BB	5	DJI_20230629211033_0016_Z.JPG	Member	235	['bent']	medium	3	center
L24	L24_417	BB	5	DJI_20230629211123_0033_Z.JPG	Member	236	['bent']	low	3	right
L24	L24_417	BB	5	DJI_20230629211123_0033_Z.JPG	Member	236	['bent']	low	4	right
L24	L24_418	BB	0	DJI_20230629211230_0047_Z.JPG	Member	228	['bent']	low	1	right
L24	L24_418	BB	0	DJI_20230629211230_0047_Z.JPG	Member	227	['bent']	low	3	left
L24	L24_418	BB	0	DJI_20230629211230_0047_Z.JPG	Member	226	['bent']	medium	3	center
L24	L24_418	BB	0	DJI_20230629211230_0047_Z.JPG	Member	228	['bent']	low	4	right
L24	L24_419	BB	5	DJI_20230629211357_0065_Z.JPG	Member	236	['bent']	low	2	left
L24	L24_419	BB	5	DJI_20230629211357_0065_Z.JPG	Member	233	['altered member']	low	3	left
L24	L24_419	BB	5	DJI_20230629211424_0074_Z.JPG	Member	236	['bent']	low	3	left
L24	L24_419	BB	5	DJI_20230629211424_0074_Z.JPG	Member	233	['bent']	low	4	left
L24	L24_420	BB	5	DJI_20230629211657_0111_Z.JPG	Member	253	['bent']	low	3	right
L24	L24_420	BB	5	DJI_20230629211657_0111_Z.JPG	Member	252	['bent']	low	3	left
L24	L24_420	BB	5	DJI_20230629211657_0111_Z.JPG	Member	252	['bent']	low	2	left
L24	L24_420	BB	5	DJI_20230629211657_0111_Z.JPG	Member	253	['bent']	low	2	right
L24	L24_420	BB	5	DJI_20230629211657_0111_Z.JPG	Member	252	['bent']	low	1	left
L24	L24_420	BB	5	DJI_20230629211657_0111_Z.JPG	Member	253	['bent']	low	1	right
L24	L24_420	BB	5	DJI_20230629211657_0111_Z.JPG	Member	252	['bent']	low	4	left

Line Number	Structure Identifier	Structure Type	Extension	Image File	Feature	ID	Defect	Severity	Lg	Side
L24	L24_420	BB	5	DJI_20230629211657_0111_Z.JPG	Member	253	['bent']	low	4	right
L24	L24_421	EE	5	DJI_20230629211816_0126_Z.JPG	Member	201	['bent']	low	3	left
L24	L24_421	EE	5	DJI_20230629211854_0139_Z.JPG	Member	202	['altered member']	low	2	right
L24	L24_421	EE	5	DJI_20230629211854_0139_Z.JPG	Member	201	['bent']	low	1	left
L24	L24_421	EE	5	DJI_20230629211854_0139_Z.JPG	Member	202	['altered member']	low	1	right
L24	L24_422	BB	0	DJI_20230629212100_0170_Z.JPG	Member	228	['bent']	low	2	right
L24	L24_422	BB	0	DJI_20230629212100_0170_Z.JPG	Member	227	['bent']	low	2	left
L24	L24_422	BB	0	DJI_20230629212100_0170_Z.JPG	Member	227	['bent']	low	1	left
L24	L24_422	BB	0	DJI_20230629212100_0170_Z.JPG	Member	228	['bent']	low	1	right
L24	L24_423	BB	0	DJI_20230629212215_0188_Z.JPG	Member	228	['bent']	low	3	right
L24	L24_423	BB	0	DJI_20230629212215_0188_Z.JPG	Member	75	['bent']	low	4	center
L24	L24_423	BB	0	DJI_20230629212215_0188_Z.JPG	Member	228	['bent']	low	2	right
L24	L24_423	BB	0	DJI_20230629212215_0188_Z.JPG	Member	227	['bent']	low	3	left
L24	L24_423	BB	0	DJI_20230629212215_0188_Z.JPG	Member	227	['bent']	low	1	left
L24	L24_423	BB	0	DJI_20230629212215_0188_Z.JPG	Member	227	['bent']	low	2	left
L24	L24_424	BB	5	DJI_20230629212450_0229_Z.JPG	Member	252	['bent']	low	1	left
L24	L24_425	BB	5	DJI_20230629212929_0016_Z.JPG	Footings		['fill too high']	low		
L24	L24_425	BB	5	DJI_20230629212929_0016_Z.JPG	Footings		['fill too high']	low		
L24	L24_425	BB	5	DJI_20230629212929_0016_Z.JPG	Footings		['fill too high']	low		
L24	L24_425	BB	5	DJI_20230629212929_0016_Z.JPG	Footings		['fill too high']	low		
L24	L24_425	BB	5	DJI_20230629212942_0021_Z.JPG	Member	234	['bent']	low	3	right
L24	L24_425	BB	5	DJI_20230629212942_0021_Z.JPG	Member	233	['bent']	low	2	left
L24	L24_426	BB	5	DJI_20230629213107_0035_Z.JPG	Member	75	['missing']	medium	4	center
L24	L24_426	BB	5	DJI_20230629213107_0035_Z.JPG	Member	75	['missing']	medium	3	center
L24	L24_426	BB	5	DJI_20230629213107_0035_Z.JPG	Member	75	['missing']	medium	2	center
L24	L24_426	BB	5	DJI_20230629213107_0035_Z.JPG	Member	75	['missing']	medium	1	center
L24	L24_426	BB	5	DJI_20230629213130_0045_Z.JPG	Footings		['fill too high']	low		
L24	L24_426	BB	5	DJI_20230629213130_0045_Z.JPG	Footings		['fill too high']	low		
L24	L24_426	BB	5	DJI_20230629213130_0045_Z.JPG	Footings		['fill too high']	low		
L24	L24_426	BB	5	DJI_20230629213130_0045_Z.JPG	Footings		['fill too high']	low		
L24	L24_427	BB	5	DJI_20230629213249_0059_Z.JPG	Member	236	['bent']	low	1	right
L24	L24_427	BB	5	DJI_20230629213249_0059_Z.JPG	Member	236	['bent']	low	2	right
L24	L24_427	BB	5	DJI_20230629213249_0059_Z.JPG	Member	236	['bent']	low	2	left
L24	L24_427	BB	5	DJI_20230629213249_0059_Z.JPG	Member	236	['bent']	low	3	left
L24	L24_427	BB	5	DJI_20230629213249_0059_Z.JPG	Member	236	['bent']	low	4	right
L24	L24_428	EE	5	DJI_20230629213411_0078_W.JPG	Structure		['many broken members']	high		
L24	L24_428	EE	5	DJI_20230629213421_0081_Z.JPG	Member	208	['bent']	low	4	right
L24	L24_428	EE	5	DJI_20230629213421_0081_Z.JPG	Member	201	['broken']	medium	2	left
L24	L24_428	EE	5	DJI_20230629213421_0081_Z.JPG	Member	208	['bent']	low	3	right
L24	L24_428	EE	5	DJI_20230629213421_0081_Z.JPG	Member	207	['bent']	low	3	left
L24	L24_428	EE	5	DJI_20230629213421_0081_Z.JPG	Member	201	['bent']	low	3	left
L24	L24_428	EE	5	DJI_20230629213421_0081_Z.JPG	Guy		['not standard practice']	high		
L24	L24_428	EE	5	DJI_20230629213421_0081_Z.JPG	Member	207	['bent']	low	2	left
L24	L24_428	EE	5	DJI_20230629213421_0081_Z.JPG	Member	202	['broken']	medium	4	right
L24	L24_428	EE	5	DJI_20230629213421_0081_Z.JPG	Member	202	['bent']	low	3	right
L24	L24_428	EE	5	DJI_20230629213421_0081_Z.JPG	Member	207	['broken']	low	4	left
L24	L24_428	EE	5	DJI_20230629213600_0105_Z.JPG	Member	208	['broken']	low	2	right
L24	L24_428	EE	5	DJI_20230629213600_0105_Z.JPG	Member	202	['bent']	low	2	right
L24	L24_428	EE	5	DJI_20230629213600_0105_Z.JPG	Member	75	['bent']	low	3	center
L24	L24_428	EE	5	DJI_20230629213600_0105_Z.JPG	Member	75	['bent']	low	2	center
L24	L24_428	EE	5	DJI_20230629213600_0105_Z.JPG	Member	207	['broken']	low	2	left
L24	L24_428	EE	5	DJI_20230629213602_0106_Z.JPG	Member	208	['bent']	low	1	right
L24	L24_428	EE	5	DJI_20230629213602_0106_Z.JPG	Member	207	['broken']	low	1	left
L24	L24_429	BB	5	DJI_20230629213805_0136_Z.JPG	Member	252	['bent']	low	1	left
L24	L24_430	EE	5	DJI_20230629220240_0021_Z.JPG	Member	201	['bent']	low	1	left
L24	L24_431	BB	5	DJI_20230629220338_0032_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_431	BB	5	DJI_20230629220344_0034_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_431	BB	5	DJI_20230629220355_0037_Z.JPG	Member	252	['bent']	low	3	left
L24	L24_431	BB	5	DJI_20230629220407_0042_Z.JPG	Member	252	['bent']	low	4	left
L24	L24_432	BB	5	DJI_20230629220515_0056_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_432	BB	5	DJI_20230629220520_0058_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_432	BB	5	DJI_20230629220607_0072_Z.JPG	Footings		['overgrown']	low		
L24	L24_432	BB	5	DJI_20230629220607_0072_Z.JPG	Footings		['overgrown']	low		
L24	L24_432	BB	5	DJI_20230629220607_0072_Z.JPG	Footings		['overgrown']	low		
L24	L24_432	BB	5	DJI_20230629220607_0072_Z.JPG	Footings		['overgrown']	low		
L24	L24_435	BB	0	DJI_20230629221155_0151_Z.JPG	Footings		['overgrown']	low		
L24	L24_435	BB	0	DJI_20230629221155_0151_Z.JPG	Member	75	['bent']	low	1	center
L24	L24_435	BB	0	DJI_20230629221155_0151_Z.JPG	Footings		['overgrown']	low		
L24	L24_435	BB	0	DJI_20230629221155_0151_Z.JPG	Footings		['overgrown']	low		
L24	L24_435	BB	0	DJI_20230629221155_0151_Z.JPG	Footings		['overgrown']	low		
L24	L24_438	BB	0	DJI_20230629222101_0074_W.JPG	Structure		['leaning']	low		
L24	L24_441	EE	5	DJI_20230629222706_0157_Z.JPG	Footings		['fill too high']	low		

Line Number	Structure Identifier	Structure Type	Extension	Image File	Feature	ID	Defect	Severity	Lg	Side
L24	L24_441	EE	5	DJI_20230629222706_0157_Z.JPG	Footings		['fill too high']	low		
L24	L24_441	EE	5	DJI_20230629222706_0157_Z.JPG	Footings		['fill too high']	low		
L24	L24_441	EE	5	DJI_20230629222706_0157_Z.JPG	Footings		['fill too high']	low		
L24	L24_443	BB	5	DJI_20230629223042_0201_Z.JPG	Member	75	['missing']	medium	1	center
L24	L24_443	BB	5	DJI_20230629223042_0201_Z.JPG	Member	75	['missing']	medium	4	center
L24	L24_443	BB	5	DJI_20230629223042_0201_Z.JPG	Member	75	['missing']	medium	3	center
L24	L24_443	BB	5	DJI_20230629223042_0201_Z.JPG	Member	75	['missing']	medium	2	center
L24	L24_443	BB	5	DJI_20230629223109_0211_Z.JPG	Footings		['fill too high']	low		
L24	L24_443	BB	5	DJI_20230629223109_0211_Z.JPG	Footings		['fill too high']	low		
L24	L24_443	BB	5	DJI_20230629223109_0211_Z.JPG	Footings		['fill too high']	low		
L24	L24_443	BB	5	DJI_20230629223109_0211_Z.JPG	Footings		['fill too high']	low		
L24	L24_449	BB	10	DJI_20230623220429_0094_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_449	BB	10	DJI_20230623220435_0096_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_451	BB	5	DJI_20230623220010_0050_Z.JPG	Footings		['fill too high']	low		
L24	L24_451	BB	5	DJI_20230623220010_0050_Z.JPG	Footings		['fill too high']	low		
L24	L24_451	BB	5	DJI_20230623220010_0050_Z.JPG	Footings		['fill too high']	low		
L24	L24_451	BB	5	DJI_20230623220010_0050_Z.JPG	Footings		['fill too high']	low		
L24	L24_453	BB	0	DJI_20230623220756_0118_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_453	BB	0	DJI_20230623220841_0128_Z.JPG	Footings		['overgrown']	low		
L24	L24_457	BB	20	DJI_20230624004328_0005_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_457	BB	20	DJI_20230624004333_0007_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_458	BB	20	DJI_20230624004634_0043_Z.JPG	Footings		['overgrown']	low		
L24	L24_458	BB	20	DJI_20230624004634_0043_Z.JPG	Footings		['overgrown']	low		
L24	L24_458	BB	20	DJI_20230624004634_0043_Z.JPG	Footings		['overgrown']	low		
L24	L24_459	BB	20	DJI_20230624004736_0052_Z.JPG	Hardware		['worn hardware']	medium		
L24	L24_461	BB	0	DJI_20230624005153_0100_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_461	BB	0	DJI_20230624005200_0102_Z.JPG	Hardware		['worn hardware']	medium		
L24	L24_461	BB	0	DJI_20230624005219_0105_Z.JPG	Member	228	['bent']	low	1	right
L24	L24_462	BB	5	DJI_20230624005414_0124_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_462	BB	5	DJI_20230624005423_0126_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_463	BB	5	DJI_20230624005624_0147_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_463	BB	5	DJI_20230624005634_0149_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_465	BB	20	DJI_20230630002906_0009_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_467	BB	0	DJI_20230630003304_0061_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_467	BB	0	DJI_20230630003357_0076_Z.JPG	Footings		['overgrown']	low		
L24	L24_467	BB	0	DJI_20230630003357_0076_Z.JPG	Footings		['overgrown']	low		
L24	L24_467	BB	0	DJI_20230630003357_0076_Z.JPG	Footings		['overgrown']	low		
L24	L24_467	BB	0	DJI_20230630003357_0076_Z.JPG	Footings		['overgrown']	low		
L24	L24_469	BB	5	DJI_20230630003729_0119_Z.JPG	Footings		['overgrown']	low		
L24	L24_469	BB	5	DJI_20230630003729_0119_Z.JPG	Footings		['overgrown']	low		
L24	L24_469	BB	5	DJI_20230630003729_0119_Z.JPG	Footings		['overgrown']	low		
L24	L24_469	BB	5	DJI_20230630003729_0119_Z.JPG	Footings		['overgrown']	low		
L24	L24_469	BB	5	DJI_20230630003742_0124_Z.JPG	Member	75	['missing']	medium	1	center
L24	L24_469	BB	5	DJI_20230630003742_0124_Z.JPG	Member	75	['missing']	medium	2	center
L24	L24_469	BB	5	DJI_20230630003742_0124_Z.JPG	Member	75	['missing']	medium	3	center
L24	L24_469	BB	5	DJI_20230630003742_0124_Z.JPG	Member	75	['missing']	medium	4	center
L24	L24_474	EE	5	DJI_20230630005306_0047_Z.JPG	Footings		['overgrown']	low		
L24	L24_474	EE	5	DJI_20230630005306_0047_Z.JPG	Footings		['overgrown']	low		
L24	L24_474	EE	5	DJI_20230630005306_0047_Z.JPG	Footings		['overgrown']	low		
L24	L24_479	BB	5	DJI_20230630022305_0034_Z.JPG	Footings		['overgrown']	low		
L24	L24_479	BB	5	DJI_20230630022305_0034_Z.JPG	Member	75	['missing']	medium	4	center
L24	L24_479	BB	5	DJI_20230630022305_0034_Z.JPG	Footings		['overgrown']	low		
L24	L24_479	BB	5	DJI_20230630022305_0034_Z.JPG	Footings		['overgrown']	low		
L24	L24_479	BB	5	DJI_20230630022305_0034_Z.JPG	Member	75	['missing']	medium	3	center
L24	L24_479	BB	5	DJI_20230630022305_0034_Z.JPG	Member	75	['missing']	medium	2	center
L24	L24_479	BB	5	DJI_20230630022305_0034_Z.JPG	Footings		['overgrown']	low		
L24	L24_479	BB	5	DJI_20230630022305_0034_Z.JPG	Member	75	['missing']	medium	1	center
L24	L24_480	BB	5	DJI_20230630022509_0062_Z.JPG	Environmental		['raptor nest']	low		
L24	L24_481	BB	5	DJI_20230630022707_0086_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_481	BB	5	DJI_20230630022713_0088_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_486	EE	5	DJI_20230630024136_0004_Z.JPG	Footings		['fill too high']	low		
L24	L24_486	EE	5	DJI_20230630024136_0004_Z.JPG	Footings		['fill too high']	low		
L24	L24_486	EE	5	DJI_20230630024136_0004_Z.JPG	Footings		['fill too high']	low		
L24	L24_486	EE	5	DJI_20230630024136_0004_Z.JPG	Footings		['fill too high']	low		
L24	L24_488	BB	5	DJI_20230630024556_0071_Z.JPG	Footings		['fill too high']	low		
L24	L24_488	BB	5	DJI_20230630024556_0071_Z.JPG	Footings		['fill too high']	low		
L24	L24_488	BB	5	DJI_20230630024556_0071_Z.JPG	Footings		['fill too high']	low		
L24	L24_488	BB	5	DJI_20230630024556_0071_Z.JPG	Footings		['fill too high']	low		
L24	L24_494	BB	0	DJI_20230630205631_0003_Z.JPG	Footings		['fill too high']	low		
L24	L24_494	BB	0	DJI_20230630205631_0003_Z.JPG	Footings		['fill too high']	low		
L24	L24_494	BB	0	DJI_20230630205631_0003_Z.JPG	Footings		['fill too high']	low		
L24	L24_494	BB	0	DJI_20230630205631_0003_Z.JPG	Footings		['fill too high']	low		

Line Number	Structure Identifier	Structure Type	Extension	Image File	Feature	ID	Defect	Severity	Lg	Side
L24	L24_501	BB	0	DJI_20230630211822_0029_Z.JPG	Footings		['fill too high']	low		
L24	L24_501	BB	0	DJI_20230630211822_0029_Z.JPG	Footings		['fill too high']	low		
L24	L24_501	BB	0	DJI_20230630211822_0029_Z.JPG	Footings		['fill too high']	low		
L24	L24_501	BB	0	DJI_20230630211822_0029_Z.JPG	Footings		['fill too high']	low		
L24	L24_510	BB	0	DJI_20230623210300_0103_Z.JPG	Hardware		['worn hardware']	medium		
L24	L24_510	BB	0	DJI_20230623210306_0105_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_511	BB	5	DJI_20230623210121_0080_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_511	BB	5	DJI_20230623210128_0082_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_512	BB	5	DJI_20230623210027_0071_Z.JPG	Footings		['fill too high']	low		
L24	L24_512	BB	5	DJI_20230623210027_0071_Z.JPG	Footings		['fill too high']	low		
L24	L24_512	BB	5	DJI_20230623210027_0071_Z.JPG	Footings		['fill too high']	low		
L24	L24_512	BB	5	DJI_20230623210027_0071_Z.JPG	Footings		['fill too high']	low		
L24	L24_513	BB	0	DJI_20230623205730_0031_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_513	BB	0	DJI_20230623205738_0033_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_513	BB	0	DJI_20230623205838_0048_Z.JPG	Member	227	['bent']	low	3	left
L24	L24_513	BB	0	DJI_20230623205838_0048_Z.JPG	Member	228	['bent']	low	3	right
L24	L24_514	BB	5	DJI_20230623204101_0088_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_514	BB	5	DJI_20230623204114_0090_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_515	BB	10	DJI_20230623203903_0064_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_515	BB	10	DJI_20230623203906_0065_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_515	BB	10	DJI_20230623203908_0066_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_517	BB	10	DJI_20230623203430_0006_Z.JPG	Hardware		['worn hardware']	medium		
L24	L24_517	BB	10	DJI_20230623203435_0008_Z.JPG	Hardware		['worn hardware']	low		
L24	L24_523	BB	5	DJI_20230614052713_0194_Z.JPG	Footings		['overgrown']	low		
L24	L24_523	BB	5	DJI_20230614052713_0194_Z.JPG	Footings		['overgrown']	low		
L24	L24_523	BB	5	DJI_20230614052713_0194_Z.JPG	Footings		['overgrown']	low		
L24	L24_523	BB	5	DJI_20230614052713_0194_Z.JPG	Footings		['overgrown']	low		
L24	L24_526	BB	5	DJI_20230614051617_0067_Z.JPG	Footings		['fill too high']	low		
L24	L24_526	BB	5	DJI_20230614051655_0075_Z.JPG	Footings		['fill too high']	low		
L24	L24_527	BB	5	DJI_20230614051253_0033_Z.JPG	Footings		['fill too high']	low		
L24	L24_527	BB	5	DJI_20230614051253_0033_Z.JPG	Footings		['overgrown']	low		
L24	L24_527	BB	5	DJI_20230614051253_0033_Z.JPG	Footings		['overgrown']	low		
L24	L24_527	BB	5	DJI_20230614051253_0033_Z.JPG	Footings		['overgrown']	low		
L24	L24_528	BB	5	DJI_20230614020807_0211_Z.JPG	Footings		['overgrown']	low		
L24	L24_528	BB	5	DJI_20230614020807_0211_Z.JPG	Footings		['overgrown']	low		
L24	L24_528	BB	5	DJI_20230614020807_0211_Z.JPG	Footings		['overgrown']	low		
L24	L24_528	BB	5	DJI_20230614020807_0211_Z.JPG	Footings		['overgrown']	low		
L24	L24_529	BB	5	DJI_20230614020507_0168_Z.JPG	Member	75	['missing']	medium	1	center
L24	L24_529	BB	5	DJI_20230614020507_0168_Z.JPG	Member	75	['missing']	medium	3	center
L24	L24_529	BB	5	DJI_20230614020507_0168_Z.JPG	Member	75	['missing']	medium	2	center
L24	L24_529	BB	5	DJI_20230614020507_0168_Z.JPG	Member	75	['missing']	medium	4	center
L24	L24_530	BB	5	DJI_20230614020004_0113_Z.JPG	Environmental		['raptor nest']	low		
L24	L24_541	BB	5	DJI_20230613214219_0157_Z.JPG	Footings		['fill too high']	high		
L24	L24_541	BB	5	DJI_20230613214219_0157_Z.JPG	Footings		['fill too high']	high		
L24	L24_541	BB	5	DJI_20230613214219_0157_Z.JPG	Footings		['fill too high']	high		
L24	L24_541	BB	5	DJI_20230613214219_0157_Z.JPG	Footings		['fill too high']	high		
L24	L24_544	BB	5	DJI_20230613212817_0038_Z.JPG	Footings		['fill too high']	low		
L24	L24_544	BB	5	DJI_20230613212817_0038_Z.JPG	Footings		['fill too high']	low		
L24	L24_544	BB	5	DJI_20230613212817_0038_Z.JPG	Footings		['fill too high']	low		
L24	L24_544	BB	5	DJI_20230613212817_0038_Z.JPG	Footings		['fill too high']	low		
L24	L24_545	BB	5	DJI_20230613211311_0113_Z.JPG	Footings		['overgrown']	low		
L24	L24_545	BB	5	DJI_20230613211311_0113_Z.JPG	Footings		['overgrown']	low		
L24	L24_547	HH	5	DJI_20230613210216_0006_Z.JPG	Footings		['fill too high']	low		
L24	L24_547	HH	5	DJI_20230613210216_0006_Z.JPG	Footings		['fill too high']	low		
L24	L24_547	HH	5	DJI_20230613210216_0006_Z.JPG	Footings		['fill too high']	low		
L24	L24_547	HH	5	DJI_20230613210216_0006_Z.JPG	Footings		['fill too high']	low		
L24	L24_550	BB	5	DJI_20230613065328_0066_Z.JPG	Environmental		['raptor nest']	low		
L24	L24_552	BB	20	DJI_20230613063654_0187_Z.JPG	Footings		['submerged']	low		
L24	L24_560	HH	20	DJI_20230613032012_0135_Z.JPG	Environmental		['raptor']	low		
L24	L24_560	HH	20	DJI_20230613032043_0141_Z.JPG	Environmental		['raptor nest', 'raptor']	low		
L24	L24_563	BB	15	DJI_20230613012010_0206_Z.JPG	Footings		['fill too low']	low		
L24	L24_563	BB	15	DJI_20230613012317_0239_Z.JPG	Footings		['fill too high']	low		
L24	L24_570	H	0	DJI_20230612225731_0044_W.JPG	good		[]	good		
L24	L24_570	H	0	DJI_20230612230002_0072_Z.JPG	Insulator		['porcelain']	low		
L24A	L24A_1	RT-DE-70	15	DJI_20230615044639_0123_Z.JPG	Environmental		['raptor nest']	low		
L24A	L24A_2	RT-0	5	DJI_20230615044026_0055_Z.JPG	Member	171	['altered member']	low	4	right
L24A	L24A_2	RT-0	5	DJI_20230615044151_0071_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_2	RT-0	5	DJI_20230615044151_0071_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_2	RT-0	5	DJI_20230615044151_0071_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_3	RT-0	20	DJI_20230615043553_0006_Z.JPG	Member	175	['bent']	low	4	right
L24A	L24A_3	RT-0	20	DJI_20230615043750_0031_Z.JPG	Footings		['fill too low']	low		
L24A	L24A_3	RT-0	20	DJI_20230615043844_0037_Z.JPG	Insulator		['porcelain']	low		

Line Number	Structure Identifier	Structure Type	Extension	Image File	Feature	ID	Defect	Severity	Lg	Side
L24A	L24A_3	RT-0	20	DJI_20230615043903_0040_Z.JPG	Insulator		['porcelain']	low		
L24A	L24A_3	RT-0	20	DJI_20230615043903_0040_Z.JPG	Insulator		['porcelain']	low		
L24A	L24A_4	RT-0	0	DJI_20230615033502_0080_Z.JPG	Insulator		['porcelain']	low		
L24A	L24A_4	RT-0	0	DJI_20230615033529_0084_Z.JPG	Insulator		['porcelain']	low		
L24A	L24A_4	RT-0	0	DJI_20230615033529_0084_Z.JPG	Insulator		['porcelain']	low		
L24A	L24A_4	RT-0	0	DJI_20230615033632_0094_Z.JPG	Insulator		['porcelain']	low		
L24A	L24A_4	RT-0	0	DJI_20230615033632_0094_Z.JPG	Insulator		['porcelain']	low		
L24A	L24A_4	RT-0	0	DJI_20230615033733_0106_Z.JPG	Member	161	['bent']	low	4	left
L24A	L24A_5	RT-0	20	DJI_20230615033328_0072_Z.JPG	Insulator		['porcelain']	low		
L24A	L24A_5	RT-0	20	DJI_20230615033328_0072_Z.JPG	Insulator		['porcelain']	low		
L24A	L24A_5	RT-0	20	DJI_20230615033330_0073_Z.JPG	Insulator		['porcelain']	low		
L24A	L24A_6	RT-0	15	DJI_20230615032726_0002_Z.JPG	Insulator		['porcelain']	low		
L24A	L24A_6	RT-0	15	DJI_20230615032810_0012_Z.JPG	Insulator		['porcelain']	low		
L24A	L24A_6	RT-0	15	DJI_20230615032810_0012_Z.JPG	Insulator		['porcelain']	low		
L24A	L24A_7	RT-DE-70	10	DJI_20230615053745_0006_Z.JPG	Member	54	['bent']	low		
L24A	L24A_7	RT-DE-70	10	DJI_20230615053756_0011_Z.JPG	Footings		['fill too high']	low		
L24A	L24A_8	GV-0	0	DJI_20230615054248_0056_Z.JPG	Insulator		['porcelain']	low		
L24A	L24A_8	GV-0	0	DJI_20230615054251_0057_Z.JPG	Insulator		['porcelain']	low		
L24A	L24A_8	GV-0	0	DJI_20230615054251_0057_Z.JPG	Insulator		['porcelain']	low		
L24A	L24A_9	GV-0	0	DJI_20230615054715_0090_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_9	GV-0	0	DJI_20230615054715_0090_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_9	GV-0	0	DJI_20230615054715_0090_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_10	GV-0	0	DJI_20230615055035_0111_Z.JPG	Insulator		['porcelain']	low		
L24A	L24A_10	GV-0	0	DJI_20230615055035_0111_Z.JPG	Insulator		['porcelain']	low		
L24A	L24A_10	GV-0	0	DJI_20230615055127_0122_Z.JPG	Insulator		['porcelain']	low		
L24A	L24A_11	GV-0	0	DJI_20230615194850_0014_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_11	GV-0	0	DJI_20230615194850_0014_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_11	GV-0	0	DJI_20230615194850_0014_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_12	GV-0	0	DJI_20230615195239_0050_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_12	GV-0	0	DJI_20230615195239_0050_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_12	GV-0	0	DJI_20230615195239_0050_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_12	GV-0	0	DJI_20230615195306_0054_W.JPG	Insulator		['not plomb']	medium		
L24A	L24A_12	GV-0	0	DJI_20230615195306_0054_W.JPG	Insulator		['not plomb']	medium		
L24A	L24A_12	GV-0	0	DJI_20230615195306_0054_W.JPG	Insulator		['not plomb']	high		
L24A	L24A_13	GV-0	0	DJI_20230615195647_0088_W.JPG	Insulator		['not plomb']	medium		
L24A	L24A_13	GV-0	0	DJI_20230615195647_0088_W.JPG	Insulator		['not plomb']	low		
L24A	L24A_13	GV-0	0	DJI_20230615195647_0088_W.JPG	Insulator		['not plomb']	medium		
L24A	L24A_13	GV-0	0	DJI_20230615195659_0090_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_13	GV-0	0	DJI_20230615195659_0090_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_13	GV-0	0	DJI_20230615195659_0090_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_14	GV-0	0	DJI_20230615200038_0124_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_14	GV-0	0	DJI_20230615200038_0124_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_14	GV-0	0	DJI_20230615200038_0124_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_15	GV-0	0	DJI_20230615200531_0164_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_15	GV-0	0	DJI_20230615200531_0164_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_15	GV-0	0	DJI_20230615200531_0164_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_16	GV-0	0	DJI_20230615213639_0143_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_16	GV-0	0	DJI_20230615213639_0143_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_16	GV-0	0	DJI_20230615213639_0143_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_17	GV-0	0	DJI_20230615213303_0106_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_17	GV-0	0	DJI_20230615213303_0106_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_17	GV-0	0	DJI_20230615213303_0106_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_18	GV-0	0	DJI_20230615212840_0059_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_18	GV-0	0	DJI_20230615212840_0059_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_18	GV-0	0	DJI_20230615212840_0059_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_19	GV-0	0	DJI_20230615212547_0031_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_19	GV-0	0	DJI_20230615212547_0031_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_19	GV-0	0	DJI_20230615212547_0031_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_20	GV-0	0	DJI_20230617051138_0028_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_20	GV-0	0	DJI_20230617051138_0028_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_20	GV-0	0	DJI_20230617051138_0028_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_21	GV-0	0	DJI_20230617051415_0044_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_21	GV-0	0	DJI_20230617051415_0044_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_21	GV-0	0	DJI_20230617051415_0044_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_22	GV-0	0	DJI_20230616214332_0223_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_22	GV-0	0	DJI_20230616214332_0223_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_22	GV-0	0	DJI_20230616214332_0223_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_23	GV-0	0	DJI_20230616214147_0205_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_23	GV-0	0	DJI_20230616214147_0205_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_23	GV-0	0	DJI_20230616214147_0205_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_24	GV-0	0	DJI_20230616213813_0158_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_24	GV-0	0	DJI_20230616213813_0158_W.JPG	Insulator		['porcelain']	low		

Line Number	Structure Identifier	Structure Type	Extension	Image File	Feature	ID	Defect	Severity	Lg	Side
L24A	L24A_24	GV-0	0	DJI_20230616213813_0158_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_25	GV-0	0	DJI_20230616213426_0104_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_25	GV-0	0	DJI_20230616213426_0104_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_25	GV-0	0	DJI_20230616213426_0104_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_26	GV-0	0	DJI_20230616213326_0098_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_26	GV-0	0	DJI_20230616213326_0098_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_26	GV-0	0	DJI_20230616213326_0098_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_27	GV-0	0	DJI_20230616213040_0062_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_27	GV-0	0	DJI_20230616213040_0062_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_27	GV-0	0	DJI_20230616213040_0062_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_28	GV-0	0	DJI_20230616212800_0029_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_28	GV-0	0	DJI_20230616212800_0029_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_28	GV-0	0	DJI_20230616212800_0029_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_29	GV-0	0	DJI_20230616215539_0033_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_29	GV-0	0	DJI_20230616215539_0033_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_29	GV-0	0	DJI_20230616215539_0033_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_30	GV-0	0	DJI_20230616215801_0058_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_30	GV-0	0	DJI_20230616215801_0058_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_30	GV-0	0	DJI_20230616215801_0058_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_31	GV-0	0	DJI_20230616220043_0093_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_31	GV-0	0	DJI_20230616220043_0093_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_31	GV-0	0	DJI_20230616220043_0093_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_32	GV-0	0	DJI_20230616220305_0121_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_32	GV-0	0	DJI_20230616220305_0121_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_32	GV-0	0	DJI_20230616220305_0121_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_33	GV-0	0	DJI_20230616220512_0143_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_33	GV-0	0	DJI_20230616220512_0143_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_33	GV-0	0	DJI_20230616220512_0143_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_34	GV-0	0	DJI_20230616220931_0204_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_34	GV-0	0	DJI_20230616220931_0204_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_34	GV-0	0	DJI_20230616220931_0204_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_35	GV-0	0	DJI_20230616221207_0227_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_35	GV-0	0	DJI_20230616221207_0227_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_35	GV-0	0	DJI_20230616221207_0227_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_36	GV-0	0	DJI_20230616233153_0013_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_36	GV-0	0	DJI_20230616233153_0013_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_36	GV-0	0	DJI_20230616233153_0013_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_37	GV-0	0	DJI_20230617001132_0111_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_37	GV-0	0	DJI_20230617001132_0111_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_37	GV-0	0	DJI_20230617001132_0111_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_38	GV-0	0	DJI_20230617000829_0070_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_38	GV-0	0	DJI_20230617000829_0070_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_38	GV-0	0	DJI_20230617000829_0070_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_39	GV-0	0	DJI_20230617000747_0064_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_39	GV-0	0	DJI_20230617000747_0064_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_39	GV-0	0	DJI_20230617000747_0064_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_40	GV-0	0	DJI_20230617000506_0030_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_40	GV-0	0	DJI_20230617000506_0030_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_41	GV-0	0	DJI_20230616235637_0017_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_41	GV-0	0	DJI_20230616235637_0017_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_41	GV-0	0	DJI_20230616235637_0017_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_42	GV-0	0	DJI_20230617001734_0159_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_42	GV-0	0	DJI_20230617001734_0159_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_42	GV-0	0	DJI_20230617001734_0159_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_43	GV-0	0	DJI_20230617002021_0190_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_43	GV-0	0	DJI_20230617002021_0190_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_43	GV-0	0	DJI_20230617002021_0190_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_44	GV-0	0	DJI_20230617002219_0207_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_44	GV-0	0	DJI_20230617002219_0207_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_44	GV-0	0	DJI_20230617002219_0207_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_45	GV-0	0	DJI_20230617013006_0004_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_45	GV-0	0	DJI_20230617013006_0004_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_45	GV-0	0	DJI_20230617013006_0004_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_46	GV-0	0	DJI_20230617013256_0037_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_46	GV-0	0	DJI_20230617013256_0037_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_46	GV-0	0	DJI_20230617013256_0037_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_47	GV-0	0	DJI_20230617014419_0013_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_47	GV-0	0	DJI_20230617014419_0013_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_47	GV-0	0	DJI_20230617014419_0013_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_48	GV-0	0	DJI_20230617014927_0073_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_48	GV-0	0	DJI_20230617014927_0073_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_48	GV-0	0	DJI_20230617014927_0073_W.JPG	Insulator		['porcelain']	low		

Line Number	Structure Identifier	Structure Type	Extension	Image File	Feature	ID	Defect	Severity	Lg	Side
L24A	L24A_49	GV-0	0	DJI_20230617015241_0107_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_49	GV-0	0	DJI_20230617015241_0107_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_49	GV-0	0	DJI_20230617015241_0107_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_50	GV-0	0	DJI_20230617015530_0140_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_50	GV-0	0	DJI_20230617015530_0140_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_50	GV-0	0	DJI_20230617015530_0140_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_51	GV-0	0	DJI_20230617015852_0174_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_51	GV-0	0	DJI_20230617015852_0174_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_51	GV-0	0	DJI_20230617015852_0174_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_52	GV-0	0	DJI_20230617020134_0202_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_52	GV-0	0	DJI_20230617020134_0202_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_52	GV-0	0	DJI_20230617020134_0202_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_53	GV-0	0	DJI_20230619215156_0001_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_53	GV-0	0	DJI_20230619215156_0001_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_53	GV-0	0	DJI_20230619215156_0001_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_54	GV-0	0	DJI_20230619215442_0030_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_54	GV-0	0	DJI_20230619215442_0030_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_54	GV-0	0	DJI_20230619215442_0030_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_55	GV-0	0	DJI_20230619215654_0058_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_55	GV-0	0	DJI_20230619215654_0058_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_55	GV-0	0	DJI_20230619215654_0058_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_56	GV-0	0	DJI_20230619215928_0086_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_56	GV-0	0	DJI_20230619215928_0086_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_56	GV-0	0	DJI_20230619215928_0086_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_57	GV-0	0	DJI_20230619220251_0127_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_57	GV-0	0	DJI_20230619220251_0127_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_57	GV-0	0	DJI_20230619220251_0127_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_58	GV-0	0	DJI_20230619220426_0140_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_58	GV-0	0	DJI_20230619220426_0140_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_58	GV-0	0	DJI_20230619220426_0140_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_59	GV-0	0	DJI_20230619220656_0168_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_59	GV-0	0	DJI_20230619220656_0168_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_59	GV-0	0	DJI_20230619220656_0168_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_60	GV-0	0	DJI_20230619220922_0195_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_60	GV-0	0	DJI_20230619220922_0195_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_60	GV-0	0	DJI_20230619220922_0195_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_61	GV-0	0	DJI_20230619224000_0002_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_61	GV-0	0	DJI_20230619224000_0002_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_61	GV-0	0	DJI_20230619224000_0002_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_62	GV-0	0	DJI_20230619224243_0028_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_62	GV-0	0	DJI_20230619224243_0028_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_62	GV-0	0	DJI_20230619224243_0028_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_63	GV-0	0	DJI_20230619224602_0069_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_63	GV-0	0	DJI_20230619224602_0069_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_63	GV-0	0	DJI_20230619224602_0069_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_63	GV-0	0	DJI_20230619224609_0071_Z.JPG	Member	148	['bent']	low		
L24A	L24A_64	GV-0	0	DJI_20230619224735_0081_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_64	GV-0	0	DJI_20230619224735_0081_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_64	GV-0	0	DJI_20230619224735_0081_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_65	GV-0	0	DJI_20230619225023_0108_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_65	GV-0	0	DJI_20230619225023_0108_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_65	GV-0	0	DJI_20230619225023_0108_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_66	GV-0	0	DJI_20230619225800_0001_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_66	GV-0	0	DJI_20230619225800_0001_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_66	GV-0	0	DJI_20230619225800_0001_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_67	GV-0	0	DJI_20230619230036_0029_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_67	GV-0	0	DJI_20230619230036_0029_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_67	GV-0	0	DJI_20230619230036_0029_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_68	GV-0	0	DJI_20230619230345_0066_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_68	GV-0	0	DJI_20230619230345_0066_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_68	GV-0	0	DJI_20230619230345_0066_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_69	GV-0	0	DJI_20230619231610_0032_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_69	GV-0	0	DJI_20230619231610_0032_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_69	GV-0	0	DJI_20230619231610_0032_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_70	GV-0	0	DJI_20230619231843_0061_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_70	GV-0	0	DJI_20230619231843_0061_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_70	GV-0	0	DJI_20230619231843_0061_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_71	GV-0	0	DJI_20230619232121_0088_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_71	GV-0	0	DJI_20230619232121_0088_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_71	GV-0	0	DJI_20230619232121_0088_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_72	GV-0	0	DJI_20230619232404_0117_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_72	GV-0	0	DJI_20230619232404_0117_W.JPG	Insulator		['porcelain']	low		

Line Number	Structure Identifier	Structure Type	Extension	Image File	Feature	ID	Defect	Severity	Lg	Side
L24A	L24A_72	GV-0	0	DJI_20230619232404_0117_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_73	GV-0	0	DJI_20230619232719_0156_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_73	GV-0	0	DJI_20230619232719_0156_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_73	GV-0	0	DJI_20230619232719_0156_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_74	GV-0	0	DJI_20230619232904_0170_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_74	GV-0	0	DJI_20230619232904_0170_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_74	GV-0	0	DJI_20230619232904_0170_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_75	GV-0	0	DJI_20230620011452_0002_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_75	GV-0	0	DJI_20230620011452_0002_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_75	GV-0	0	DJI_20230620011452_0002_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_76	GV-0	0	DJI_20230620011852_0045_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_76	GV-0	0	DJI_20230620011852_0045_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_76	GV-0	0	DJI_20230620011852_0045_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_77	GV-0	0	DJI_20230620012204_0076_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_77	GV-0	0	DJI_20230620012204_0076_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_77	GV-0	0	DJI_20230620012204_0076_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_77	GV-0	0	DJI_20230620012221_0079_Z.JPG	Environmental		['raptor nest']	low		
L24A	L24A_78	GV-0	0	DJI_20230620012518_0108_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_78	GV-0	0	DJI_20230620012518_0108_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_78	GV-0	0	DJI_20230620012518_0108_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_78	GV-0	0	DJI_20230620012613_0122_Z.JPG	Environmental		['raptor nest']	low		
L24A	L24A_79	GV-0	0	DJI_20230620012811_0140_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_79	GV-0	0	DJI_20230620012811_0140_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_79	GV-0	0	DJI_20230620012811_0140_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_81	GV-0	0	DJI_20230620040802_0016_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_81	GV-0	0	DJI_20230620040802_0016_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_81	GV-0	0	DJI_20230620040802_0016_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_82	GV-0	0	DJI_20230620040947_0033_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_82	GV-0	0	DJI_20230620040947_0033_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_82	GV-0	0	DJI_20230620040947_0033_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_83	GV-0	0	DJI_20230620041218_0063_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_83	GV-0	0	DJI_20230620041218_0063_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_83	GV-0	0	DJI_20230620041218_0063_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_84	GV-0	0	DJI_20230620041524_0105_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_84	GV-0	0	DJI_20230620041524_0105_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_84	GV-0	0	DJI_20230620041524_0105_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_85	GV-0	0	DJI_20230620041731_0126_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_85	GV-0	0	DJI_20230620041731_0126_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_85	GV-0	0	DJI_20230620041731_0126_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_86	GV-0	0	DJI_20230620044602_0001_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_86	GV-0	0	DJI_20230620044602_0001_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_86	GV-0	0	DJI_20230620044602_0001_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_86	GV-0	0	DJI_20230620044746_0024_Z.JPG	Structure		['rusted']	low		
L24A	L24A_87	GV-0	0	DJI_20230620044902_0033_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_87	GV-0	0	DJI_20230620044902_0033_W.JPG	Insulator		['porcelain']	low		
L24A	L24A_87	GV-0	0	DJI_20230620044902_0033_W.JPG	Insulator		['porcelain']	low		

Appendix B – Structural Assessment Results

L23	General Details					Analysis Results (before deficiency simulation)						Analysis Results (after deficiency simulation)				
Str. #	Tower Type & Extension	Deficient Member ID # (Drawings)	Leg	Side	Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed incorrectly D5: Missing bolt D6: Altered member	Max Tower Usage (%)	Max Tower Usage Member # Tower Model	Drawings	Defective Member Max Usage (%)	Defective Member Max Usage Mode (Comp./Tens.)	Defective Member KL/R	Deficiency Modeling M1: Remove member M2: Change to 0% Comp. Capacity (T-Only) M3: Change to 25% Comp. Capacity M4: Change to 50% Comp. Capacity M5: Change to 75% Comp. Capacity	Max. Tower Structure Usage (%)	Member # (Drawings) Governing Max Tower Usage	Max. Usage of Deficient Member (%)	Additional Remarks (notes, assumptions, discrepancies)
5	A_+0+0+0+0	109	2	left	D1	63.0	g81Y	41	27.4	Comp.	208.4	M2	62.9	41	9.7	
		109	4	right	D1							M2				
9	S_+0+0+0+0	131	4	right	D1	73.6	LXY_131-T1P	131	73.6	Comp.	236.6	M2	55.0	131	5.3	
		131	1	left	D1							M2				
		131	3	right	D1							M2				
13	S_+0+0+0+0	131	4	right	D1	71.7	LXY_131-T1P	131	71.7	Comp.	236.6	M2	63.1	131	6.2	
		131	2	left	D1							M2				
		131	1	left	D1							M2				
15	S_+0+0+0+0	131	3	right	D1	75.1	LXY_131-T1P	131	75.1	Comp.	236.6	M2	86.1	131	4.1	
17	S_+5+5+5+5	136	3	right	D1	93.9	Fg143-3P	136	93.9	Comp.	240.0	M2	104.3	136	7.7	
18	S_+5+5+5+5	136	3	right	D1	95.2	Fg143-4P	136	95.2	Comp.	240.0	M2	86.7	136	8.4	
		136	4	left	D1							M2				
		136	4	right	D1							M2				
		136	1	left	D1							M2				
21	S_+0+0+0+0	131	2	left	D1	83.7	131-T1P	131	83.7	Comp.	236.6	M2	86.1	131	8.2	
		131	2	right	D1							M2				
22	S_+5+5+5+5	136	3	right	D1	89.1	Fg143-3P	136	89.1	Comp.	240.0	M2	103.1	136	5.4	
		136	2	right	D1							M2			8.8	
23	S_+0+0+0+0	131	3	left	D1	77.7	131-T1P	131	77.7	Comp.	236.6	M2	75.6	131	7.4	
25	S_+0+0+0+0	131	3	right	D1	84.9	LY-131-T1P	131	84.9	Comp.	236.6	M2	84.0	131	8.0	
		131	3	left	D1							M2				
32	S_+5+5+5+5	136	1	right	D1	99.5	Fg143-4P	136	99.5	Comp.	240.0	M2	115.6	136	6.3	
38	S_+0+0+0+0	133	2	left	D1	74.6	LY-131-T1P	131	74.6	Comp.	236.6	M2	74.7	131	1.3	
44	S_+5+5+5+5	136	3	left	D1	87.8	Fg143-4P	136	87.8	Comp.	240.0	M2	85.5	136	7.7	
49	S_+0+0+0+0	131	3	left	D1	78.8	LY-131-T1P	131	78.8	Comp.	236.6	M2	77.9	131	7.6	
54	S_+0+0+0+0	131	2	right	D1	76.4	LX_131-T1P	131	76.4	Comp.	236.6	M2	87.0	131	8.2	
		131	1	left	D1							M2				
		131	3	right	D1							M2				
62	S_+0+0+0+0	131	3	right	D1	77.3	LY-131-T1P	131	77.3	Comp.	236.6	M2	87.1	131	4.7	
63	S_+0+0+0+0	131	1	right	D2	79.31	131-T1P	131	79.31	Comp.	236.57	M1	82.74	131	NA	
		131	1	left	D1							M2			7.2	
75	S_+0+0+0+0	131	4	left	D1	79.5	LX_131-T1P	131	79.5	Comp.	236.6	M2	90.9	131	8.5	
		131	2	right	D1							M2				
79	S_+0+0+0+0	131	2	left	D1	82.0	LXY_131-T1P	131	82.0	Comp.	236.6	M2	93.5	131	9.0	
		131	2	right	D1							M2				
		131	4	left	D1							M2				
90	S_+0+0+0+0	129	3	center	D1	77.6	131-T1P	131	21.3	Comp.	90.1	M5	88.7	131	29.8	
		131	3	right	D1				77.7	Comp.	236.6	M2			8.1	
		131	1	left	D1							M2				
94	S_+0+0+0+0	131	2	left	D1	68.8	131-T1P	131	68.8	Comp.	236.6	M2	68.2	131	4.3	
		131	3	left	D1							M2				
95	S_+0+0+0+0	131	4	left	D1	151.0	LXY_131-T1P	131	151.0	Comp.	236.6	M2	167.0	131	18.3	Type S tower with DE strings; analyzed for tangent/suspension loadings.
		131	4	right	D1							M2			17.8	
96	S_-5-5-5-5	127	4	right	D1	74.4	g143-2P	127	74.4	Comp.	267.6	M2	46.8	127	4.5	
		127	1	right	D1							M2				
		127	1	left	D1							M2				
100	S_+0+0+0+0	131	3	left	D1	80.9	LY-131-T1P	131	80.9	Comp.	236.6	M2	76.2	131	8.8	
		131	3	right	D1							M2				
		131	4	right	D1							M2				
		131	1	left	D1							M2				
101	S_+5+5+5+5	140	2	center	D1	98.2	Fg143-3P	136	1.9	Comp.	173.5	M1	106.5	136	NA	Member and connected bracing removed.
		136	2	right	D1				98.2	Comp.	240.0	M1			NA	
		136	2	left	D1							M2			5.8	
		136	3	left	D1							M2			5.7	
104	S_+15+15+15+15	154	3	left	D1	78.4	115-T2Y	115	26.6	Comp.	151.5	M2	72.6	115	7.4	
		154	2	right	D1							M2				
		154	3	right	D1							M2				
		152	3	center	D1				21.0	Comp.	91.5	M5			30.6	
109	T_+0+0+0+0	124	3	right	D1	123.6	g136P	63	99.8	Comp.	339.9	M2	123.6	63	50.5	

L23	General Details					Analysis Results (before deficiency simulation)						Analysis Results (after deficiency simulation)				
Str. #	Tower Type & Extension	Deficient Member			Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed incorrectly D5: Missing bolt D6: Altered member	Max Tower Usage (%)	Max Tower Usage Member #		Defective Member Max Usage (%)	Defective Member Max Usage Mode (Comp./Tens.)	Defective Member KL/R	Deficiency Modeling M1: Remove member M2: Change to 0% Comp. Capacity (T-Only) M3: Change to 25% Comp. Capacity M4: Change to 50% Comp. Capacity M5: Change to 75% Comp. Capacity	Max. Tower Structure Usage (%)	Member # (Drawings) Governing Max Tower Usage	Max. Usage of Deficient Member (%)	Additional Remarks (notes, assumptions, discrepancies)
		ID # (Drawings)	Leg	Side			Tower Model	Drawings								
113	S_+0+0+0+0	131	1	left	D1	86.0	LY-131-T1P	131	86.0	Comp.	236.6	M2	86.0	131	7.3	
114	S_-5-5-5-5	115	4	right	D1	88.0	g143-2P	127	29.1	Comp.	186.8	M2	92.0	127	5.8	
		115	2	left	D1							M2				
116	S_+0+0+0+0	131	1	left	D1	83.8	131-T1P	131	83.8	Comp.	236.6	M2	83.8	131	8.1	
117	S_+0+0+0+0	131	3	left	D1	80.9	131-T1P	131	80.9	Comp.	236.6	M2	76.1	131	8.2	
		131	1	left	D1							M2				
		131	4	right	D1							M2				
134	S_+0+0+0+0	131	3	right	D1	74.7	131-T1P	131	74.7	Comp.	236.6	M2	85.3	131	7.9	
		131	2	left	D1							M2				
151	S_+0+0+0+0	131	2	right	D1	63.4	131-T1P	131	63.4	Comp.	236.6	M2	63.4	131	5.8	
168	S_+0+0+0+0	131	2	right	D1	71.6	LY-131-T1P	131	71.6	Comp.	236.6	M2	71.6	131	6.8	
169	S_+0+0+0+0	131	2	right	D1	73.2	131-T1P	131	73.2	Comp.	236.6	M2	73.2	131	6.8	
		131	1	left	D1							M2				
171	S_-5-5-5-5	118	3	right	D1	87.3	g143-3P	127	4.0	Comp.	162.3	M2	87.3	127	0.8	
172	S_+0+0+0+0	131	4	left	D1	79.4	131-T1P	131	79.4	Comp.	236.6	M2	88.1	131	8.1	
		131	2	right	D1							M2				
173	S_+5+5+5+5	136	1	left	D1	95.2	Fg143-3P	136	95.2	Comp.	240.0	M2	109.4	136	9.8	
		136	3	left	D1							M2			9.5	
174	S_+0+0+0+0	131	3	left	D1	76.2	131-T1P	131	76.2	Comp.	236.6	M2	74.7	131	6.9	
175	S_+0+0+0+0	131	3	right	D1	79.9	131-T1P	131	79.9	Comp.	236.6	M2	92.0	131	3.9	
181	S_+0+0+0+0	131	4	right	D1	80.6	131-T1P	131	80.6	Comp.	236.6	M2	78.8	131	7.7	
184	S_+10+10+10+10	144	2	right	D1	72.5	115-T2Y	115	50.1	Comp.	195.1	M2	72.5	115	7.0	
188	S_-5-5-5-5	127	1	right	D1	76.1	g143-3P	127	76.1	Comp.	267.6	M2	76.3	127	1.2	
225	S_+0+0+0+0	131	4	right	D1	77.0	131-T1P	131	77.0	Comp.	236.6	M2	85.8	131	7.1	
		131	1	right	D1							M2				
228	S_+0+0+0+0	131	2	right	D1	71.7	131-T1P	131	71.7	Comp.	236.6	M2	71.7	131	6.3	
235	S_+0+0+0+0	131	4	left	D1	77.1	LY-131-T1P	131	77.1	Comp.	236.6	M2	87.9	131	4.4	
239	S_-5-5-5-5	127	1	left	D1	94.4	g143-4P	127	94.4	Comp.	267.6	M2	94.4	127	7.2	
241	S_-5-5-5-5	127	3	right	D1	85.3	g143-3P	127	85.3	Comp.	267.6	M2	87.8	127	4.1	
244	S_-5-5-5-5	118	1	left	D1	103.8	g143-2P	127	4.1	Comp.	162.3	M2	104.1	127	1.9	
245	S_+0+0+0+0	131	1	right	D1	72.4	LY-131-T1P	131	72.4	Comp.	236.6	M2	83.2	131	3.1	
247	S_-5-5-5-5	127	2	left	D1	96.3	g143-2P	127	96.3	Comp.	267.6	M2	99.1	127	7.5	
248	S_+5+5+5+5	136	4	right	D1	89.7	Fg143-4P	136	89.7	Comp.	240.0	M2	92.0	136	8.7	
249	S_+0+0+0+0	131	3	right	D1	72.5	LY-131-T1P	131	72.5	Comp.	236.6	M2	79.1	131	4.4	
251	S_+0+0+0+0	131	4	right	D1	73.3	LY-131-T1P	131	73.3	Comp.	236.6	M2	72.8	131	6.9	
255	S_+0+0+0+0	131	4	right	D1	88.5	131-T1P	131	88.5	Comp.	236.6	M2	87.8	131	8.2	
260	S_+10+10+10+10	144	3	left	D1	61.4	115-T2Y	115	41.5	Comp.	195.1	M2	57.2	115	5.6	
264	S_-5-5-5-5	127	1	right	D1	84.4	g143-3P	127	84.4	Comp.	267.6	M2	89.4	127	3.3	
271	S_+0+0+0+0	131	4	right	D1	78.2	131-T1P	131	78.2	Comp.	236.6	M2	76.4	131	7.0	
273	S_-5-5-5-5	127	3	right	D1	93.3	g143-1P	127	93.3	Comp.	267.6	M2	97.6	127	4.0	
276	S_+0+0+0+0	131	4	right	D1	60.1	131-T1P	131	60.1	Comp.	236.6	M2	57.3	131	5.2	
280	S_-5-5-5-5	118	1	right	D1	77.8	g143-3P	127	4.0	Comp.	162.3	M2	78.0	127	1.9	
		118	1	left	D1							M2				
284	S_-5-5-5-5	127	2	left	D1	90.2	g143-3P	127	90.2	Comp.	267.6	M2	91.7	127	4.5	
293	S_+5+5+5+5	136	1	right	D1	91.3	Fg143-3P	136	91.3	Comp.	240.0	M2	94.3	136	9.0	
		136	1	left	D1							M2				
299	S_+5+5+5+5	136	1	right	D1	84.7	Fg143-4P	136	84.7	Comp.	240.0	M2	91.5	136	5.0	
300	S_+0+0+0+0	131	3	right	D1	61.4	131-T1P	131	61.4	Comp.	236.6	M2	68.7	131	6.3	
		131	1	left	D1							M2				
303	S_+0+0+0+0	131	4	right	D1	69.1	LXY_131-T1P	131	69.1	Comp.	236.6	M2	73.8	131	7.3	
		131	2	left	D1							M2				
		131	4	left	D1							M2				
		131	3	left	D1							M2				
305	S_+0+0+0+0	131	1	right	D1	87.2	LY-131-T1P	131	87.2	Comp.	236.6	M2	98.7	131	5.0	
306	S_-5-5-5-5	127	2	right	D1	92.2	g143-2P	127	92.2	Comp.	267.6	M2	91.6	127	6.7	
308	S_-5-5-5-5	127	1	left	D1	91.7	g143-4P	127	91.7	Comp.	267.6	M2	91.7	127	6.8	
309	S_-5-5-5-5	127	4	right	D1	87.0	g143-3P	127	87.0	Comp.	267.6	M2	68.3	127	4.9	
		127	1	left	D1							M2				

NEWFOUNDLAND AND LABRADOR HYDRO
230KV TOWERS – DEFICIENCIES ANALYSIS OF LINES L23, L24, L23A, L24A
Appendix B – Structural Assessment Results - L23

L23	General Details						Analysis Results (before deficiency simulation)						Analysis Results (after deficiency simulation)				
Str. #	Tower Type & Extension		Deficient Member			Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed incorrectly D5: Missing bolt D6: Altered member	Max Tower Usage (%)	Max Tower Usage Member #		Defective Member Max Usage (%)	Defective Member Max Usage Mode (Comp./Tens.)	Defective Member KL/R	Deficiency Modeling M1: Remove member M2: Change to 0% Comp. Capacity (T-Only) M3: Change to 25% Comp. Capacity M4: Change to 50% Comp. Capacity M5: Change to 75% Comp. Capacity	Max. Tower Structure Usage (%)	Member # (Drawings) Governing Max Tower Usage	Max. Usage of Deficient Member (%)	Additional Remarks (notes, assumptions, discrepancies)
			ID # (Drawings)	Leg	Side			Tower Model	Drawings								
313	S_-5-5-5-5		127	2	left	D1	84.5	g143-1P	127	84.5	Comp.	267.6	M2	85.9	127	6.9	
			127	4	right	D1							M2				
			127	1	right	D2							M1			NA	
			127	4	left	D1							M2			6.9	
			127	1	left	D1							M2				
318	S_+0+0+0+0		131	1	right	D1	77.2	LY-131-T1P	131	77.2	Comp.	236.6	M2	89.3	131	8.8	
			131	4	left	D1							M2				
			131	2	left	D1							M2				
			131	1	left	D1							M2				
319	S_+0+0+0+0		131	3	right	D1	64.3	131-T1P	131	64.3	Comp.	236.6	M2	43.9	48	9.4	
			131	2	left	D1							M2				
			131	1	left	D1							M2				
			131	4	right	D1							M2				
320	S_+0+0+0+0		131	4	right	D1	70.2	131-T1P	131	70.2	Comp.	236.6	M2	53.1	131	10.3	
			131	1	right	D1							M2				
			131	3	left	D1							M2				
			131	3	right	D1							M2				
			131	2	left	D1							M2				
			131	1	left	D1							M2				
322	S_+0+0+0+0		131	4	left	D1	75.8	131-T1P	131	75.8	Comp.	236.6	M2	85.5	131	7.6	
			131	2	left	D1							M2				
			131	3	right	D1							M2				
323	T_+0+0+0+0	With guying	124	2	right	D1	120.0	g136X	63	92.0	Comp.	339.9	M2	120.0	63	44.4	Makeshift guying identified on tower. Analysis completed for structure both with and without guying.
			124	1	left	D1							M2			45.5	
			124	4	left	D1							M2			49.1	
		Without guying	124	2	right	D1	120.0	g136X	63	97.5	Comp.	339.9	M2	120.0	63	48.9	
			124	1	left	D1							M2				
			124	4	left	D1							M2				
324	T_+0+0+0+0		124	2	left	D1	116.6	g136P	63	99.9	Comp.	339.9	M2	116.6	63	46.2	
337	S_+0+0+0+0		131	1	right	D1	85.6	131-T1P	131	85.6	Comp.	236.6	M2	95.6	131	5.4	
340	S_-5-5-5-5		127	1	right	D1	91.2	g143-3P	127	91.2	Comp.	267.6	M2	92.1	127	4.1	
342	S_-5-5-5-5		127	1	right	D1	88.4	g143-3P	127	88.4	Comp.	267.6	M2	76.1	127	6.2	
			127	3	left	D1							M2				
			127	2	right	D2							M1			NA	
347	S_-5-5-5-5		127	1	right	D1	95.8	g143-1P	127	95.8	Comp.	267.6	M2	99.2	127	5.7	
			127	3	left	D1							M2			7.1	
349	S_+0+0+0+0	With guying	131	4	right	D1	84.7	131-T1P	131	84.7	Comp.	236.6	M2	73.5	131	8.7	Makeshift guying identified on tower. Analysis completed for structure both with and without guying.
			131	2	right	D1							M2				
		Without guying	131	4	right	D1	77.0	131-T1P	131	77.0	Comp.	236.6	M2	77.1	131	7.9	
			131	2	right	D1							M2				
350	S_+10+10+10+10		144	1	left	D1	71.5	115-T2P	115	49.8	Comp.	195.1	M2	71.5	115	7.8	
351	S_+0+0+0+0		131	1	right	D1	78.2	LY-131-T1P	131	78.2	Comp.	236.6	M2	73.5	131	9.4	
			131	3	left	D1							M2				
			131	1	left	D1							M2				
			131	3	right	D1							M2				
357	S_+0+0+0+0		131	4	right	D1	70.3	LX_131-T1P	131	70.3	Comp.	236.6	M2	70.3	131	6.7	
363	S_+0+0+0+0		131	3	left	D1	88.1	LY-131-T1P	131	88.1	Comp.	236.6	M2	65.6	131	15.1	
			131	3	right	D1							M2				
			131	2	left	D1							M2				
			131	4	left	D1							M2				
			131	4	right	D1							M2				
			131	1	left	D1							M2				
364	S_-5-5-5-5		127	4	left	D6	95.61	g143-3P	127	95.61	Comp.	267.60	M1	103.08	127	NA	Same member flagged as both altered and bent; removed.
			127	4	left	D1							M1				
367	S_-5-5-5-5		127	1	right	D3	90.30	g143-1P	127	90.30	Comp.	267.60	M1	97.14	127	NA	
369	S_+0+0+0+0		131	1	right	D1	71.9	131-T1P	131	71.9	Comp.	236.6	M2	75.5	131	3.7	
371	T_+0+0+0+0		124	3	right	D1	130.3	g136P	63	89.7	Comp.	339.9	M2	130.3	63	47.9	
			124	1	left	D1							M2			43.1	

L23	General Details					Analysis Results (before deficiency simulation)						Analysis Results (after deficiency simulation)				
Str. #	Tower Type & Extension	Deficient Member			Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed incorrectly D5: Missing bolt D6: Altered member	Max Tower Usage (%)	Max Tower Usage Member #		Defective Member Max Usage (%)	Defective Member Max Usage Mode (Comp./Tens.)	Defective Member KL/R	Deficiency Modeling M1: Remove member M2: Change to 0% Comp. Capacity (T-Only) M3: Change to 25% Comp. Capacity M4: Change to 50% Comp. Capacity M5: Change to 75% Comp. Capacity	Max. Tower Structure Usage (%)	Member # (Drawings) Governing Max Tower Usage	Max. Usage of Deficient Member (%)	Additional Remarks (notes, assumptions, discrepancies)
		ID # (Drawings)	Leg	Side			Tower Model	Drawings								
372	S_+10+10+10+10	144	3	right	D1	61.5	115-T2P	115	41.4	Comp.	195.1	M2	68.9	115	7.6	
		144	1	left	D1							M2				
374	S_+0+0+0+0	131	2	left	D1	81.7	LY-131-T1P	131	81.7	Comp.	236.6	M2	85.2	131	8.1	
		131	2	right	D1							M2				
381	S_+0+0+0+0	131	1	right	D1	85.2	LY-131-T1P	131	85.2	Comp.	236.6	M2	97.7	131	9.8	
		131	4	left	D1							M2				
382	S_+10+10+10+10	144	4	right	D1	75.3	115-T2Y	115	52.7	Comp.	195.1	M2	63.1	115	14.9	
		144	4	left	D1							M2				
		144	2	left	D1							M2				
		144	2	right	D1							M2				
		144	3	right	D1							M2				
		144	1	left	D1							M2				
		144	1	right	D1							M2				
		150	2	right	D1				9.6	Comp.	229.5	M2			2.1	
		150	2	left	D1							M2				
385	S_-5-5-5-5	127	4	right	D1	86.4	g143-4P	127	86.4	Comp.	267.6	M2	84.5	127	6.7	
388	S_+0+0+0+0	131	4	right	D1	72.1	131-T1P	131	72.1	Comp.	236.6	M2	68.1	131	5.4	
		131	1	left	D1							M2				
401	S_+0+0+0+0	131	1	right	D1	77.4	LY-131-T1P	131	77.4	Comp.	236.6	M2	82.0	131	7.7	
		131	3	left	D1							M2				
402	S_+0+0+0+0	131	2	right	D1	80.9	131-T1P	131	80.9	Comp.	236.6	M2	91.8	131	11.5	
		131	1	left	D1							M2				
		131	1	right	D1							M2				
		131	4	left	D1							M2				
		131	3	right	D1							M2				
405	S_+0+0+0+0	131	4	right	D1	81.7	LX_131-T1P	131	81.7	Comp.	236.6	M2	81.7	131	8.0	
		129	2	left	D1							M4			43.5	
407	C_+0+0+0+0 With guying	122	2	left	D1	90.8	g7XY	118	62.2	Comp.	189.4	M2	184.5	98	25.4	Makeshift guying identified on tower. Analysis completed for structure both with and without guying.
	C_+0+0+0+0 Without guying	122	2	left	D1	94.6	g7XY	118	64.8	Comp.	189.4	M2	181.9	98	26.5	
409	S_+5+5+5+5	136	1	left	D6	85.92	Fg143-3P	136	85.92	Comp.	240.00	M1	130.67	136	NA	
412	C_+0+0+0+0 With guying	123	1	left	D1	84.3	g7P	118	10.1	Comp.	169.5	M1	84.6	118	NA	Makeshift guying identified on tower. Analysis completed for structure both with and without guying.
		123	1	right	D1							M1				
		123	3	right	D1							M1				
		123	3	left	D1							M1				
		123	4	left	D1							M1				
		123	4	right	D1							M1				
		123	2	left	D1							M1				
		123	2	right	D1							M1				
	C_+0+0+0+0 Without guying	123	1	left	D1	88.3	g7P	118	7.5	Comp.	169.5	M1	88.5	118	NA	
		123	1	right	D1							M1				
		123	3	right	D1							M1				
		123	3	left	D1							M1				
		123	4	left	D1							M1				
		123	4	right	D1							M1				
		123	2	left	D1							M1				
		123	2	right	D1							M1				
418	T_+0+0+0+0	124	3	left	D1	117.0	g136P	63	96.3	Comp.	339.9	M2	117.0	63	44.8	
419	S_+0+0+0+0	131	3	left	D1	70.1	LY-131-T1P	131	70.1	Comp.	236.6	M2	67.4	131	5.8	
		131	3	right	D2							M1			NA	
420	S_+0+0+0+0	131	1	right	D1	75.3	LY-131-T1P	131	75.3	Comp.	236.6	M2	51.5	48	11.5	
		131	4	left	D1							M2				
		131	3	left	D1							M2				
		131	2	left	D1							M2				
		131	2	m	D1							M2				
		131	1	left	D1							M2				

NEWFOUNDLAND AND LABRADOR HYDRO
230KV TOWERS – DEFICIENCIES ANALYSIS OF LINES L23, L24, L23A, L24A
Appendix B – Structural Assessment Results - L23

L23	General Details					Analysis Results (before deficiency simulation)						Analysis Results (after deficiency simulation)				
Str. #	Tower Type & Extension	Deficient Member			Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed incorrectly D5: Missing bolt D6: Altered member	Max Tower Usage (%)	Max Tower Usage Member #		Defective Member Max Usage (%)	Defective Member Max Usage Mode (Comp./Tens.)	Defective Member KL/R	Deficiency Modeling M1: Remove member M2: Change to 0% Comp. Capacity (T-Only) M3: Change to 25% Comp. Capacity M4: Change to 50% Comp. Capacity M5: Change to 75% Comp. Capacity	Max. Tower Structure Usage (%)	Member # (Drawings) Governing Max Tower Usage	Max. Usage of Deficient Member (%)	Additional Remarks (notes, assumptions, discrepancies)
		ID # (Drawings)	Leg	Side			Tower Model	Drawings								
422	S_+0+0+0+0	131	4	right	D1	75.2	131-T1P	131	75.2	Comp.	236.6	M2	52.7	131	6.8	
		131	3	right	D1							M2				
		131	2	right	D1							M2				
		131	4	left	D1							M2				
423	T_+0+0+0+0	124	4	right	D1	123.0	g136P	63	99.0	Comp.	339.9	M2	123.1	63	77.0	
		124	2	left	D1							M2			78.2	
		124	1	right	D2							M1			NA	
		124	1	left	D2							M1				
424	S_+0+0+0+0	131	4	left	D1	72.8	LY-131-T1P	131	72.8	Comp.	236.6	M2	81.6	131	2.9	
426	S_+0+0+0+0	131	1	left	D1	75.0	LY-131-T1P	131	75.0	Comp.	236.6	M2	75.0	131	6.9	
427	S_+0+0+0+0	131	3	left	D1	75.0	131-T1P	131	75.0	Comp.	236.6	M2	82.8	131	7.6	
		131	1	right	D1							M2				
428	S_+0+0+0+0	131	4	right	D1	76.6	131-T1P	131	76.6	Comp.	236.6	M2	86.1	131	8.0	
		131	2	left	D1							M2				
429	S_+0+0+0+0	131	3	left	D1	72.9	LX_131-T1P	131	72.9	Comp.	236.6	M2	68.1	131	4.5	
		131	4	right	D2							M1			NA	
		131	3	right	D1							M2			4.5	
430	T_+0+0+0+0	124	3	left	D1	127.9	g136P	63	99.8	Comp.	339.9	M2	127.9	63	42.3	
		124	2	left	D1							M2			50.5	
		124	1	left	D1							M2			43.9	
432	T_+0+0+0+0	124	3	left	D1	131.1	g136P	63	100.0	Comp.	339.9	M2	131.1	63	44.1	
		124	1	right	D1							M2			50.7	
		124	1	left	D1							M2			43.0	
438	S_+0+0+0+0	131	2	left	D1	83.2	131-T1P	131	83.2	Comp.	236.6	M2	91.5	131	8.6	
		131	4	right	D1							M2				
442	S_+0+0+0+0	131	4	right	D1	67.0	LX_131-T1P	131	67.0	Comp.	236.6	M2	75.1	131	6.9	
		131	2	left	D1							M2				
450	S_+0+0+0+0	131	4	left	D1	80.5	131-T1P	131	80.5	Comp.	236.6	M2	90.5	131	4.9	
451	S_+0+0+0+0	131	4	left	D1	80.2	131-T1P	131	80.2	Comp.	236.6	M2	88.8	131	4.8	
458	S_+0+0+0+0	131	1	left	D1	78.0	LY-131-T1P	131	78.0	Comp.	236.6	M2	88.8	131	8.6	
		131	3	right	D1							M2				
474	S_+0+0+0+0	131	3	left	D1	71.8	131-T1P	131	71.8	Comp.	236.6	M2	67.8	131		
477	S_+0+0+0+0	131	4	right	D1	77.3	LY-131-T1P	131	77.3	Comp.	236.6	M2	74.7	131	6.6	
481	S_+10+10+10+10	144	1	right	D1	74.2	115-T2P	115	51.8	Comp.	195.1	M2	69.9	115	10.9	
		144	3	left	D1							M2				
		144	1	left	D1							M2				
490	S_+0+0+0+0	131	4	right	D1	74.7	LY-131-T1P	131	74.7	Comp.	236.6	M2	67.7	131	8.3	
		131	1	left	D1							M2				
		131	1	right	D1							M2				
		131	3	left	D1							M2				
494	S_+0+0+0+0	131	2	left	D2	75.21	LY-131-T1P	131	75.21	Comp.	236.57	M1	80.49	131	NA	
496	S_+0+0+0+0	131	1	left	D1	57.4	LY-131-T1P	131	57.4	Comp.	236.6	M2	57.4	131	5.4	
499	S_+0+0+0+0	131	4	left	D1	70.5	131-T1P	131	70.5	Comp.	236.6	M2	78.6	131	4.4	
503	S_+0+0+0+0	131	4	right	D1	74.3	LX_131-T1P	131	74.3	Comp.	236.6	M2	74.3	131	6.6	
504	S_+0+0+0+0	131	3	right	D1	62.0	LX_131-T1P	131	62.0	Comp.	236.6	M2	66.9	131	2.2	
517	S_+0+0+0+0	131	4	right	D1	80.7	131-T1P	131	80.7	Comp.	236.6	M2	79.0	131	7.2	
522	S_+0+0+0+0 With guying	131	1	left	D1	86.0	131-T1P	131	78.1	Comp.	236.6	M2	86.0	131	6.2	Makeshift guying identified on tower. Analysis completed for structure both with and without guying.
	S_+0+0+0+0 Without guying	131	1	left	D1	78.1	131-T1P	131	78.1	Comp.	236.6	M2	78.1	131	7.6	
549	S_-5-5-5-5	116	3	left	D1	87.3	g143-1P	127	2.9	Comp.	186.4	M2	87.4	127	0.9	
555	S_-5-5-5-5	127	4	right	D1	82.5	g143-1P	127	82.5	Comp.	267.6	M1	78.5	127	NA	
559	S_+5+5+5+5	136	4	right	D1	93.3	Fg143-2P	136	93.3	Comp.	240.0	M2	93.3	136	7.8	
566	S_-5-5-5-5	127	2	right	D1	73.9	g143-2P	127	73.9	Comp.	267.6	M2	72.6	127	4.8	
568	C_+10+10+10+10	140	3	left	D1	122.0	g82P	18	17.6	Comp.	223.3	M2	122.0	18	0.0	
570	A_+0+0+0+0	12	NA	NA	D1	59.0	g81Y	41	6.9	Tens.	166.3	M2	59.0	41	6.7	

NEWFOUNDLAND AND LABRADOR HYDRO
230KV TOWERS – DEFICIENCIES ANALYSIS OF LINES L23, L24, L23A, L24A
Appendix B – Structural Assessment Results - L24

L24	General Details						Analysis Results (before deficiency simulation)						Analysis Results (after deficiency simulation)				
Str. #	Tower Type & Extension		Deficient Member			Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed incorrectly D5: Missing bolt D6: Altered member D7: Loose nuts	Max Tower Usage (%)	Max Tower Usage Member #		Defective Member Max Usage (%)	Defective Member Max Usage Mode (Comp./Tens.)	Defective Member KL/R	Deficiency Modeling M1: Remove member M2: Change to 0% Comp. Capacity (T-Only) M3: Change to 25% Comp. Capacity M4: Change to 50% Comp. Capacity M5: Change to 75% Comp. Capacity	Max. Tower Structure Usage (%)	Member # (Drawings) Governing Max Tower Usage	Maximum Usage of Deficient Member (%)	Additional Remarks (notes, assumptions, discrepancies)
			ID # (Drawings)	Leg	Side			Tower Model	Drawings								
4	H_+20+20+20+20	With guying	125	1	right	D1	155.8	198XY	198	50.0	Comp	151.2	M2	222.8	132	40.3	Makeshift guying identified on tower. Analysis completed for structure both with and without guying.
			124	1	right	D1				17.1	Comp	153.7	M2			4.3	
			107	3	right	D1				148.5	Tension	128.4	M2			54.5	
			106	1	left	D1							M2				
		Without guying	125	1	right	D1	155.8	198XY	198	50.3	Comp	151.2	M2	223.6	132	39.9	
			124	1	right	D1				17.1	Comp	153.7	M2			4.3	
			107	3	right	D1				149.4	Tension	128.4	M2			54.3	
			106	1	left	D1							M2				
10	BB_+10+10+10+10		277	4	Left	D1	66.6	103Y	103	33.0	comp	128.5	M2	67.7	103	12.5	
			277	1	right	D1							M2				
24	BB_+0+0+0+0		227	2	left	D1	71.9	103Y	103	33.8	Comp	175.0	M2	71.9	103	19.9	
			227	1	right	D1							M2				
			227	1	left	D1							M2				
			232	1	right	D1							M2			1.3	
29	BB_+5+5+5+5		252	2	Left	D1	64.2	103P	103	31.2	Comp	160.8	M2	64.2	103	12.8	
33	BB_+20+20+20+20		63	2	Right	D1	53.8	95-1XY	95	3.5	Comp	165.2	M2	53.8	95	2.1	
35	BB_+0+0+0+0		228	3	Left	D1	61.7	103P	103	29.8	Comp	175.0	M2	61.3	103	21.0	
			228	3	Right	D1											
36	BB_-5-5-5-5		228	2	Right	D1	57.1	103Y	103	23.8	Comp	161.4	M2	57.1	103	10.9	
40	BB_-5-5-5-5		236	4	Left	D1	70.7	103P	103	26.2	Comp	161.4	M2	71.6	103	11.3	
			237	3	Right	D1											
51	BB_+5+5+5+5		253	2	Right	D1	70.2	103Y	103	35.7	Comp	160.8	M2	69.9	103	23.4	
			252	4	Left	D1											
57	BB_+5+5+5+5		252	3	Left	D1	71.2	103Y	103	34.1	Comp	160.8	M2	70.9	103	2.0	
			253	2	Right	D1											
			253	1	Left	D1											
67	BB_+0+0+0+0		75	2	Left	D5	74.5	103Y	103	3.8	Comp	170.7	M1	74.5	103	-	
73	BB_+0+0+0+0		75	1	Right	D2	70.6	103P	103	3.6	Comp	170.7	M1	76.2	103	-	
			227	4	left	D1				32.2	Comp	175.0	M2			20.7	
75	BB_+0+0+0+0		228	3	Right	D1	70.4	103Y	103	33.7	Comp	175.0	M2	71.6	103	18.9	
81	BB_+5+5+5+5		257	4	Right	D1	68.3	103Y	103	7.5	Comp	234.5	M2	68.3	103	1.9	
93	BB_+5+5+5+5		252	2	left	D1	67.3	103Y	103	31.5	Comp	160.8	M2	67.3	103	13.6	
100	BB_+5+5+5+5		252	4	Right	D1	69.3	103XY	103	NA	NA	NA	NA	NA	NA	NA	Tower inspection not completed properly; no post-deficiency analysis results available. Exact deficient member could not be captured.
107	BB_-5-5-5-5		234	2	left	D1	51.1	103P	103	0.2	Tension	172.2	M2	51.1	103	0.2	
			234	2	Right	D1											
117	BB_+0+0+0+0		227	3	left	D1	68.7	103Y	103	30.8	Comp	175.0	M2	68.7	103	12.1	
121	EE_-5-5-5-5		175	1	Center	D1	136.9	102-3XY	102	79.8	Comp	146.5	M2	136.9	102	5.7	
129	BB_+10+10+10+10		278	4	Right	D1	64.1	103Y	103	30.7	Comp	128.5	M2	63.8	103	4.7	
			277	1	left	D1											
130	EE_+5+5+5+5		101	NA	NA	D1	128.5	78XY	78	84.2	Comp	88.0	M4	167.8	101	167.8	
131	BB_+0+0+0+0		228	2	right	D1	63.4	103P	103	27.8	Comp	175.0	M2	82.2	226	27.5	
			228	3	right	D1											
			228	1	left	D1											
			228	1	right	D1											
			228	4	Left	D1											
			231	4	right	D6				3.0	Comp	230.9	M1			0.5	
			231	4	left	D6											
134	BB_-5-5-5-5		236	2	left	D1	55.3	103P	103	22.0	Comp	161.4	M2	57.3	103	8.3	
			75	2	center	D1				2.4	Comp	170.7	M2			1.3	
			75	4	center	D1											
			75	3	center	D1											
			75	1	center	D3							M1			-	
137	BB_+0+0+0+0		228	2	Left	D1	60.4	103Y	103	29.2	Comp	175.0	M2	60.4	103	18.6	
151	BB_+0+0+0+0		226	1	center	D1	49.1	103P	103	40.7	Comp	112.6	M4	83.8	226	83.8	
			227	1	left	D1				23.4	Comp	175.0	M2			22.0	
			228	1	right	D1											
			227	3	left	D1											
			228	3	right	D1											

L24	General Details					Analysis Results (before deficiency simulation)						Analysis Results (after deficiency simulation)				
Str. #	Tower Type & Extension	Deficient Member			Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed incorrectly D5: Missing bolt D6: Altered member D7: Loose nuts	Max Tower Usage (%)	Max Tower Usage Member #		Defective Member Max Usage (%)	Defective Member Max Usage Mode (Comp./Tens.)	Defective Member KL/R	Deficiency Modeling M1: Remove member M2: Change to 0% Comp. Capacity (T-Only) M3: Change to 25% Comp. Capacity M4: Change to 50% Comp. Capacity M5: Change to 75% Comp. Capacity	Max. Tower Structure Usage (%)	Member # (Drawings) Governing Max Tower Usage	Maximum Usage of Deficient Member (%)	Additional Remarks (notes, assumptions, discrepancies)
		ID # (Drawings)	Leg	Side			Tower Model	Drawings								
169	BB_+10+10+10+10	277	1	left	D1	65.4	103Y	103	32.9	Comp	128.5	M2	65.0	103	25.6	
		278	4	right	D1											
		295	1	right	D1				3.5	Comp	164.1					
		277	3	left	D1				32.9	Comp	128.5					
171	BB_-5-5-5-5	237	4	right	D1	65.3	103Y	103	25.5	Comp	161.4	M2	65.0	103	9.8	
176	BB_+5+5+5+5	253	1	left	D1	80.0	103P	103	36.2	Comp	160.8	M2	79.9	103	9.7	
186	EE_+0+0+0+0	199	2	left	D1	102.1	78XY	78	84.9	Tension	130.0	M2	134.0	199	120.7	
		200	1	right	D1										72.6	
		199	1	left	D1										134.0	
		200	3	right	D1										55.9	
222	BB_+0+0+0+0	227	2	left	D1	67.1	103Y	103	31.4	Comp	175.0	M2	67.2	103	18.1	
		227	3	left	D1											
231	BB_+20+20+20+20	53	1	right	D1	56.2	20-3Y	20	45.2	Comp	151.0	M2	75.0	26	28.1	
235	BB_-5-5-5-5	236	3	Left	D1	63.7	103P	103	25.8	Comp	161.4	M2	63.9	103	18.4	
		237	1	right	D1											
236	BB_+0+0+0+0	227	2	Left	D1	65.2	103XY	103	33.2	Comp	175.0	M2	66.3	103	16.3	
247	BB_+5+5+5+5	252	1	Left	D1	69.2	103P	103	34.3	Comp	160.8	M2	69.0	103	6.8	
278	BB_+5+5+5+5	252	2	Left	D1	58.5	103P	103	27.7	Comp	160.8	M2	58.5	103	11.8	
281	BB_+0+0+0+0	75	1	center	D3	67.5	103P	103	3.4	Comp	170.7	M1	67.6	103	-	
		75	2	center	D3										-	
		75	3	center	D3										-	
		75	4	center	D3										-	
285	BB_-5-5-5-5	237	1	right	D1	67.7	103Y	103	27.2	Comp	161.4	M2	67.7	103	13.1	
		234	4	right	D1				0.2	Tension	172.2	M2			0.2	
		235	4	left	D1				53.8	Comp	112.6	M5			67.4	
290	BB_+10+10+10+10	278	2	right	D1	64.1	103P	103	31.1	Comp	128.5	M2	64.1	103	11.9	
291	BB_+10+10+10+10	278	3	right	D1	74.0	103Y	103	36.5	Comp	128.5	M2	75.7	103	20.4	
294	BB_+0+0+0+0	227	3	left	D1	72.4	103Y	103	33.2	Comp	175.0	M2	72.4	103	21.6	
		227	4	left	D1											
306	BB_-5-5-5-5	23	2	left	D7	77.2	103P	103	19.1	Comp	140.3	M1	77.6	103	-	
320	BB_+10+10+10+10	277	4	left	D1	72.7	103Y	103	32.0	Comp	128.5	M2	72.6	103	17.7	
		277	1	left	D1											
329	BB_+10+10+10+10	277	2	left	D1	79.7	103P	103	37.6	Comp	128.5	M2	79.7	103	16.7	
		278	3	right	D1											
334	BB_+10+10+10+10	277	4	left	D1	63.3	103Y	103	32.6	Comp	128.5	M2	63.8	103	18.9	
336	BB_+20+20+20+20	52	1	right	D1	70.6	95-1X	95	50.5	Comp	151.0	M2	83.7	26	29.7	
337	BB_+5+5+5+5	252	1	left	D1	57.2	103P	103	28.6	Comp	160.3	M2	57.1	103	7.2	
		253	2	right	D1											
338	BB_+5+5+5+5	253	3	right	D1	68.6	103Y	103	34.2	Comp	160.3	M2	79.0	26	27.4	
		252	2	left	D1											
		253	1	right	D1											
		252	1	left	D1											
344	BB_-5-5-5-5	75	4	center	D3	53.3	103Y	103	2.4	Comp	170.7	M1	53.3	103	-	
		75	3	center	D3										-	
		75	2	center	D3										-	
		75	1	center	D3										-	
347	BB_+5+5+5+5	253	1	right	D1	68.5	103P	103	32.8	Comp	160.3	M2	82.7	26	29.2	
		252	3	left	D1											
		252	1	left	D1											
		252	2	left	D1											
		253	3	right	D1											
349	BB_+15+15+15+15	253	1	right	D1	60.8	95-1X	95	NA	NA	NA	NA	NA	NA	NA	Tower inspection not completed properly; no post-deficiency analysis results available. Exact deficient member could not be captured.
		253	4	right	D1											
		252	3	left	D1											
		312	1	left	D1											
351	BB_+5+5+5+5	253	3	right	D1	72.1	103Y	103	34.3	Comp	160.3	M2	84.7	26	27.2	
		252	2	left	D1											
		253	2	right	D1											
		252	1	left	D1											
		253	1	right	D1											
		253	4	right	D1											
362	BB_+5+5+5+5	252	4	left	D1	78.6	103Y	103	36.7	Comp	160.3	M2	80.7	103	15.4	
		252	3	left	D1											

NEWFOUNDLAND AND LABRADOR HYDRO
230KV TOWERS – DEFICIENCIES ANALYSIS OF LINES L23, L24, L23A, L24A
Appendix B – Structural Assessment Results - L24

L24	General Details					Analysis Results (before deficiency simulation)						Analysis Results (after deficiency simulation)				
Str. #	Tower Type & Extension	Deficient Member			Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed incorrectly D5: Missing bolt D6: Altered member D7: Loose nuts	Max Tower Usage (%)	Max Tower Usage Member #		Defective Member Max Usage (%)	Defective Member Max Usage Mode (Comp./Tens.)	Defective Member KL/R	Deficiency Modeling M1: Remove member M2: Change to 0% Comp. Capacity (T-Only) M3: Change to 25% Comp. Capacity M4: Change to 50% Comp. Capacity M5: Change to 75% Comp. Capacity	Max. Tower Structure Usage (%)	Member # (Drawings) Governing Max Tower Usage	Maximum Usage of Deficient Member (%)	Additional Remarks (notes, assumptions, discrepancies)
		ID # (Drawings)	Leg	Side			Tower Model	Drawings								
364	BB_-5-5-5-5	237	3	right	D1	71.6	103Y	103	28.4	Comp	161.4	M2	72.6	103	13.8	
		236	4	left	D1											
371	BB_-5-5-5-5	237	2	right	D1	66.0	103P	103	25.1	Comp	161.4	M2	66.8	103	14.8	
		237	3	right	D1											
		237	4	right	D1											
		236	4	left	D1											
377	BB_+0+0+0+0	228	1	right	D1	70.9	103Y	103	32.8	Comp	175.0	M2	70.4	103	20.9	
		228	4	right	D1											
378	BB_+0+0+0+0	227	3	left	D1	71.8	103Y	103	32.5	Comp	175.0	M2	71.9	103	15.2	
379	BB_+10+10+10+10	277	3	left	D1	84.5	103P	103	39.3	Comp	128.5	M2	113.8	26	21.5	
		278	2	right	D1										24.1	
		277	2	left	D1										48.1	
		278	4	right	D1										18.1	
		277	4	left	D1										47.7	
		277	1	left	D1										18.7	
		278	3	right	D1										48.9	
		278	1	right	D1										48.3	
380	BB_-5-5-5-5	75	2	center	D3	72.5	103P	103	3.1	Comp	170.7	M1	72.5	103	-	
		75	1	center	D3											
		75	3	center	D3											
		75	4	center	D3											
387	BB_-5-5-5-5	75	1	center	D3	76.9	103P	103	3.0	Comp	170.7	M1	77.0	103	-	
		75	4	center	D3											
		75	3	center	D3											
		75	2	center	D3											
390	BB_+10+10+10+10	278	3	right	D1	76.2	103P	103	35.9	Comp	128.5	M2	76.1	103	22.0	
394	BB_+0+0+0+0	227	3	left	D1	71.9	103Y	103	33.5	Comp	175.0	M2	71.9	103	15.1	
395	BB_+10+10+10+10	278	4	right	D1	69.4	103Y	103	34.4	Comp	112.6	M2	69.0	103	13.2	
399	BB_-5-5-5-5	236	4	left	D1	63.2	103P	103	24.4	Comp	161.4	M2	64.0	103	12.8	
		234	1	left	D3				-	-	-	M1			-	
		234	2	right	D3											
404	BB_+10+10+10+10	278	1	right	D1	70.3	103Y	103	32.5	Comp	128.5	M2	70.3	103	21.1	
406	BB_+10+10+10+10	277	1	left	D1	68.5	103P	103	32.7	Comp	128.5	M2	92.7	26	40.7	
		278	1	right	D1											
		278	3	right	D1											
		277	2	left	D1											
		278	2	right	D1											
		277	4	left	D1											
		278	4	right	D1											
		277	3	left	D1											
410	HH_-5-5-5-5 — With Guying	23	4	right	D1	97.0	232-2XY	232	65.2	Comp	134.5	M2	97.0	232	0.9	Makeshift guying identified on tower. Analysis completed for structure both with and without guying.
		22	3	left	D1											
		23	3	right	D1											
	Without Guying	23	4	right	D1	97.0	232-2XY	232	65.2	Comp	134.5	M2	97.0	232	0.9	
		22	3	left	D1											
		23	3	right	D1											
412	BB_+5+5+5+5	258	1	left	D1	54.3	103P	103	2.9	Comp	191.1	M2	54.3	103	0.0	
415	EE_-5-5-5-5	201	4	right	D2	153.7	102-2X	102	93.9	Comp	130.0	M2	153.8	102	116.7	
		201	4	left	D1											
		201	1	right	D1											
		201	2	right	D1											
		207	1	right	D1				1.3	Comp	175.6				1.6	
		207	1	left	D1											
		207	2	left	D1											
		207	4	left	D1											
		175	3	center	D1				16.7	Comp	177.7				14.4	

NEWFOUNDLAND AND LABRADOR HYDRO
230KV TOWERS – DEFICIENCIES ANALYSIS OF LINES L23, L24, L23A, L24A
Appendix B – Structural Assessment Results - L24

L24	General Details					Analysis Results (before deficiency simulation)						Analysis Results (after deficiency simulation)				
Str. #	Tower Type & Extension	Deficient Member			Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed incorrectly D5: Missing bolt D6: Altered member D7: Loose nuts	Max Tower Usage (%)	Max Tower Usage Member #		Defective Member Max Usage (%)	Defective Member Max Usage Mode (Comp./Tens.)	Defective Member KL/R	Deficiency Modeling M1: Remove member M2: Change to 0% Comp. Capacity (T-Only) M3: Change to 25% Comp. Capacity M4: Change to 50% Comp. Capacity M5: Change to 75% Comp. Capacity	Max. Tower Structure Usage (%)	Member # (Drawings) Governing Max Tower Usage	Maximum Usage of Deficient Member (%)	Additional Remarks (notes, assumptions, discrepancies)
		ID # (Drawings)	Leg	Side			Tower Model	Drawings								
416	EE_-5-5-5-5	202	4	right	D1	134.3	102-2X	102	90.5	Comp	130.0	M2	163.1	102	157.4	
		208	4	right	D1				1.2	Comp	175.6				1.2	
		201	4	left	D1				90.5	`	130.0				92.4	
		201	3	left	D1										83.1	
		208	3	right	D1				1.2	Comp	175.6				1.2	
		202	3	right	D1				90.5	Comp	130.0				98.0	
		201	2	left	D1										94.7	
		207	2	left	D1				1.2	Comp	175.6				1.4	
		202	2	right	D1				90.5	Comp	130.0				163.1	
		201	1	left	D1										86.1	
		202	1	right	D6							M1			-	
417	BB_-5-5-5-5	235	3	center	D1	58.7	103P	103	47.8	Comp	112.6	M4	95.7	235	95.7	
		237	1	right	D2				-	-	-	M1			-	
		237	3	right	D1				21.2	Comp	161.4	M2			14.0	
		236	4	right	D1											
418	BB_+0+0+0+0	228	1	right	D1	67.3	103Y	103	30.6	Comp	175.0	M2	115.4	226	21.8	
		228	4	right	D1										8.1	
		226	3	center	D1				55.4	Comp	112.6	M4			115.4	
		227	3	left	D1				30.6	Comp	175.0	M2			25.9	
419	BB_-5-5-5-5	236	2	left	D1	61.2	103XY	103	23.5	Comp	161.4	M2	62.0	103	6.2	
		233	3	left	D6				0.2	Tension	172.2	M1			-	
		233	4	left	D1							M2			0.4	
		236	3	left	D1				23.5	Comp	161.4				6.2	
420	BB_+5+5+5+5	252	3	left	D1	63.0	103Y	103	30.4	Comp	160.3	M2	70.3	26	25.3	
		253	3	right	D1											
		252	2	left	D1											
		253	2	right	D1											
		252	1	left	D1											
		253	1	right	D1											
		252	4	left	D1											
		253	4	right	D1											
421	EE_-5-5-5-5	201	3	left	D1	142.1	102-2X	102	87.3	Comp	130.0	M2	223.6	102	44.3	
		201	1	left	D1										84.2	
		202	1	right	D6							M1			-	
		202	2	right	D6										-	
422	BB_+0+0+0+0	227	1	left	D1	64.3	103P	103	27.4	Comp	175.0	M2	64.2	103	15.0	
		228	1	right	D1											
		228	2	right	D1											
		227	2	left	D1											
423	BB_+0+0+0+0	227	2	left	D1	65.5	103P	103	28.5	Comp	175.0	M2	65.1	103	38.5	
		228	2	right	D1											
		227	3	left	D1											
		228	3	right	D1											
		227	1	left	D1											
		75	4	center	D1				3.2	Comp	170.7				6.9	
424	BB_+5+5+5+5	252	1	left	D1	69.4	103P	103	31.7	Comp	160.3	M2	69.1	103	8.3	
425	BB_-5-5-5-5	234	3	right	D1	64.5	103XY	103	0.2	Tension	172.2	M2	64.6	103	0.1	
		233	2	left	D1											
426	BB_-5-5-5-5	75	1	center	D3	64.0	103Y	103	2.5	Comp	170.7	M1	64.2	103	-	
		75	2	center	D3										-	
		75	3	center	D3										-	
		75	4	center	D3										-	
427	BB_-5-5-5-5	237	1	right	D1	61.5	103Y	103	NA	NA	NA	NA	NA	NA	NA	Tower inspection not completed properly; no post-deficiency analysis results available.
		237	4	right	D1											
		236	3	left	D1											
		236	2	left	D1											
		237	2	right	D1											

NEWFOUNDLAND AND LABRADOR HYDRO
230KV TOWERS – DEFICIENCIES ANALYSIS OF LINES L23, L24, L23A, L24A
Appendix B – Structural Assessment Results - L24

L24	General Details						Analysis Results (before deficiency simulation)						Analysis Results (after deficiency simulation)				
Str. #	Tower Type & Extension		Deficient Member			Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed incorrectly D5: Missing bolt D6: Altered member D7: Loose nuts	Max Tower Usage (%)	Max Tower Usage Member #		Defective Member Max Usage (%)	Defective Member Max Usage Mode (Comp./Tens.)	Defective Member KL/R	Deficiency Modeling M1: Remove member M2: Change to 0% Comp. Capacity (T-Only) M3: Change to 25% Comp. Capacity M4: Change to 50% Comp. Capacity M5: Change to 75% Comp. Capacity	Max. Tower Structure Usage (%)	Member # (Drawings) Governing Max Tower Usage	Maximum Usage of Deficient Member (%)	Additional Remarks (notes, assumptions, discrepancies)
			ID # (Drawings)	Leg	Side			Tower Model	Drawings								
428	EE_-5-5-5-5	With guying	201	2	left	D2	144.0	102-2P	102	89.7	Comp	130.0	M1	266.6	201	-	Makeshift guying identified on tower. Analysis completed for structure both with and without guying.
			207	2	left	D1				1.4	Comp	175.6	M1			-	
			202	4	right	D2				89.7	Comp	130.0	M1			-	
			208	4	right	D1				1.4	Comp	175.6	M1			-	
			207	4	left	D2				1.4	Comp	175.6	M1			-	
			202	3	right	D1				89.7	Comp	130.0	M2			133.7	
			201	3	left	D1										117.4	
			207	3	left	D1				1.4	Comp	175.6				5.7	
			208	3	right	D1										8.1	
			207	2	left	D2				1.4	Comp	175.6	M1			-	
			208	2	right	D2				1.4	Comp	175.6				-	
			202	2	right	D1				89.7	Comp	130.0	M1			-	
			175	3	center	D1				17.0	Comp	146.5	M2			0.7	
			175	2	center	D1										3.1	
			207	1	left	D2				1.4	Comp	175.6	M1			-	
			208	1	right	D1				1.4	Comp	175.6	M2			1.3	
		Without guying	201	2	left	D2	144.1	102-2P	102	90.0	Comp	130.0	M1	266.0	201	-	
			207	2	left	D1				1.4	Comp	175.6	M1			-	
			202	4	right	D2				90.0	Comp	130.0	M1			-	
			208	4	right	D1				1.4	Comp	175.6	M1			-	
			207	4	left	D2				1.4	Comp	175.6	M1			-	
			202	3	right	D1				90.0	Comp	130.0	M2			134.0	
			201	3	left	D1										117.4	
			207	3	left	D1				1.4	Comp	175.6				1.2	
			208	3	right	D1										1.1	
			207	2	left	D2				1.4	Comp	175.6	M1			-	
			208	2	right	D2				1.4	Comp	175.6				-	
			202	2	right	D1				90.0	Comp	130.0	M1			-	
			175	3	center	D1				82.2	Comp	146.5	M2			0.8	
			175	2	center	D1										0.8	
			207	1	left	D2				1.4	Comp	175.6	M1			-	
			208	1	right	D1				1.4	Comp	175.6	M2			1.3	
429	BB_+5+5+5+5		252	1	left	D1	63.2	103Y	103	27.9	Comp	160.3	M2	63.9	103	6.2	
430	EE_-5-5-5-5		201	1	left	D1	146.5	102-2P	102	89.9	Comp	130.0	M2	146.5	102	43.5	
431	BB_+5+5+5+5		252	3	left	D1	61.7	103Y	103	29.3	Comp	160.3	M2	63.2	103	10.1	
			252	4	left	D1											
435	BB_+0+0+0+0		75	1	center	D1	69.8	103Y	103	3.6	Comp	170.7	M2	70.0	103	0.0	
443	BB_-5-5-5-5		75	1	center	D3	64.8	103P	103	2.5	Comp	170.7	M1	64.9	103	-	
			75	2	center	D3										-	
			75	3	center	D3										-	
			75	4	center	D3										-	
461	BB_+0+0+0+0		228	1	right	D1	62.7	103P	103	28.9	Comp	175.0	M2	62.7	103	14.3	
469	BB_-5-5-5-5		75	2	center	D3	60.1	103Y	103	2.3	Comp	170.7	M1	60.1	103	-	
			75	3	center	D3										-	
			75	4	center	D3										-	
			75	1	center	D3										-	
479	BB_-5-5-5-5		75	4	center	D3	67.6	103Y	103	2.7	Comp	170.7	M1	67.7	103	-	
			75	1	center	D3										-	
			75	2	center	D3										-	
			75	3	center	D3										-	
513	BB_+0+0+0+0		227	3	left	D1	46.5	103P	103	23.7	Comp	175.0	M2	46.4	103	13.8	
			228	3	right	D1											
529	BB_-5-5-5-5		75	1	center	D3	63.4	103Y	103	2.5	Comp	170.7	M1	63.4	103	-	
			75	2	center	D3										-	
			75	3	center	D3										-	
			75	4	center	D3										-	

NEWFOUNDLAND AND LABRADOR HYDRO
230KV TOWERS – DEFICIENCIES ANALYSIS OF LINES L23, L24, L23A, L24A
Appendix B – Structural Assessment Results - L23A, L24A

L23A & L24A		General Details					Analysis Results (before deficiency simulation)						Analysis Results (after deficiency simulation)				
Circuit #	Str. #	Tower Type & Extension	Deficient Member			Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed incorrectly D5: Missing bolt D6: Altered member	Max Tower Usage (%)	Max Tower Usage Member #		Defective Member Max Usage (%)	Defective Member Max Usage Mode (Comp./Tens.)	Defective Member KL/R	Deficiency Modeling M1: Remove member M2: Change to 0% Comp. Capacity (T-Only) M3: Change to 25% Comp. Capacity M4: Change to 50% Comp. Capacity M5: Change to 75% Comp. Capacity	Max. Tower Structure Usage (%)	Member # (Drawings) Governing Max Tower Usage	Maximum Usage of Deficient Member (%)	Additional Remarks (notes, assumptions, discrepancies)
			ID # (Drawings)	Leg	Side			Tower Model	Drawings								
L23A	2	RT-0_+5+5+5+5	167	2	left	D1	107.7	g39P	140	99.7	Comp.	320.0	M2	107.7	140	72.9	
L23A	3	RT-0_+20+20+20+20	15	NA	NA	D1	97.2	g39Y	140	52.2	Comp.	82.1	M4	98.8	15	98.8	
L24A	2	RT-0_+5+5+5+5	171	4	right	D6	116.1	g39P	140	15.9	Comp.	147.9	M1	116.2	140	NA	
L24A	3	RT-0_+20+20+10+10	175	4	right	D1	110.6	175-L2XY_P	175	110.6	Comp.	294.9	M2	110.4	175	68.6	
L24A	4	RT-0_+5+5+5+0	161	4	left	D1	161.1	g39X	140	104.0	Tens.	249.3	M2	161.1	140	104.0	
L24A	7	RT-DE-70_+0+0+0+0	54	NA	NA	D1	88.2	37-2Y	37	19.0	Tens.	160.8	M2	88.2	37	17.6	
L24A	63	GV-0	148	NA	NA	D1	46.4	106P	E106	0.2	Tens.	111.9	M2	46.4	E106	0.2	

Appendix C – Remedy/Repair Priorities

NEWFOUNDLAND AND LABRADOR HYDRO
230KV TOWERS – DEFICIENCIES ANALYSIS OF LINES L23, L24, L23A, L24A
Appendix C – Remedy/Repair Priorities - L23

L23	Tower Type & Extension	Max. Tower Usage (%)		Max. Tower Usage Jump (%)	Maximum Combined Axial + Bending Member Usage (%) (*)		Maximum Combined Axial + Bending Member Usage Jump (%)	Jump Index: J0: no increase; J1: 0-5% increase; J2: 5-10% increase; J3: 10-15% increase; J4: 15-20% increase; J5: >20% increase	Priority Index: P1: max usage > 100% or non-susp. Str.; P2: max usage 95-100%, or J5; P3: max usage 90-95%, or J4; P4: J3; P5: J2; P6: J1; P7: J0
Str. #		(pre-deficiency)	(post-deficiency)		(pre-deficiency)	(post-deficiency)			
5	A_+0+0+0+0	63.0	62.9	-	113.5	113.6	0.1	J1	P6
9	S_+0+0+0+0	73.6	55.0	-	-	64.4	-	J0	P7
13	S_+0+0+0+0	71.7	63.1	-	-	70.8	-	J0	P7
15	S_+0+0+0+0	75.1	86.1	11.1	-	68.4	-	J3	P4
17	S_+5+5+5+5	93.9	104.3	10.4	80.2	80.2	0.0	J3	P1
18	S_+5+5+5+5	95.2	86.7	-	-	79.5	-	J0	P2
21	S_+0+0+0+0	83.7	86.1	2.4	-	82.9	-	J1	P6
22	S_+5+5+5+5	89.1	103.1	14.0	74.2	74.2	0.0	J3	P1
23	S_+0+0+0+0	77.7	75.6	-	-	71.7	-	J0	P7
25	S_+0+0+0+0	84.9	84.0	-	-	87.6	-	J0	P7
32	S_+5+5+5+5	99.5	115.6	16.0	93.9	93.9	0.0	J4	P1
38	S_+0+0+0+0	74.6	74.7	0.1	-	69.3	-	J1	P6
44	S_+5+5+5+5	87.8	85.5	-	-	79.4	-	J0	P7
49	S_+0+0+0+0	78.8	77.9	-	-	71.6	-	J0	P7
54	S_+0+0+0+0	76.4	87.0	10.6	-	77.6	-	J3	P4
62	S_+0+0+0+0	77.3	87.1	9.8	-	74.6	-	J2	P5
63	S_+0+0+0+0	79.3	82.7	3.4	-	77.2	-	J1	P6
75	S_+0+0+0+0	79.5	90.9	11.4	-	78.1	-	J3	P3
79	S_+0+0+0+0	82.0	93.5	11.5	-	92.3	-	J3	P3
90	S_+0+0+0+0	77.6	88.7	11.0	-	70.1	-	J3	P4
94	S_+0+0+0+0	68.8	68.2	-	-	46.7	-	J0	P7
95	S_+0+0+0+0	151.0	167.0	15.9	57.5	57.5	0.0	J4	P1
96	S_-5-5-5-5	74.4	46.8	-	-	54.7	-	J0	P7
100	S_+0+0+0+0	80.9	76.2	-	-	77.5	-	J0	P7
101	S_+5+5+5+5	98.2	106.5	8.3	92.2	92.7	0.5	J2	P1
104	S_+15+15+15+15	78.4	72.6	-	-	69.9	-	J0	P7
109	T_+0+0+0+0	123.6	123.6	0.0	71.0	71.0	0.0	J0	P1
113	S_+0+0+0+0	86.0	86.0	0.0	-	79.7	-	J0	P7
114	S_-5-5-5-5	88.0	92.0	4.0	-	66.9	-	J1	P3
116	S_+0+0+0+0	83.8	83.8	0.0	-	83.0	-	J0	P7
117	S_+0+0+0+0	80.9	76.1	-	-	78.7	-	J0	P7
134	S_+0+0+0+0	74.7	85.3	10.5	-	69.6	-	J3	P4
151	S_+0+0+0+0	63.4	63.4	0.0	-	54.9	-	J0	P7
168	S_+0+0+0+0	71.6	71.6	0.0	-	61.5	-	J0	P7
169	S_+0+0+0+0	73.2	73.2	0.0	-	68.0	-	J0	P7
171	S_-5-5-5-5	87.3	87.3	0.0	-	69.1	-	J0	P7
172	S_+0+0+0+0	79.4	88.1	8.7	-	75.2	-	J2	P5
173	S_+5+5+5+5	95.2	109.4	14.2	95.5	95.5	0.0	J3	P1
174	S_+0+0+0+0	76.2	74.7	-	-	68.5	-	J0	P7
175	S_+0+0+0+0	79.9	92.0	12.2	-	77.6	-	J3	P3
181	S_+0+0+0+0	80.6	78.8	-	-	73.3	-	J0	P7
184	S_+10+10+10+10	72.5	72.5	0.0	-	76.0	-	J0	P7

Notes
(*) - Manual calculation to check the (axial+bending) usage of members modelled as "BEAM" elements. Considered as critical when exceeding 140%.

NEWFOUNDLAND AND LABRADOR HYDRO
230KV TOWERS – DEFICIENCIES ANALYSIS OF LINES L23, L24, L23A, L24A
Appendix C – Remedy/Repair Priorities - L23

L23 Str. #	Tower Type & Extension		Max. Tower Usage (%) (pre-deficiency)	Max. Tower Usage (%) (post-deficiency)	Max. Tower Usage Jump (%)	Maximum Combined Axial + Bending Member Usage (%) (*) (pre-deficiency)	Maximum Combined Axial + Bending Member Usage (%) (*) (post-deficiency)	Maximum Combined Axial + Bending Member Usage Jump (%)	Jump Index: J0: no increase; J1: 0-5% increase; J2: 5-10% increase; J3: 10-15% increase; J4: 15-20% increase; J5: >20% increase	Priority Index: P1: max usage > 100% or non-susp. Str.; P2: max usage 95-100%, or J5; P3: max usage 90-95%, or J4; P4: J3; P5: J2; P6: J1; P7: J0
188	S_-5-5-5-5		76.1	76.3	0.2	-	52.9	-	J1	P6
225	S_+0+0+0+0		77.0	85.8	8.8	-	70.3	-	J2	P5
228	S_+0+0+0+0		71.7	71.7	0.0	-	61.4	-	J0	P7
235	S_+0+0+0+0		77.1	87.9	10.8	-	72.0	-	J3	P4
239	S_-5-5-5-5		94.4	94.4	0.0	-	76.0	-	J0	P3
241	S_-5-5-5-5		85.3	87.8	2.5	-	70.4	-	J1	P6
244	S_-5-5-5-5		103.8	104.1	0.3	89.6	89.6	0.0	J1	P1
245	S_+0+0+0+0		72.4	83.2	10.8	-	72.7	-	J3	P4
247	S_-5-5-5-5		96.3	99.1	2.8	81.6	81.6	0.0	J1	P2
248	S_+5+5+5+5		89.7	92.0	2.3	-	73.1	-	J1	P3
249	S_+0+0+0+0		72.5	79.1	6.6	-	68.6	-	J2	P5
251	S_+0+0+0+0		73.3	72.8	-	-	69.9	-	J0	P7
255	S_+0+0+0+0		88.5	87.8	-	-	91.7	-	J0	P7
260	S_+10+10+10+10		61.4	57.2	-	-	54.0	-	J0	P7
264	S_-5-5-5-5		84.4	89.4	5.0	-	61.5	-	J2	P5
271	S_+0+0+0+0		78.2	76.4	-	-	71.0	-	J0	P7
273	S_-5-5-5-5		93.3	97.6	4.4	-	74.4	-	J1	P2
276	S_+0+0+0+0		60.1	57.3	-	-	40.5	-	J0	P7
280	S_-5-5-5-5		77.8	78.0	0.2	-	55.4	-	J1	P6
284	S_-5-5-5-5		90.2	91.7	1.5	-	80.4	-	J1	P3
293	S_+5+5+5+5		91.3	94.3	2.9	-	77.7	-	J1	P3
299	S_+5+5+5+5		84.7	91.5	6.8	-	58.3	-	J2	P3
300	S_+0+0+0+0		61.4	68.7	7.3	-	41.7	-	J2	P5
303	S_+0+0+0+0		69.1	73.8	4.7	-	52.5	-	J1	P6
305	S_+0+0+0+0		87.2	98.7	11.5	89.9	89.9	0.0	J3	P2
306	S_-5-5-5-5		92.2	91.6	-	-	76.1	-	J0	P3
308	S_-5-5-5-5		91.7	91.7	0.0	-	72.6	-	J0	P3
309	S_-5-5-5-5		87.0	68.3	-	-	71.9	-	J0	P7
313	S_-5-5-5-5		84.5	85.9	1.4	-	61.4	-	J1	P6
318	S_+0+0+0+0		77.2	89.3	12.1	-	77.1	-	J3	P4
319	S_+0+0+0+0		64.3	43.9	-	-	49.3	-	J0	P7
320	S_+0+0+0+0		70.2	53.1	-	-	55.1	-	J0	P7
322	S_+0+0+0+0		75.8	85.5	9.6	-	69.6	-	J2	P5
323	T_+0+0+0+0	With Guying	120.0	120.0	0.0	67.3	67.3	0.0	J0	P1
		Without Guying	120.0	120.0	0.0	67.3	67.3	0.0	J0	P1
324	T_+0+0+0+0		116.6	116.6	0.0	70.3	70.3	0.0	J0	P1
337	S_+0+0+0+0		85.6	95.6	10.0	-	87.1	-	J2	P2
340	S_-5-5-5-5		91.2	92.1	0.9	-	70.7	-	J1	P3
342	S_-5-5-5-5		88.4	76.1	-	-	73.0	-	J0	P7
347	S_-5-5-5-5		95.8	99.2	3.4	88.2	88.2	0.0	J1	P2
349	S_+0+0+0+0	With Guying	84.7	73.5	-	-	76.0	-	J0	P7
		Without Guying	77.0	77.1	0.2	-	76.0	-	J1	P6

Notes

(*) - Manual calculation to check the (axial+bending) usage of members modelled as "BEAM" elements. Considered as critical when exceeding 140%.

NEWFOUNDLAND AND LABRADOR HYDRO
230KV TOWERS – DEFICIENCIES ANALYSIS OF LINES L23, L24, L23A, L24A
Appendix C – Remedy/Repair Priorities - L23

L23 Str. #	Tower Type & Extension		Max. Tower Usage (%) (pre-deficiency)	Max. Tower Usage (%) (post-deficiency)	Max. Tower Usage Jump (%)	Maximum Combined Axial + Bending Member Usage (%) (*) (pre-deficiency)	Maximum Combined Axial + Bending Member Usage (%) (*) (post-deficiency)	Maximum Combined Axial + Bending Member Usage Jump (%)	Jump Index: J0: no increase J1: 0-5% increase J2: 5-10% increase J3: 10-15% increase J4: 15-20% increase J5: >20% increase	Priority Index: P1: max usage > 100% or non-susp. Str. P2: max usage 95-100%, or J5 P3: max usage 90-95%, or J4 P4: J3 P5: J2 P6: J1 P7: J0
350	S_+10+10+10+10		71.5	71.5	0.0	-	82.9	-	J0	P7
351	S_+0+0+0+0		78.2	73.5	-	-	73.6	-	J0	P7
357	S_+0+0+0+0		70.3	70.3	0.0	-	66.6	-	J0	P7
363	S_+0+0+0+0		88.1	65.6	-	-	92.8	-	J0	P7
364	S_-5-5-5-5		95.6	103.1	7.5	82.6	82.6	0.0	J2	P1
367	S_-5-5-5-5		90.3	97.1	6.8	-	72.2	-	J2	P2
369	S_+0+0+0+0		71.9	75.5	3.6	-	57.6	-	J1	P6
371	T_+0+0+0+0		130.3	130.3	0.0	65.8	65.8	0.0	J0	P1
372	S_+10+10+10+10		61.5	68.9	7.4	-	50.9	-	J2	P5
374	S_+0+0+0+0		81.7	85.2	3.4	-	57.6	-	J1	P6
381	S_+0+0+0+0		85.2	97.7	12.6	84.3	84.3	0.0	J3	P2
382	S_+10+10+10+10		75.3	63.1	-	-	84.3	-	J0	P7
385	S_-5-5-5-5		86.4	84.5	-	-	64.1	-	J0	P7
388	S_+0+0+0+0		72.1	68.1	-	-	65.9	-	J0	P7
401	S_+0+0+0+0		77.4	82.0	4.7	-	71.0	-	J1	P6
402	S_+0+0+0+0		80.9	91.8	10.9	-	74.7	-	J3	P3
405	S_+0+0+0+0		81.7	81.7	0.0	-	76.0	-	J0	P7
407	C_+0+0+0+0	With Guying	90.8	184.5	93.7	48.2	90.7	42.5	J5	P1
		Without Guying	94.6	181.9	87.3	-	90.7	-	J5	P1
409	S_+5+5+5+5		85.9	130.7	44.8	-	70.0	-	J5	P1
412	C_+0+0+0+0	With Guying	84.3	84.6	0.3	-	50.7	-	J1	P1
		Without Guying	88.3	88.5	0.3	-	50.7	-	J1	P1
418	T_+0+0+0+0		117.0	117.0	0.0	64.1	64.1	0.0	J0	P1
419	S_+0+0+0+0		70.1	67.4	-	-	56.4	-	J0	P7
420	S_+0+0+0+0		75.3	51.5	-	-	63.7	-	J0	P7
422	S_+0+0+0+0		75.2	52.7	-	-	65.5	-	J0	P7
423	T_+0+0+0+0		123.0	123.1	0.1	67.9	86.6	18.7	J1	P1
424	S_+0+0+0+0		72.8	81.6	8.8	-	56.1	-	J2	P5
426	S_+0+0+0+0		75.0	75.0	0.0	-	72.0	-	J0	P7
427	S_+0+0+0+0		75.0	82.8	7.8	-	65.4	-	J2	P5
428	S_+0+0+0+0		76.6	86.1	9.5	-	70.9	-	J2	P5
429	S_+0+0+0+0		72.9	68.1	-	-	62.2	-	J0	P7
430	T_+0+0+0+0		127.9	127.9	0.0	68.8	68.8	0.0	J0	P1
432	T_+0+0+0+0		131.1	131.1	0.0	72.2	72.2	0.0	J0	P1
438	S_+0+0+0+0		83.2	91.5	8.3	-	81.9	-	J2	P3
442	S_+0+0+0+0		67.0	75.1	8.1	-	48.5	-	J2	P5
450	S_+0+0+0+0		80.5	90.5	10.0	-	73.7	-	J3	P3
451	S_+0+0+0+0		80.2	88.8	8.7	-	75.5	-	J2	P5
458	S_+0+0+0+0		78.0	88.8	10.8	-	72.0	-	J3	P4
474	S_+0+0+0+0		71.8	67.8	-	-	78.6	-	J0	P7
477	S_+0+0+0+0		77.3	74.7	-	-	67.8	-	J0	P7
481	S_+10+10+10+10		74.2	69.9	-	-	88.8	-	J0	P7

Notes
(*) - Manual calculation to check the (axial+bending) usage of members modelled as "BEAM" elements. Considered as critical when exceeding 140%.

NEWFOUNDLAND AND LABRADOR HYDRO
230KV TOWERS – DEFICIENCIES ANALYSIS OF LINES L23, L24, L23A, L24A
Appendix C – Remedy/Repair Priorities - L23

L23	Tower Type & Extension		Max. Tower Usage (%)		Max. Tower Usage Jump (%)	Maximum Combined Axial + Bending Member Usage (%) (*)		Maximum Combined Axial + Bending Member Usage Jump (%)	Jump Index: J0: no increase J1: 0-5% increase J2: 5-10% increase J3: 10-15% increase J4: 15-20% increase J5: >20% increase	Priority Index: P1: max usage > 100% or non-susp. Str. P2: max usage 95-100%, or J5 P3: max usage 90-95%, or J4 P4: J3 P5: J2 P6: J1 P7: J0
Str. #			(pre-deficiency)	(post-deficiency)		(pre-deficiency)	(post-deficiency)			
490	S_+0+0+0+0		74.7	67.7	-	-	66.7	-	J0	P7
494	S_+0+0+0+0		75.2	80.5	5.3	-	65.9	-	J2	P5
496	S_+0+0+0+0		57.4	57.4	0.0	-	46.6	-	J0	P7
499	S_+0+0+0+0		70.5	78.6	8.1	-	65.6	-	J2	P5
503	S_+0+0+0+0		74.3	74.3	0.0	-	62.9	-	J0	P7
504	S_+0+0+0+0		62.0	66.9	4.9	-	43.4	-	J1	P6
517	S_+0+0+0+0		80.7	79.0	-	-	76.4	-	J0	P7
522	S_+0+0+0+0	With Guying	86.0	86.0	0.0	-	77.1	-	J0	P7
		Without Guying	78.1	78.1	0.0	-	77.1	-	J0	P7
549	S_-5-5-5-5		87.3	87.4	0.0	-	63.1	-	J1	P6
555	S_-5-5-5-5		82.5	78.5	-	-	63.5	-	J0	P7
559	S_+5+5+5+5		93.3	93.3	0.0	-	78.1	-	J0	P3
566	S_-5-5-5-5		73.9	72.6	-	-	45.0	-	J0	P7
568	C_+10+10+10+10		122.0	122.0	0.0	98.3	98.3	0.0	J0	P1
570	A_+0+0+0+0		59.0	59.0	0.0	99.5	99.5	0.0	J0	P7

Notes

(*) - Manual calculation to check the (axial+bending) usage of members modelled as "BEAM" elements. Considered as critical when exceeding 140%.

NEWFOUNDLAND AND LABRADOR HYDRO
230KV TOWERS – DEFICIENCIES ANALYSIS OF LINES L23, L24, L23A, L24A
Appendix C – Remedy/Repair Priorities - L24

L24	Tower Type & Extension		Max. Tower Usage (%)		Max. Tower Usage Jump (%)	Maximum Combined Axial + Bending Member Usage (%) (*)		Maximum Combined Axial + Bending Member Usage Jump (%)	Jump Index: J0: no increase; J1: 0-5% increase; J2: 5-10% increase; J3: 10-15% increase; J4: 15-20% increase; J5: >20% increase	Priority Index: P1: max usage > 100% or non-susp. Str.; P2: max usage 95-100%, or J5; P3: max usage 90-95%, or J4; P4: J3; P5: J2; P6: J1; P7: J0
Str. #			(pre-deficiency)	(post-deficiency)		(pre-deficiency)	(post-deficiency)			
4	H_+20+20+20+20	With Guying	155.8	222.8	67.0		401.4		J5	P1
		Without Guying	155.8	223.6	67.8	229.4	401.4	172.0	J5	P1
10	BB_+10+10+10+10		66.6	67.7	1.1		81.7		J1	P6
24	BB_+0+0+0+0		71.9	71.9	0.0		98.9		J0	P6
29	BB_+5+5+5+5		64.2	64.2	0.0		84.1		J0	P7
33	BB_+20+20+20+20		53.8	53.8	0.0		86.8		J0	P7
35	BB_+0+0+0+0		61.7	61.3	-		82.7		J0	P7
36	BB_-5-5-5-5		57.1	57.1	0.0		7.2		J0	P6
40	BB_-5-5-5-5		70.7	71.6	0.9		90.5		J1	P6
51	BB_+5+5+5+5		70.2	69.9	-		110.4		J0	P7
57	BB_+5+5+5+5		71.2	70.9	-		104.3		J0	P7
67	BB_+0+0+0+0		74.5	74.5	0.0		109.5		J0	P7
73	BB_+0+0+0+0		70.6	76.2	5.6		95.6		J2	P5
75	BB_+0+0+0+0		70.4	71.6	1.2		98.6		J1	P6
81	BB_+5+5+5+5		68.3	68.3	0.0		95.7		J0	P7
93	BB_+5+5+5+5		67.3	67.3	0.0		91.5		J0	P7
100	BB_+5+5+5+5		69.3	NA	NA	NA	NA	NA	NA	P7
107	BB_-5-5-5-5		51.1	51.1	0.0		56.2		J0	P7
117	BB_+0+0+0+0		68.7	68.7	0.0		91.4		J0	P6
121	EE_-5-5-5-5		136.9	136.9	-		54.8		J0	P1
129	BB_+10+10+10+10		64.1	63.8	-		81.3		J0	P7
130	EE_+5+5+5+5		128.5	130.3	1.8		601.6		J1	P1
131	BB_+0+0+0+0		63.4	77.1	13.7		76.2		J3	P4
134	BB_-5-5-5-5		55.3	57.3	2.0		11.3		J1	P6
137	BB_+0+0+0+0		60.4	60.4	0.0		80.8		J0	P7
151	BB_+0+0+0+0		49.1	83.8	34.6		58.1		J5	P2
169	BB_+10+10+10+10		65.4	65.0	-		92.8		J0	P7
171	BB_-5-5-5-5		65.3	65.0	-		85.1		J0	P7
176	BB_+5+5+5+5		80.0	79.9	-		113.8		J0	P7
186	EE_+0+0+0+0		102.1	134.0	31.9		162.2		J5	P1
222	BB_+0+0+0+0		67.1	67.2	0.0		95.5		J0	P6
231	BB_+20+20+20+20		56.2	75.0	18.8		92.9		J4	P3
235	BB_-5-5-5-5		63.7	63.9	0.1		90.6		J1	P6
236	BB_+0+0+0+0		65.2	66.3	1.1		95.8		J1	P6
247	BB_+5+5+5+5		69.2	69.0	-		103.2		J0	P7
278	BB_+5+5+5+5		58.5	58.5	0.0		69.0		J0	P7
281	BB_+0+0+0+0		67.5	67.6	0.1		88.3		J1	P6
285	BB_-5-5-5-5		67.7	67.7	0.0		94.1		J0	P6
290	BB_+10+10+10+10		64.1	64.1	0.0		84.0		J0	P7
291	BB_+10+10+10+10		74.0	75.7	1.7		108.3		J1	P6

Notes

(*) - Manual calculation to check the (axial+bending) usage of members modelled as "BEAM" elements. Considered as critical when exceeding 140%.

NEWFOUNDLAND AND LABRADOR HYDRO
230KV TOWERS – DEFICIENCIES ANALYSIS OF LINES L23, L24, L23A, L24A
Appendix C – Remedy/Repair Priorities - L24

L24 Str. #	Tower Type & Extension		Max. Tower Usage (%) (pre-deficiency)	Max. Tower Usage (%) (post-deficiency)	Max. Tower Usage Jump (%)	Maximum Combined Axial + Bending Member Usage (%) (*) (pre-deficiency)	Maximum Combined Axial + Bending Member Usage (%) (*) (post-deficiency)	Maximum Combined Axial + Bending Member Usage Jump (%)	Jump Index: J0: no increase; J1: 0-5% increase; J2: 5-10% increase; J3: 10-15% increase; J4: 15-20% increase; J5: >20% increase	Priority Index: P1: max usage > 100% or non-susp. Str.; P2: max usage 95-100%, or J5; P3: max usage 90-95%, or J4; P4: J3; P5: J2; P6: J1; P7: J0
294	BB_+0+0+0+0		72.4	72.4	0.0		111.4		J0	P7
306	BB_-5-5-5-5		77.2	77.6	0.4		105.2		J1	P6
320	BB_+10+10+10+10		72.7	72.6	-		83.0		J0	P7
329	BB_+10+10+10+10		79.7	79.7	0.0		110.3		J0	P6
334	BB_+10+10+10+10		63.3	63.8	0.5		83.6		J1	P6
336	BB_+20+20+20+20		70.6	83.7	13.0		124.9		J3	P4
337	BB_+5+5+5+5		57.2	57.1	-		75.3		J0	P7
338	BB_+5+5+5+5		68.6	79.0	10.4		96.1		J3	P4
344	BB_-5-5-5-5		53.3	53.3	0.0		70.2		J0	P6
347	BB_+5+5+5+5		68.5	82.7	14.2		92.7		J3	P4
349	BB_+15+15+15+15		60.8	NA	NA	NA	NA	NA	NA	P7
351	BB_+5+5+5+5		72.1	84.7	12.6		101.5		J3	P4
362	BB_+5+5+5+5		78.6	80.7	2.2		109.7		J1	P6
364	BB_-5-5-5-5		71.6	72.6	1.0		96.1		J1	P6
371	BB_-5-5-5-5		66.0	66.8	0.8		84.6		J1	P6
377	BB_+0+0+0+0		70.9	70.4	-		100.5		J0	P7
378	BB_+0+0+0+0		71.8	71.9	0.0		97.5		J0	P6
379	BB_+10+10+10+10		84.5	113.8	29.3		131.4		J5	P1
380	BB_-5-5-5-5		72.5	72.5	0.0		103.9		J0	P6
387	BB_-5-5-5-5		76.9	77.0	0.0		111.0		J0	P6
390	BB_+10+10+10+10		76.2	76.1	-		105.3		J0	P7
394	BB_+0+0+0+0		71.9	71.9	0.0		98.6		J0	P6
395	BB_+10+10+10+10		69.4	69.0	-		96.8		J0	P7
399	BB_-5-5-5-5		63.2	80.6	17.4		83.7		J4	P3
404	BB_+10+10+10+10		70.3	70.3	0.0		79.5		J0	P7
406	BB_+10+10+10+10		68.5	92.7	24.2		128.5		J5	P2
410	HH_-5-5-5-5	With Guying	97.0	97.0	0.0		122.9		J0	P1
		Without Guying	97.0	97.0	0.0		122.9		J0	P1
412	BB_+5+5+5+5		54.3	54.3	0.0		59.6		J0	P7
415	EE_-5-5-5-5		153.7	153.8	0.2		146.0		J1	P1
416	EE_-5-5-5-5		134.3	163.1	28.9		186.3		J5	P1
417	BB_-5-5-5-5		58.7	95.6	36.9		65.4		J5	P2
418	BB_+0+0+0+0		67.3	115.4	48.1		85.7		J5	P1
419	BB_-5-5-5-5		61.2	62.0	0.8		77.5		J1	P6
420	BB_+5+5+5+5		63.0	70.3	7.3		67.7		J2	P5
421	EE_-5-5-5-5		142.1	223.6	81.4		93.5		J5	P1
422	BB_+0+0+0+0		64.3	64.2	-		76.1		J0	P7
423	BB_+0+0+0+0		65.5	65.1	-		79.1		J0	P7
424	BB_+5+5+5+5		69.4	69.1	-		86.6		J0	P7
425	BB_-5-5-5-5		64.5	64.6	0.1		88.2		J1	P6

Notes

(*) - Manual calculation to check the (axial+bending) usage of members modelled as "BEAM" elements. Considered as critical when exceeding 140%.

NEWFOUNDLAND AND LABRADOR HYDRO
230KV TOWERS – DEFICIENCIES ANALYSIS OF LINES L23, L24, L23A, L24A
Appendix C – Remedy/Repair Priorities - L24

L24	Tower Type & Extension		Max. Tower Usage (%)		Max. Tower Usage Jump (%)	Maximum Combined Axial + Bending Member Usage (%) (*)		Maximum Combined Axial + Bending Member Usage Jump (%)	Jump Index: J0: no increase J1: 0-5% increase J2: 5-10% increase J3: 10-15% increase J4: 15-20% increase J5: >20% increase	Priority Index: P1: max usage > 100% or non-susp. Str. P2: max usage 95-100%, or J5 P3: max usage 90-95%, or J4 P4: J3 P5: J2 P6: J1 P7: J0
Str. #			(pre-deficiency)	(post-deficiency)		(pre-deficiency)	(post-deficiency)			
426	BB_-5-5-5-5		64.0	64.2	0.2		81.6		J1	P6
427	BB_-5-5-5-5		61.5	NA	NA	NA	NA	NA	NA	P7
428	EE_-5-5-5-5	With Guying	144.1	266.0	122.0		165.1		J5	P1
		Without Guying	144.1	266.0	122.0		165.1		J5	P1
429	BB_+5+5+5+5		63.2	63.9	0.6		68.0		J1	P6
430	EE_-5-5-5-5		146.5	146.5	0.0	88.3	88.2		J1	P1
431	BB_+5+5+5+5		61.7	63.2	1.5		66.1		J1	P6
435	BB_+0+0+0+0		69.8	70.0	0.2		101.7		J1	P6
443	BB_-5-5-5-5		64.8	64.9	0.0		75.1		J0	P6
461	BB_+0+0+0+0		62.7	62.7	0.0		81.6		J0	P7
469	BB_-5-5-5-5		60.1	60.1	0.0		66.6		J0	P6
479	BB_-5-5-5-5		67.6	67.7	0.0		89.3		J0	P6
513	BB_+0+0+0+0		46.5	46.4	-		59.4		J0	P7
529	BB_-5-5-5-5		63.4	63.4	0.0		87.9		J0	P6

Notes

(*) - Manual calculation to check the (axial+bending) usage of members modelled as "BEAM" elements. Considered as critical when exceeding 140%.

NEWFOUNDLAND AND LABRADOR HYDRO
230KV TOWERS – DEFICIENCIES ANALYSIS OF LINES L23, L24, L23A, L24A
Appendix C – Remedy/Repair Priorities - L23A, L24A

L23A, L24A		Tower Type & Extension	Max. Tower Usage (%)		Max. Tower Usage Jump (%)	Maximum Combined Axial + Bending Member Usage (%) (*)		Maximum Combined Axial + Bending Member Usage Jump (%)	Jump Index: J0: no increase J1: 0-5% increase J2: 5-10% increase J3: 10-15% increase J4: 15-20% increase J5: >20% increase	Priority Index: P1: max usage > 100% or non-susp. Str. P2: max usage 95-100%, or J5 P3: max usage 90-95%, or J4 P4: J3 P5: J2 P6: J1 P7: J0
Line	Str. #		(pre-deficiency)	(post-deficiency)		(pre-deficiency)	(post-deficiency)			
L23A	2	RT-0_+5+5+5+5	107.7	107.7	0.0	193.6	193.6	0.0	J0	P1
L23A	3	RT-0_+20+20+20+20	97.2	98.8	1.6	196.0	196.0	0.0	J1	P1
L24A	2	RT-0_+5+5+5+5	116.1	116.2	0.0	192.6	192.6	0.0	J0	P1
L24A	3	RT-0_+20+20+10+10	110.6	110.4	-	194.1	194.1	0.0	J0	P1
L24A	4	RT-0_+5+5+5+0	161.1	161.1	0.0	230.8	230.8	0.0	J0	P1
L24A	7	RT-DE-70_+0+0+0+0	88.2	88.2	0.0	69.0	69.0	0.0	J0	P1
L24A	63	GV-0	46.4	46.4	0.0	56.5	56.5	0.0	J0	P7

Notes

(*) - Manual calculation to check the (axial+bending) usage of members modelled as "BEAM" elements. Considered as critical when exceeding 140%.

Appendix D – Work Plan Summary

NEWFOUNDLAND AND LABRADOR HYDRO
230KV TOWERS – DEFICIENCIES ANALYSIS OF LINES L23, L24, L23A, L24A
Appendix D – Work Plan Summary - L23

L23	General Details					Repair & Remedy Analysis					
Str#	Tower Type and Extension	Defective Member			Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed incorrectly D5: Missing bolt D6: Altered member	Impact of Individual Deficient Member Removal (Construction and Maintenance Loading)				Remedy Index: R1: Replace Member R2: Create Double Angle R3: Install Redundants R4: No Actions Needed	Temporary Support or Tower Unloading Required
		ID (Drawings)	Leg	Side		Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage		Governing Member Maximum Combined Axial + Bending Usage (%)(*)		
							Tower model	Drawings			
5	A_+0+0+0+0	109	2	left	D1	25.4	g66Y	33	30.8	R1	
		109	4	right	D1	25.4	g66Y	33	30.8	R1	
9	S_+0+0+0+0	131	4	right	D1					R1	
		131	1	left	D1					R1	
		131	3	right	D1					R1	
13	S_+0+0+0+0	131	4	right	D1					R1	
		131	2	left	D1					R1	
		131	1	left	D1					R1	
15	S_+0+0+0+0	131	3	right	D1					R1	
17	S_+5+5+5+5	136	3	right	D1	57.0	Fg143-3P	136	25.7	R1	
18	S_+5+5+5+5	136	3	right	D1	27.1	Fg143149-3P	136	23.7	R1	
		136	4	left	D1	27.8	Fg141144Y_P	134	23.7	R1	
		136	4	right	D1	27.8	Fg141144Y_P	134	23.7	R1	
		136	1	left	D1	29.5	Fg142146-1P	136	23.7	R1	
21	S_+0+0+0+0	131	2	left	D1					R1	
		131	2	right	D1					R1	
22	S_+5+5+5+5	136	3	right	D1	56.4	Fg143149-3P	136	22.1	R1	
		136	2	right	D1	30.2	Fg143-4P	136	22.1	R1	
23	S_+0+0+0+0	131	3	left	D1					R1	
25	S_+0+0+0+0	131	3	right	D1					R1	
		131	3	left	D1					R1	
32	S_+5+5+5+5	136	1	right	D1	55.2	Fg143149-1P	136	39.6	R1	
38	S_+0+0+0+0	133	2	left	D1					R1	
44	S_+5+5+5+5	136	3	left	D1					R1	
49	S_+0+0+0+0	131	3	left	D1					R1	
54	S_+0+0+0+0	131	2	right	D1					R1	
		131	1	left	D1					R1	
		131	3	right	D1					R1	
62	S_+0+0+0+0	131	3	right	D1					R1	
63	S_+0+0+0+0	131	1	right	D2					R1	
		131	1	left	D1					R1	
75	S_+0+0+0+0	131	4	left	D1					R1	
		131	2	right	D1					R1	
79	S_+0+0+0+0	131	2	left	D1					R1	
		131	2	right	D1					R1	
		131	4	left	D1					R1	
90	S_+0+0+0+0	129	3	center	D1					R2	
		131	3	right	D1					R1	
		131	1	left	D1					R1	
94	S_+0+0+0+0	131	2	left	D1					R1	
		131	3	left	D1					R1	
95	S_+0+0+0+0	131	4	left	D1	49.4	LXY_131-L1P	131	28.1	R1	
		131	4	right	D1	48.8	LXY_131-L1P	131	28.1	R1	
96	S_-5-5-5-5	127	4	right	D1					R1	
		127	1	right	D1					R1	
		127	1	left	D1					R1	
100	S_+0+0+0+0	131	3	left	D1					R1	
		131	3	right	D1					R1	
		131	4	right	D1					R1	
		131	1	left	D1					R1	

Notes
(*) - Manual calculation to check the (axial+bending) usage of members modelled as "BEAM" elements. Considered as critical when exceeding 140%.

NEWFOUNDLAND AND LABRADOR HYDRO
230KV TOWERS – DEFICIENCIES ANALYSIS OF LINES L23, L24, L23A, L24A
Appendix D – Work Plan Summary - L23

L23	General Details					Repair & Remedy Analysis					
Str#	Tower Type and Extension	Defective Member			Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed incorrectly D5: Missing bolt D6: Altered member	Impact of Individual Deficient Member Removal (Construction and Maintenance Loading)				Remedy Index: R1: Replace Member R2: Create Double Angle R3: Install Redundants R4: No Actions Needed	Temporary Support or Tower Unloading Required
		ID (Drawings)	Leg	Side		Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage		Governing Member Maximum Combined Axial + Bending Usage (%)$^{(*)}$		
							Tower model	Drawings			
101	S_+5+5+5+5	140	2	center	D1	39.5	Fg142-4P	136	35.0	R1	
		136	2	right	D1					R1	
		136	2	left	D1	45.7	Fg141144X_P	134	35.0	R1	
		136	3	left	D1	39.8	Fg142-4P	136	35.0	R1	
104	S_+15+15+15+15	154	3	left	D1					R1	
		154	2	right	D1	31.3	Fg142149X_P	136		R1	
		154	3	right	D1	61.4	Fg141146P_P	134		R1	
		152	3	center	D1					R2	
109	T_+0+0+0+0	124	3	right	D1	37.7	g165Y	30	25.1	R1	
113	S_+0+0+0+0	131	1	left	D1					R1	
114	S_-5-5-5-5	115	4	right	D1					R1	
		115	2	left	D1					R1	
116	S_+0+0+0+0	131	1	left	D1					R1	
117	S_+0+0+0+0	131	3	left	D1					R1	
		131	1	left	D1					R1	
		131	4	right	D1					R1	
134	S_+0+0+0+0	131	3	right	D1					R1	
		131	2	left	D1					R1	
151	S_+0+0+0+0	131	2	right	D1					R1	
168	S_+0+0+0+0	131	2	right	D1					R1	
169	S_+0+0+0+0	131	2	right	D1					R1	
		131	1	left	D1					R1	
171	S_-5-5-5-5	118	3	right	D1					R1	
172	S_+0+0+0+0	131	4	left	D1					R1	
		131	2	right	D1					R1	
173	S_+5+5+5+5	136	1	left	D1	64.8	Fg142146-1P	136	41.0	R1	
		136	3	left	D1	48.3	Fg142-4P	136	41.0	R1	
174	S_+0+0+0+0	131	3	left	D1					R1	
175	S_+0+0+0+0	131	3	right	D1					R1	
181	S_+0+0+0+0	131	4	right	D1					R1	
184	S_+10+10+10+10	144	2	right	D1					R1	
188	S_-5-5-5-5	127	1	right	D1					R1	
225	S_+0+0+0+0	131	4	right	D1					R1	
		131	1	right	D1					R1	
228	S_+0+0+0+0	131	2	right	D1					R1	
235	S_+0+0+0+0	131	4	left	D1					R1	
239	S_-5-5-5-5	127	1	left	D1					R1	
241	S_-5-5-5-5	127	3	right	D1					R1	
244	S_-5-5-5-5	118	1	left	D1	32.9	g142-4P	136		R1	
245	S_+0+0+0+0	131	1	right	D1					R1	
247	S_-5-5-5-5	127	2	left	D1	28.8	g143-1P	136	22.1	R1	
248	S_+5+5+5+5	136	4	right	D1					R1	
249	S_+0+0+0+0	131	3	right	D1					R1	
251	S_+0+0+0+0	131	4	right	D1					R1	
255	S_+0+0+0+0	131	4	right	D1					R1	
260	S_+10+10+10+10	144	3	left	D1					R1	
264	S_-5-5-5-5	127	1	right	D1					R1	
271	S_+0+0+0+0	131	4	right	D1					R1	
273	S_-5-5-5-5	127	3	right	D1	30.2	g143-4P	136	25.0	R1	
276	S_+0+0+0+0	131	4	right	D1					R1	

Notes
(*) - Manual calculation to check the (axial+bending) usage of members modelled as "BEAM" elements. Considered as critical when exceeding 140%.

NEWFOUNDLAND AND LABRADOR HYDRO
230KV TOWERS – DEFICIENCIES ANALYSIS OF LINES L23, L24, L23A, L24A
Appendix D – Work Plan Summary - L23

L23	General Details					Repair & Remedy Analysis					
		Defective Member				Impact of Individual Deficient Member Removal (Construction and Maintenance Loading)					
Str#	Tower Type and Extension	ID (Drawings)	Leg	Side	Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed incorrectly D5: Missing bolt D6: Altered member	Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage – Tower model	Member Governing Maximum Tower Usage – Drawings	Governing Member Maximum Combined Axial + Bending Usage (%)$^{(*)}$	Remedy Index: R1: Replace Member R2: Create Double Angle R3: Install Redundants R4: No Actions Needed	Temporary Support or Tower Unloading Required
280	S_-5-5-5-5	118	1	right	D1					R1	
		118	1	left	D1					R1	
284	S_-5-5-5-5	127	2	left	D1					R1	
293	S_+5+5+5+5	136	1	right	D1					R1	
		136	1	left	D1					R1	
299	S_+5+5+5+5	136	1	right	D1					R1	
300	S_+0+0+0+0	131	3	right	D1					R1	
		131	1	left	D1					R1	
303	S_+0+0+0+0	131	4	right	D1					R1	
		131	2	left	D1					R1	
		131	4	left	D1					R1	
		131	3	left	D1					R1	
305	S_+0+0+0+0	131	1	right	D1	41.7	26Y	26	37.2	R1	
306	S_-5-5-5-5	127	2	right	D1					R1	
308	S_-5-5-5-5	127	1	left	D1					R1	
309	S_-5-5-5-5	127	4	right	D1					R1	
		127	1	left	D1					R1	
313	S_-5-5-5-5	127	2	left	D1					R1	
		127	4	right	D1					R1	
		127	1	right	D2					R1	
		127	4	left	D1					R1	
		127	1	left	D1					R1	
318	S_+0+0+0+0	131	1	right	D1					R1	
		131	4	left	D1					R1	
		131	2	left	D1					R1	
		131	1	left	D1					R1	
319	S_+0+0+0+0	131	3	right	D1					R1	
		131	2	left	D1					R1	
		131	1	left	D1					R1	
		131	4	right	D1					R1	
320	S_+0+0+0+0	131	4	right	D1					R1	
		131	1	right	D1					R1	
		131	3	left	D1					R1	
		131	3	right	D1					R1	
		131	2	left	D1					R1	
		131	1	left	D1					R1	
322	S_+0+0+0+0	131	4	left	D1					R1	
		131	2	left	D1					R1	
		131	3	right	D1					R1	
323	T_+0+0+0+0 – With guying	124	2	right	D1	34.0	g98Y	47	30.2	R1	
		124	1	left	D1	34.0	g98Y	47	30.2	R1	
		124	4	left	D1	34.0	g98Y	47	30.2	R1	
	T_+0+0+0+0 – Without guying	124	2	right	D1	33.9	g98Y	47	30.3	R1	
		124	1	left	D1	33.9	g98Y	47	30.3	R1	
		124	4	left	D1	33.9	g98Y	47	30.3	R1	
324	T_+0+0+0+0	124	2	left	D1	41.2	g165XY	30	26.1	R1	
337	S_+0+0+0+0	131	1	right	D1	31.6	LXY_131-T1P	131	27.5	R1	
340	S_-5-5-5-5	127	1	right	D1					R1	
342	S_-5-5-5-5	127	1	right	D1					R1	
		127	3	left	D1					R1	
		127	2	right	D2					R1	

Notes
(*) - Manual calculation to check the (axial+bending) usage of members modelled as "BEAM" elements. Considered as critical when exceeding 140%.

NEWFOUNDLAND AND LABRADOR HYDRO
230KV TOWERS – DEFICIENCIES ANALYSIS OF LINES L23, L24, L23A, L24A
Appendix D – Work Plan Summary - L23

L23	General Details					Repair & Remedy Analysis					
Str#	Tower Type and Extension	Defective Member			Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed incorrectly D5: Missing bolt D6: Altered member	Impact of Individual Deficient Member Removal (Construction and Maintenance Loading)				Remedy Index: R1: Replace Member R2: Create Double Angle R3: Install Redundants R4: No Actions Needed	Temporary Support or Tower Unloading Required
		ID (Drawings)	Leg	Side		Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage		Governing Member Maximum Combined Axial + Bending Usage (%)(*)		
							Tower model	Drawings			
347	S_-5-5-5-5	127	1	right	D1	35.2	g142-2P	136	31.5	R1	
		127	3	left	D1	35.5	g142-2P	136	31.5	R1	
349	S_+0+0+0+0 With guying	131	4	right	D1					R1	
		131	2	right	D1					R1	
	S_+0+0+0+0 Without guying	131	4	right	D1					R1	
		131	2	right	D1					R1	
350	S_+10+10+10+10	144	1	left	D1					R1	
351	S_+0+0+0+0	131	1	right	D1					R1	
		131	3	left	D1					R1	
		131	1	left	D1					R1	
		131	3	right	D1					R1	
357	S_+0+0+0+0	131	4	right	D1					R1	
363	S_+0+0+0+0	131	3	left	D1					R1	
		131	3	right	D1					R1	
		131	2	left	D1					R1	
		131	4	left	D1					R1	
		131	4	right	D1					R1	
		131	1	left	D1					R1	
364	S_-5-5-5-5	127	4	left	D6	33.6	g143-3P	136	27.5	R1	
		127	4	left	D1					R1	
367	S_-5-5-5-5	127	1	right	D3	29.9	g143-2P	136	19.4	R1	
369	S_+0+0+0+0	131	1	right	D1					R1	
371	T_+0+0+0+0	124	3	right	D1	39.0	g165P	30	28.1	R1	
		124	1	left	D1	39.0	g165P	30	28.1	R1	
372	S_+10+10+10+10	144	3	right	D1					R1	
		144	1	left	D1					R1	
374	S_+0+0+0+0	131	2	left	D1					R1	
		131	2	right	D1					R1	
381	S_+0+0+0+0	131	1	right	D1	31.1	LY_131-T1P	131	25.4	R1	
		131	4	left	D1	30.4	LXY_131-T1P	131	25.4	R1	
382	S_+10+10+10+10	144	4	right	D1					R1	
		144	4	left	D1					R1	
		144	2	left	D1					R1	
		144	2	right	D1					R1	
		144	3	right	D1					R1	
		144	1	left	D1					R1	
		144	1	right	D1	51.3	Fg141145X0P	134		R1	
		150	2	right	D1					R1	
		150	2	left	D1					R1	
385	S_-5-5-5-5	127	4	right	D1					R1	
388	S_+0+0+0+0	131	4	right	D1					R1	
		131	1	left	D1					R1	
401	S_+0+0+0+0	131	1	right	D1					R1	
		131	3	left	D1					R1	
402	S_+0+0+0+0	131	2	right	D1					R1	
		131	1	left	D1					R1	
		131	1	right	D1					R1	
		131	4	left	D1					R1	
		131	3	right	D1					R1	
405	S_+0+0+0+0	131	4	right	D1					R1	
		129	2	left	D1					R2	

Notes
(*) - Manual calculation to check the (axial+bending) usage of members modelled as "BEAM" elements. Considered as critical when exceeding 140%.

NEWFOUNDLAND AND LABRADOR HYDRO
230KV TOWERS – DEFICIENCIES ANALYSIS OF LINES L23, L24, L23A, L24A
Appendix D – Work Plan Summary - L23

L23	General Details						Repair & Remedy Analysis					
Str#	Tower Type and Extension		Defective Member			Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed incorrectly D5: Missing bolt D6: Altered member	Impact of Individual Deficient Member Removal (Construction and Maintenance Loading)				Remedy Index: R1: Replace Member R2: Create Double Angle R3: Install Redundants R4: No Actions Needed	Temporary Support or Tower Unloading Required
			ID (Drawings)	Leg	Side		Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage		Governing Member Maximum Combined Axial + Bending Usage (%)(*)		
								Tower model	Drawings			
407	C_+0+0+0+0	With guying	122	2	left	D1	37.0	g124P	42	23.7	R1	
		Without guying	122	2	left	D1	37.0	g124P	42	23.7	R1	
409	S_+5+5+5+5		136	1	left	D6	52.4	Fg142146-1P	136	25.0	R1	
412	C_+0+0+0+0	With guying	123	1	left	D1	36.2	g124P	42		R1	
			123	1	right	D1					R1	
			123	3	right	D1					R1	
			123	3	left	D1					R1	
			123	4	left	D1					R1	
			123	4	right	D1					R1	
			123	2	left	D1					R1	
			123	2	right	D1					R1	
		Without guying	123	1	left	D1					R1	
			123	1	right	D1					R1	
			123	3	right	D1					R1	
			123	3	left	D1					R1	
			123	4	left	D1					R1	
			123	4	right	D1					R1	
			123	2	left	D1					R1	
			123	2	right	D1					R1	
418	T_+0+0+0+0		124	3	left	D1	31.0	g165XY	30	22.6	R1	
419	S_+0+0+0+0		131	3	left	D1					R1	
			131	3	right	D2					R1	
420	S_+0+0+0+0		131	1	right	D1					R1	
			131	4	left	D1					R1	
			131	3	left	D1					R1	
			131	2	left	D1					R1	
			131	2	m	D1					R1	
			131	1	left	D1					R1	
422	S_+0+0+0+0		131	4	right	D1					R1	
			131	3	right	D1					R1	
			131	2	right	D1					R1	
			131	4	left	D1					R1	
423	T_+0+0+0+0		124	4	right	D1	39.3	g165XY	30	22.8	R1	
			124	2	left	D1	39.3	g165XY	30	22.8	R1	
			124	1	right	D2	39.3	g165XY	30	22.8	R1	
			124	1	left	D2					R1	
424	S_+0+0+0+0		131	4	left	D1					R1	
426	S_+0+0+0+0		131	1	left	D1					R1	
427	S_+0+0+0+0		131	3	left	D1					R1	
			131	1	right	D1					R1	
428	S_+0+0+0+0		131	4	right	D1					R1	
			131	2	left	D1					R1	
429	S_+0+0+0+0		131	3	left	D1					R1	
			131	4	right	D2					R1	
			131	3	right	D1					R1	
430	T_+0+0+0+0		124	3	left	D1	36.7	g165P	30	23.4	R1	
			124	2	left	D1	36.7	g165P	30	23.4	R1	
			124	1	left	D1	36.7	g165P	30	23.4	R1	
432	T_+0+0+0+0		124	3	left	D1	47.1	g165P	30	25.3	R1	
			124	1	right	D1	47.1	g165P	30	25.3	R1	
			124	1	left	D1	47.1	g165P	30	25.3	R1	

Notes

(*) - Manual calculation to check the (axial+bending) usage of members modelled as "BEAM" elements. Considered as critical when exceeding 140%.

L23	General Details					Repair & Remedy Analysis					
Str#	Tower Type and Extension	Defective Member			Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed incorrectly D5: Missing bolt D6: Altered member	Impact of Individual Deficient Member Removal (Construction and Maintenance Loading)				Remedy Index: R1: Replace Member R2: Create Double Angle R3: Install Redundants R4: No Actions Needed	Temporary Support or Tower Unloading Required
		ID (Drawings)	Leg	Side		Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage		Governing Member Maximum Combined Axial + Bending Usage (%)$^{(*)}$		
							Tower model	Drawings			
438	S_+0+0+0+0	131	2	left	D1					R1	
		131	4	right	D1					R1	
442	S_+0+0+0+0	131	4	right	D1					R1	
		131	2	left	D1					R1	
450	S_+0+0+0+0	131	4	left	D1					R1	
451	S_+0+0+0+0	131	4	left	D1					R1	
458	S_+0+0+0+0	131	1	left	D1					R1	
		131	3	right	D1					R1	
474	S_+0+0+0+0	131	3	left	D1					R1	
477	S_+0+0+0+0	131	4	right	D1					R1	
481	S_+10+10+10+10	144	1	right	D1					R1	
		144	3	left	D1					R1	
		144	1	left	D1					R1	
490	S_+0+0+0+0	131	4	right	D1					R1	
		131	1	left	D1					R1	
		131	1	right	D1					R1	
		131	3	left	D1					R1	
494	S_+0+0+0+0	131	2	left	D2					R1	
496	S_+0+0+0+0	131	1	left	D1					R1	
499	S_+0+0+0+0	131	4	left	D1					R1	
503	S_+0+0+0+0	131	4	right	D1					R1	
504	S_+0+0+0+0	131	3	right	D1					R1	
517	S_+0+0+0+0	131	4	right	D1					R1	
522	S_+0+0+0+0 With guying	131	1	left	D1					R1	
	S_+0+0+0+0 Without guying	131	1	left	D1					R1	
549	S_-5-5-5-5	116	3	left	D1					R1	
555	S_-5-5-5-5	127	4	right	D1					R1	
559	S_+5+5+5+5	136	4	right	D1					R1	
566	S_-5-5-5-5	127	2	right	D1					R1	
568	C_+10+10+10+10	140	3	left	D1	64.2	g79X	9	66.9	R1	
570	A_+0+0+0+0	12	NA		D1	25.4	g104Y	108	37.6	R1	

Notes

$^{(*)}$ *- Manual calculation to check the (axial+bending) usage of members modelled as "BEAM" elements. Considered as critical when exceeding 140%.*

L24	General Details					Repair & Remedy Analysis						
Str#	Tower Type and Extension	Defective Member			Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed incorrectly D5: Missing bolt D6: Altered member	Impact of Individual Deficient Member Removal (Construction and Maintenance Loading)				Remedy Index: R1: Replace Member R2: Create Double Angle R3: Install Redundants R4: No Actions Needed	Temporary Support or Tower Unloading Required
		ID (Drawings)	Leg	Side		Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage		Governing Member Maximum Combined Axial + Bending Usage (%)(*)		
							Tower model	Drawings			
4	H_+20+20+20+20	125	1	right	D1	148.0	198XY	198	120.0	R1	X
		124	1	right	D1	148.0	198XY	198	120.1	R1	X
		107	3	right	D1	148.8	105-5Y_P	105	120.0	R1	X
		106	1	left	D1	148.0	198XY	198	119.9	R1	X
10	BB_+10+10+10+10	277	4	Left	D1					R1	
		277	1	right	D1					R1	
24	BB_+0+0+0+0	227	2	left	D1					R1	
		227	1	right	D1					R1	
		227	1	left	D1					R1	
		232	1	right	D1					R1	
29	BB_+5+5+5+5	252	2	Left	D1					R1	
33	BB_+20+20+20+20	63	2	Right	D1	22.5	LXY_51-1P	51	55.0	R1	
35	BB_+0+0+0+0	228	3	Left	D1					R1	
		228	3	right	D1					R1	
36	BB_-5-5-5-5	228	2	right	D1					R1	
40	BB_-5-5-5-5	236	4	Left	D1					R1	
		237	3	Right	D1					R1	
51	BB_+5+5+5+5	253	2	Right	D1	89.0	LXY_251-3P	251	51.1	R1	
		252	4	Left	D1	44.4	157-1X	157	51.2	R1	
57	BB_+5+5+5+5	252	3	Left	D1	79.6	LY_251-1P	251	36.5	R1	
		253	2	Right	D1	80.9	LXY_251-3P	251	36.5	R1	
		253	1	Left	D1	39.9	LX_251-1P	251	36.5	R1	
67	BB_+0+0+0+0	75	2	Left	D5	34.4	157-1P	157	29.7	R1	
73	BB_+0+0+0+0	75	1	Right	D1					R1	
		227	4	left	D1					R1	
75	BB_+0+0+0+0	228	3	Right	D1					R1	
81	BB_+5+5+5+5	257	4	Right	D1					R1	
93	BB_+5+5+5+5	252	2	left	D1					R1	
100	BB_+5+5+5+5	252	4	Right	D1	51.7	251-1P	251	27.4	R1	
107	BB_-5-5-5-5	234	2	left	D1					R1	
		234	2	Right	D1					R1	
117	BB_+0+0+0+0	227	3	left	D1					R1	
121	EE_-5-5-5-5	175	1	Center	D1					R1	
129	BB_+10+10+10+10	278	4	Right	D1					R1	
		277	1	left	D1					R1	
130	EE_+5+5+5+5	101	NA	NA	D1					R2+R3	
131	BB_+0+0+0+0	228	2	right	D1					R1	
		228	3	right	D1					R1	
		228	1	left	D1					R1	
		228	1	right	D1					R1	
		228	4	right	D1					R1	
		231	4	right	D6					R1	
		231	4	left	D6					R1	

Notes

(*) - Manual calculation to check the (axial+bending) usage of members modelled as "BEAM" elements. Considered as critical when exceeding 140%.

NEWFOUNDLAND AND LABRADOR HYDRO
230KV TOWERS – DEFICIENCIES ANALYSIS OF LINES L23, L24, L23A, L24A
Appendix D – Work Plan Summary - L24

L24	General Details					Repair & Remedy Analysis					
Str#	Tower Type and Extension	Defective Member			Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed incorrectly D5: Missing bolt D6: Altered member	Impact of Individual Deficient Member Removal (Construction and Maintenance Loading)				Remedy Index: R1: Replace Member R2: Create Double Angle R3: Install Redundants R4: No Actions Needed	Temporary Support or Tower Unloading Required
		ID (Drawings)	Leg	Side		Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage		Governing Member Maximum Combined Axial + Bending Usage (%)(*)		
							Tower model	Drawings			
134	BB_-5-5-5-5	236	2	left	D1					R1	
		75	2	center	D1					R1	
		75	4	center	D1					R1	
		75	3	center	D1					R1	
		75	1	center	D3					R1	
137	BB_+0+0+0+0	228	2	Left	D1					R1	
151	BB_+0+0+0+0	226	1	center	D1					R2	
		227	1	left	D1					R1	
		228	1	right	D1					R1	
		227	3	left	D1					R1	
		228	3	right	D1					R1	
169	BB_+10+10+10+10	277	1	left	D1					R1	
		278	4	right	D1					R1	
		295	1	right	D1					R1	
		277	3	left	D1					R1	
171	BB_-5-5-5-5	237	4	right	D1					R1	
176	BB_+5+5+5+5	253	1	left	D1	78.8	251-3P	251	38.9	R1	
186	EE_+0+0+0+0	199	2	left	D1	64.8	121P	121	88.9	R1	
		200	1	right	D1	64.8	121P	121	88.9	R1	
		199	1	left	D1	64.8	121P	121	88.9	R1	
		200	3	right	D1	64.8	121P	121	88.9	R1	
222	BB_+0+0+0+0	227	2	left	D1					R1	
		227	3	left	D1					R1	
231	BB_+20+20+20+20	53	1	right	D1	188.1	LX_51-3P	51	92.9	R1	X
235	BB_-5-5-5-5	236	3	Left	D1					R1	
		237	1	right	D1					R1	
236	BB_+0+0+0+0	227	2	Left	D1					R1	
247	BB_+5+5+5+5	252	1	Left	D1	57.3	LX_251-1P	251	30.1	R1	
278	BB_+5+5+5+5	252	2	Left	D1					R1	
281	BB_+0+0+0+0	75	1	center	D3					R1	
		75	2	center	D3					R1	
		75	3	center	D3					R1	
		75	4	center	D3					R1	
285	BB_-5-5-5-5	237	1	right	D1					R1	
		234	4	right	D1					R1	
		235	4	left	D1					R2	
290	BB_+10+10+10+10	278	2	right	D1					R1	
291	BB_+10+10+10+10	278	3	right	D1	147.3	LY_276-2P	276	41.1	R1	X
294	BB_+0+0+0+0	227	3	left	D1	27.2	157-1X	157	32.1	R1	
		227	4	left	D1	27.2	157-1X	157	32.1	R1	
306	BB_-5-5-5-5	23	2	left	D7					R1	
320	BB_+10+10+10+10	277	4	left	D1					R1	
		277	1	left	D1					R1	
329	BB_+10+10+10+10	277	2	left	D1	129.1	LXY_276-2P	276	38.8	R1	X
		278	3	right	D1	119.5	LY_276-2P	276	38.8	R1	X

Notes
(*) - Manual calculation to check the (axial+bending) usage of members modelled as "BEAM" elements. Considered as critical when exceeding 140%.

L24	General Details					Repair & Remedy Analysis					
Str#	Tower Type and Extension	Defective Member			Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed incorrectly D5: Missing bolt D6: Altered member	Impact of Individual Deficient Member Removal (Construction and Maintenance Loading)				Remedy Index: R1: Replace Member R2: Create Double Angle R3: Install Redundants R4: No Actions Needed	Temporary Support or Tower Unloading Required
		ID (Drawings)	Leg	Side		Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage		Governing Member Maximum Combined Axial + Bending Usage (%)(*)		
							Tower model	Drawings			
334	BB_+10+10+10+10	277	4	left	D1					R1	
336	BB_+20+20+20+20	52	1	right	D1	289.7	LX_51-3P	51	73.0	R1	X
337	BB_+5+5+5+5	252	1	left	D1					R1	
		253	2	right	D1					R1	
338	BB_+5+5+5+5	253	3	right	D1					R1	
		252	2	left	D1					R1	
		253	1	right	D1					R1	
		252	1	left	D1					R1	
344	BB_-5-5-5-5	75	4	center	D3					R1	
		75	3	center	D3					R1	
		75	2	center	D3					R1	
		75	1	center	D3					R1	
347	BB_+5+5+5+5	253	1	right	D1					R1	
		252	3	left	D1					R1	
		252	1	left	D1					R1	
		252	2	left	D1					R1	
		253	3	right	D1					R1	
349	BB_+15+15+15+15	253	1	right	Photo not clear					R1	
		253	4	right						R1	
		252	3	left						R1	
		312	1	left	D1					R1	
351	BB_+5+5+5+5	253	3	right	D1	71.8	LXY_251-3P	251	25.3	R1	
		252	2	left	D1	74.1	LXY_251-1P	251	25.4	R1	
		253	2	right	D1	73.5	LXY_251-1P	251	25.1	R1	
		252	1	left	D1	61.9	LX_251-1P	251	25.1	R1	
		253	1	right	D1	62.3	LX_251-1P	251	25.1	R1	
		253	4	right	D1	74.2	LXY_251-1P	251	25.8	R1	
362	BB_+5+5+5+5	252	4	left	D1	77.8	251-3P	251	39.3	R1	
		252	3	left	D1	48.3	157-1X	157	39.3	R1	
364	BB_-5-5-5-5	237	3	right	D1					R1	
		236	4	left	D1					R1	
371	BB_-5-5-5-5	237	2	right	D1					R1	
		237	3	right	D1					R1	
		237	4	right	D1					R1	
		236	4	left	D1					R1	
377	BB_+0+0+0+0	228	1	right	D1	27.7	157-1P	157	24.1	R1	
		228	4	right	D1	27.7	157-1P	157	24.1	R1	
378	BB_+0+0+0+0	227	3	left	D1					R1	

Notes
(*) - Manual calculation to check the (axial+bending) usage of members modelled as "BEAM" elements. Considered as critical when exceeding 140%.

L24	General Details					Repair & Remedy Analysis					
Str#	Tower Type and Extension	Defective Member			Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed incorrectly D5: Missing bolt D6: Altered member	Impact of Individual Deficient Member Removal (Construction and Maintenance Loading)				Remedy Index: R1: Replace Member R2: Create Double Angle R3: Install Redundants R4: No Actions Needed	Temporary Support or Tower Unloading Required
		ID (Drawings)	Leg	Side		Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage		Governing Member Maximum Combined Axial + Bending Usage (%)(*)		
							Tower model	Drawings			
379	BB_+10+10+10+10	277	3	left	D1					R1	
		278	2	right	D1					R1	
		277	2	left	D1					R1	
		278	4	right	D1	195.1	276-1P	276	52.4	R1	X
		277	4	left	D1	195.0	4P	4P	52.4	R1	X
		277	1	left	D1				52.1	R1	
		278	3	right	D1					R1	
		278	1	right	D1	191.3	LX_276-1P	276	52.4	R1	X
380	BB_-5-5-5-5	75	2	center	D3	28.8	157-1P	157	27.2	R1	
		75	1	center	D3	28.8	157-1P	157	27.2	R1	
		75	3	center	D3	28.8	157-1P	157	27.2	R1	
		75	4	center	D3	28.8	157-1P	157	27.2	R1	
387	BB_-5-5-5-5	75	1	center	D3	43.7	152P	152	32.2	R1	
		75	4	center	D3	43.7	152P	152	32.2	R1	
		75	3	center	D3	43.7	152P	152	32.2	R1	
		75	2	center	D3	43.7	152P	152	32.2	R1	
390	BB_+10+10+10+10	278	3	right	D1	115.2	LY_276-2P	276	28.1	R1	X
394	BB_+0+0+0+0	227	3	left	D1					R1	
395	BB_+10+10+10+10	278	4	right	D1					R1	
399	BB_-5-5-5-5	236	4	left	D1					R1	
		234	1	left	D3					R1	
		234	2	right	D3					R1	
404	BB_+10+10+10+10	278	1	right	D1					R1	
406	BB_+10+10+10+10	277	1	left	D1	110.7	LX_276-1P	276	37.9	R1	X
		278	1	right	D1	111.6	LX_276-1P	276	44.9	R1	X
		278	3	right	D1	144.0	LY_276-1P	276	44.6	R1	X
		277	2	left	D1	151.1	LXY_276-1P	276	34.3	R1	X
		278	2	right	D1	37.0	157-1P	157	36.1	R1	
		277	4	left	D1	122.3	276-1P	276	44.6	R1	X
		278	4	right	D1	122.7	276-1P	276	48.6	R1	X
		277	3	left	D1	143.8	LY_276-1P	276	48.6	R1	X
410	HH_-5+-5+-5+-5	23	4	right	D1	64.6	283P	283	56.5	R1	
		22	3	left	D1	64.6	283P	283	56.5	R1	
		23	3	right	D1	64.6	283P	283	56.5	R1	
		23	4	right	D1	64.6	283P	283	56.5	R1	
		22	3	left	D1	64.6	283P	283	56.5	R1	
		23	3	right	D1	64.6	283P	283	56.5	R1	
412	BB_+5+5+5+5	258	1	left	D1					R1	

Notes

(*) - Manual calculation to check the (axial+bending) usage of members modelled as "BEAM" elements. Considered as critical when exceeding 140%.

L24	General Details					Repair & Remedy Analysis					
Str#	Tower Type and Extension	Defective Member			Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed incorrectly D5: Missing bolt D6: Altered member	Impact of Individual Deficient Member Removal (Construction and Maintenance Loading)				Remedy Index: R1: Replace Member R2: Create Double Angle R3: Install Redundants R4: No Actions Needed	Temporary Support or Tower Unloading Required
		ID (Drawings)	Leg	Side		Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage		Governing Member Maximum Combined Axial + Bending Usage (%)(*)		
							Tower model	Drawings			
415	EE_-5-5-5-5	201	4	right	D2					R1	
		201	4	left	D1	86.0	22-1XY	22	48.9	R1	
		201	1	right	D1	82.2	60-1Y	60	48.9	R1	
		201	2	right	D1	82.2	60-1Y	60	48.9	R1	
		207	1	right	D1	NA	NA	NA	NA	R1	
		207	1	left	D1	82.2	60-1Y	60	48.9	R1	
		207	2	left	D1	82.2	60-1Y	60	48.9	R1	
		207	4	left	D1	NA	NA	NA	NA	R1	
		175	3	center	D1	82.2	60-1Y	60	48.9	R1	
416	EE_-5-5-5-5	202	4	right	D1	68.2	121Y	121	58.4	R1	
		208	4	right	D1	68.2	121Y	121	58.4	R1	
		201	4	left	D1	68.2	121Y	121	58.4	R1	
		201	3	left	D1	68.2	121Y	121	58.4	R1	
		208	3	right	D1	68.2	121Y	121	58.4	R1	
		202	3	right	D1	68.2	121Y	121	58.4	R1	
		201	2	left	D1	68.2	121Y	121	58.4	R1	
		207	2	left	D1	68.2	121Y	121	58.4	R1	
		202	2	right	D1	68.2	121Y	121	58.4	R1	
		201	1	left	D1	68.2	121Y	121	58.4	R1	
		202	1	right	D1	68.2	121Y	121	58.4	R1	
		202	1	left	D6	68.2	121Y	121	58.4	R1	
417	BB_-5-5-5-5	235	3	center	D1					R2	
		237	1	right	D2					R1	
		237	3	right	D1					R1	
		236	4	right	D1					R1	
418	BB_+0+0+0+0	228	1	right	D1	45.1	g139P	226	35.6	R1	
		228	4	right	D1	`	g139P	226	35.6	R1	
		226	3	center	D1					R2	
		227	3	left	D1	45.8	g139P	226	35.6	R1	
419	BB_-5-5-5-5	236	2	left	D1					R1	
		233	3	left	D6					R1	
		233	4	left	D1					R1	
		236	3	left	D1					R1	
420	BB_+5+5+5+5	252	3	left	D1					R1	
		253	3	right	D1					R1	
		252	2	left	D1					R1	
		253	2	right	D1					R1	
		252	1	left	D1					R1	
		253	1	right	D1					R1	
		252	4	left	D1					R1	
		253	4	right	D1					R1	
421	EE_-5-5-5-5	201	3	left	D1	60.5	121P	121	39.4	R1	
		201	1	left	D1	60.5	121P	121	39.4	R1	
		202	1	right	D6	60.5	121P	121	39.4	R1	
		202	2	right	D6	60.5	121P	121	39.4	R1	

Notes

(*) - Manual calculation to check the (axial+bending) usage of members modelled as "BEAM" elements. Considered as critical when exceeding 140%.

NEWFOUNDLAND AND LABRADOR HYDRO
230KV TOWERS – DEFICIENCIES ANALYSIS OF LINES L23, L24, L23A, L24A
Appendix D – Work Plan Summary - L24

L24	General Details					Repair & Remedy Analysis					
Str#	Tower Type and Extension	Defective Member			Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed incorrectly D5: Missing bolt D6: Altered member	Impact of Individual Deficient Member Removal (Construction and Maintenance Loading)				Remedy Index: R1: Replace Member R2: Create Double Angle R3: Install Redundants R4: No Actions Needed	Temporary Support or Tower Unloading Required
		ID (Drawings)	Leg	Side		Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage		Governing Member Maximum Combined Axial + Bending Usage (%)(*)		
							Tower model	Drawings			
422	BB_+0+0+0+0	227	1	left	D1					R1	
		228	1	right	D1					R1	
		228	2	right	D1					R1	
		227	2	left	D1					R1	
423	BB_+0+0+0+0	227	2	left	D1					R1	
		228	2	right	D1					R1	
		227	3	left	D1					R1	
		228	3	right	D1					R1	
		227	1	left	D1					R1	
		75	4	center	D1					R1	
424	BB_+5+5+5+5	252	1	left	D1					R1	
425	BB_-5-5-5-5	234	3	right	D1					R1	
		233	2	left	D1					R1	
426	BB_-5-5-5-5	75	1	center	D3					R1	
		75	2	center	D3					R1	
		75	3	center	D3					R1	
		75	4	center	D3					R1	
427	BB_-5-5-5-5	237	1	right	D1					R1	
		237	4	right	D1					R1	
		236	3	left	D1					R1	
		236	2	left	D1					R1	
		237	2	right	D1					R1	
428	EE_-5-5-5-5	201	2	left	D2	NA	NA	NA	NA	R1	
		207	2	left	D1	NA	NA	NA	NA	R1	
		202	4	right	D2	NA	NA	NA	NA	R1	
		208	4	right	D1	NA	NA	NA	NA	R1	
		207	4	left	D2	NA	NA	NA	NA	R1	
		202	3	right	D1	63.1	121Y	121	42.1	R1	
		201	3	left	D1	63.1	121Y	121	42.1	R1	
		207	3	left	D1	63.1	121Y	121	42.1	R1	
		208	3	right	D1	63.1	121Y	121	42.1	R1	
		207	2	left	D2	NA	NA	NA	NA	R1	
		208	2	right	D2	NA	NA	NA	NA	R1	
		202	2	right	D1	63.1	121Y	121	42.1	R1	
		75	3	center	D1	63.1	121Y	121	42.1	R1	
		75	2	center	D1	63.1	121Y	121	42.1	R1	
		207	1	left	D2	NA	NA	NA	NA	R1	
		208	1	right	D1	63.1	121Y	121	42.1	R1	
429	BB_+5+5+5+5	252	1	left	D1					R1	
430	EE_-5-5-5-5	201	1	left	D1	62.8	121Y	121	42.9	R1	
431	BB_+5+5+5+5	252	3	left	D1					R1	
		252	4	left	D1					R1	
435	BB_+0+0+0+0	75	1	center	D1	30.5	157-1P	157	30.8	R1	

Notes
(*) - Manual calculation to check the (axial+bending) usage of members modelled as "BEAM" elements. Considered as critical when exceeding 140%.

NEWFOUNDLAND AND LABRADOR HYDRO
230KV TOWERS – DEFICIENCIES ANALYSIS OF LINES L23, L24, L23A, L24A
Appendix D – Work Plan Summary - L24

L24	General Details					Repair & Remedy Analysis					
Str#	Tower Type and Extension	Defective Member			Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed incorrectly D5: Missing bolt D6: Altered member	Impact of Individual Deficient Member Removal (Construction and Maintenance Loading)				Remedy Index: R1: Replace Member R2: Create Double Angle R3: Install Redundants R4: No Actions Needed	Temporary Support or Tower Unloading Required
		ID (Drawings)	Leg	Side		Maximum Tower Structure Usage (%)	Member Governing Maximum Tower Usage		Governing Member Maximum Combined Axial + Bending Usage (%)(*)		
							Tower model	Drawings			
443	BB_-5-5-5-5	75	1	center	D3					R1	
		75	2	center	D3					R1	
		75	3	center	D3					R1	
		75	4	center	D3					R1	
461	BB_+0+0+0+0	228	1	right	D1					R1	
469	BB_-5-5-5-5	75	2	center	D3					R1	
		75	3	center	D3					R1	
		75	4	center	D3					R1	
		75	1	center	D3					R1	
479	BB_-5-5-5-5	75	4	center	D3					R1	
		75	1	center	D3					R1	
		75	2	center	D3					R1	
		75	3	center	D3					R1	
513	BB_+0+0+0+0	227	3	left	D1					R1	
		228	3	right	D1					R1	
529	BB_-5-5-5-5	75	1	center	D3					R1	
		75	2	center	D3					R1	
		75	3	center	D3					R1	
		75	4	center	D3					R1	

Notes

(*) - Manual calculation to check the (axial+bending) usage of members modelled as "BEAM" elements. Considered as critical when exceeding 140%.

L23A, L24A		General Details					Repair & Remedy Analysis					
Circuit #	Str#	Tower Type and Extension	Defective Member			Defeciency Type: D1: Bent Member D2: Broken Member D3: Missing Member D4: Installed incorrectly D5: Missing bolt D6: Altered member	Impact of Individual Deficient Member Removal (Construction and Maintenance Loading)				Remedy Index: R1: Replace Member R2: Create Double Angle R3: Install Redundants R4: No Actions Needed	Temporary Support or Tower Unloading Required
			ID (Drawings)	Leg	Side		Maximum Tower Structure Usage (%)	Member Governing		Governing Member Maximum Combined Axial + Bending Usage (%)(*)		
								Tower model	Drawings			
L23A	2	RT-0_+5+5+5+5	167	2	left	D1	10.7	10Y	10	0.193	R1	
L23A	3	RT-0_+20+20+20+20	15	NA	NA	D1	NA	NA		NA	R4	
L24A	2	RT-0_+5+5+5+5	171	4	right	D6	46.9	LXY_167-L2P	167	0.232	R1	
L24A	3	RT-0_+20+20+10+10	175	4	right	D1	14.3	174-1XY_P	174	0.228	R1	
L24A	4	RT-0_+5+5+5+0	161	4	left	D1	67.3	LXY_167-T2P	167	0.593	R1	
L24A	7	RT-DE-70_+0+0+0+0	54	NA	NA	D1	NA	NA		NA	R4	
L24A	63	GV-0	148	NA	NA	D1	24.9	106P	E106		R1	

Notes

(*) - Manual calculation to check the (axial+bending) usage of members modelled as "BEAM" elements. Considered as critical when exceeding 140%.

Overhaul Turbine Valves and Generator – Unit 2

(2026)

Holyrood

Overhaul Turbine Valves and Generator – Unit 2 (2026)

Location: Holyrood

Investment Classification: Renewal

Asset Category: Thermal Plant

Estimated Cost: $6,969,600

Executive Summary

To support the continued safe and reliable availability for operation of the Holyrood Thermal Generating Station ("Holyrood TGS"), Newfoundland and Labrador Hydro ("Hydro") is proposing the overhaul of the Unit 2 generator and turbine valves at the Holyrood TGS.

The Unit 2 generator overhaul was last performed in 2020, and the turbine valves overhaul was last performed in 2023. As such, the Unit 2 generator and turbine valves are due for overhaul in 2026 according to the established generator and turbine valve overhaul cycles.

As identified through the *Reliability and Resource Adequacy Study Review* proceeding (*"RRA Study Review"*),[1] the Holyrood TGS shall remain available for a Bridging Period until 2030,[2] or until such time that sufficient alternative generation is commissioned, adequate performance of the Labrador-Island Link ("LIL") is proven, and generation reserves are met. At this time, capital investment related to the generation function of the Holyrood TGS, such as the overhaul of the Unit 2 generator and turbine valves, is necessary to support system reliability and maintain Hydro's ability to meet customer demand during peak periods.

Completing this overhaul will contribute to the continued safe and reliable operation of Unit 2 through a reduction in forced outages due to generator and turbine valve component failures.

[1] "2024 Resource Adequacy Plan – An Update to the Reliability and Resource Adequacy Study," Newfoundland and Labrador Hydro, rev. August 26, 2024 (originally filed July 9, 2024).

[2] Hydro considers the Bridging Period to be from the present to 2030. During the Bridging Period, the system would rely primarily on existing sources of generation capacity to maintain reliability while new generation capacity is being built. The primary, readily available supply options in this period are extending the retirements of the Holyrood TGS, Stephenville Gas Turbine and the Hardwoods Gas Turbine until their capacities can be adequately replaced.

Contents

1.0 Introduction

The Unit 2 generator at the Holyrood TGS is a critical asset required for the generation of 170 MW of power. The Unit 2 turbine valves are required for the safe and reliable operation of the turbine. To support the continued safe and reliable operation of the Holyrood TGS, Hydro is proposing to overhaul the Unit 2 generator and turbine valves in 2026.

Hydro's historical experience at the Holyrood TGS has demonstrated that an overhaul on a six-year cycle for the generators and a three-year cycle for the turbine valves is appropriate, based on the observations made during previous overhauls. The Unit 2 generator overhaul was last performed in 2020. The Unit 2 turbine valves overhaul was last performed in 2023. As such, the Unit 2 generator and turbine valves are due for an overhaul in 2026 according to the established generator and turbine valve overhaul cycles.[3]

The overhaul cycles are also consistent with the original equipment manufacturer's ("OEM") recommendation, and the Life Extension Condition Assessment ("LECA") as conducted by Hatch Ltd. ("Hatch") as part of the *RRA Study Review*,[4] with a Capital Plan Refresh performed in March 2025.[5]

If an overhaul is not completed at this time, the generator and turbine valves could fail while in operation. Such failure could result in unsafe operating conditions and forced unit outages, resulting in the loss of up to 170 MW for several weeks to several months in duration, depending on the magnitude of the failure.

As identified through the *RRA Study Review*, the Holyrood TGS shall remain available for a Bridging Period until 2030, or until such time that sufficient alternative generation is commissioned, adequate performance of the LIL is proven, and generation reserves are met. At this time, capital investment related to the generation function of the Holyrood TGS, such as the overhaul of the Unit 2 generator and turbine valves, is necessary to support system reliability and maintain Hydro's ability to meet customer demand during peak periods.

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[3] As the turbine overhaul is not due to be performed until a future year, it is not included in this project.

[4] "*Reliability and Resource Adequacy Study Review* – Assessment to Determine the Potential Long-Term Viability of the Holyrood Thermal Generating Station," Newfoundland and Labrador Hydro, March 31, 2022, att. 2.

[5] "*Reliability and Resource Adequacy Study Review* – Holyrood Thermal Generating Station Capital Plan Refresh," Newfoundland and Labrador Hydro, March 7, 2025, att. 1.

2.0 Project Description and Justification

The scope of work under this project consists of inspections and associated refurbishments completed every six years for the Unit 2 generator and every three years for the Unit 2 turbine valves. The overhaul frequency is based on OEM recommendations, third-party assessors, industry standards, and Hydro's operational experience.

The generator overhaul includes removal of the rotor, electrical testing of the windings, visual inspection, non-destructive examination and refurbishment of components as required, such as rotor retaining rings, bearings,[6] hydrogen seals,[7] end-winding supports, hydrogen coolers[8] and collector rings. These components are subject to deterioration during operation due to different degradation mechanisms such as wear, vibration and thermal stresses. Failure of critical generator components such as bearings, hydrogen seals, winding, and rotor retaining rings would require premature, costly repair work and a major outage to the unit.

The turbine valves' overhaul includes the removal and disassembly of valve components to inspect, test, clean, and refurbish, as required. If the turbine valves are not overhauled per this schedule, they are at an elevated risk of not functioning as designed. From a safety perspective, the stop valves, blowdown valves, and non-return valves must function properly during an operational upset condition to prevent overspeed of the turbine and generator rotor. Overspeed can happen very quickly, and these valves must slam shut (or open in the case of the blowdown valve) to avoid unsafe operating conditions. An overspeed failure has the potential to be catastrophic and can severely impact safe and reliable operations.[9] Furthermore, the steam admitted to the turbine is at very high temperatures and pressures. The failure of any pressure boundary valve component has the potential to become a serious safety hazard.

To ensure the Unit 2 generator and turbine valves remain in safe and reliable operating conditions, it is prudent that regular preventive maintenance is performed. Completing this overhaul will contribute to the continued safe and reliable operation of Unit 2 through a reduction in forced outages due to

[6] The generator is supported by two journal bearings.
[7] Hydrogen seals prevent hydrogen used for the generator cooling from leaking out of the generator casing, particularly around the rotor shaft, using pressurized oil at both hydrogen and air sides to maintain a pressure barrier higher than the hydrogen pressure, ensuring hydrogen remains inside the generator.
[8] Hydrogen coolers utilize cooling water to maintain the correct hydrogen temperature within the generator.
[9] The turbine rotor weighs approximately 60,000 pounds and rotates at 60 times per second.

generator and turbine valve component failures as well as confirmation of operational accuracy of critical safety valves.

Following the receipt of the 2025 Capital Budget Application ("CBA") Board of Commissioners of Public Utilities ("Board") Order No. P.U. 28(2024), Hydro conducted a review of the classification of its programs within the 2025 CBA and determined that due to the nature of the assets being replaced (i.e., individual asset values higher than lowest materiality threshold), the scopes of work contained in overhaul proposals for generators and turbine valves were more appropriately defined as projects. As a result, Hydro has provided the information within this proposal as required by the provisional CBA Guidelines[10] relating to projects.

3.0 Asset Overview

3.1 Asset Background

The Unit 2 generator and turbine were manufactured by General Electric in 1969. The generator is comprised of two primary components, a stator and a rotating field ("rotor"). The rotor is coupled to and driven by the steam turbine (as shown in Figure 1) and rotates inside the stator to produce electricity in the stator windings.

Figure 1: Holyrood TGS Unit 2 Turbine Generator

[10] "Capital Budget Application Guidelines (Provisional)," Board of Commissioners of Public Utilities, January 2022.

The turbine valves control the admission of steam energy into the turbine to control the quantity of steam necessary to generate the desired MW output from the generator, and also provide protection to the turbine during operational upset situations, such as a unit trip, powerline trip, or generator fault that could otherwise cause a catastrophic turbine overspeed condition or other damage to the turbine components.

Unit 2 is equipped with 17 major turbine valves with functions summarized as follows:

- **One main stop valve:** All steam from the boiler passes through this valve, and it is designed to automatically close in the event of a trip to stop the supply of steam to the high-pressure section of the turbine.
- **Six control valves and two combined reheat stop/intercept valves:** These valves are used for the regulation of steam flow from the boiler into the turbine for turbine speed control as well as the output of the generator. They are also designed to automatically close and seal off the steam supply in the event of a trip for over-speed protection.
- **One blowdown valve:** This valve remains closed during normal turbine operation. It automatically opens for emergency steam pressure release in the event of a trip to release steam that becomes trapped in the turbine on the high-pressure and intermediate pressure sections.
- **Seven extraction steam non-return valves:** During normal operation, these valves allow steam to be extracted from various sections of the turbine to be used for pre-heating of boiler feedwater for efficiency gains. In the event of a trip, they are also designed to shut in to prevent backflow of steam into the turbine that could lead to overspeed.

3.2 Historical Reliability

Hydro tracks performance data for its thermal generation units using the Derated Adjusted Forced Outage Rate (“DAFOR”);[11] this data is filed quarterly with the Board.[12] This overhaul allows Hydro to continue minimizing the DAFOR of its thermal generation units to ensure the provision of reliable service to customers.

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[11] DAFOR is a metric that measures the percentage of time that a unit or group of units is unable to generate at its maximum continuous rating due to forced outages or unit deratings.

[12] Most recent “Quarterly Report on Asset Performance in Support of Resource Adequacy for the Twelve Months Ended March 31, 2025,” Newfoundland and Labrador Hydro, April 30, 2025.

3.3 Asset Condition

The Unit 2 generator is original to Holyrood TGS and is approaching 56 years old. Annual electrical testing is being carried out on the generator due to the asset's age and total hours of operation. While such testing is beneficial in getting an indication of the generator's health, there are many components of the generator that cannot be inspected without doing an overhaul.

The 2021 LECA conducted by Hatch determined that the Unit 2 generator and turbine valves are in good condition, indicating that the generator and turbine valves may show signs of slightly defective or deteriorated components, but are overall functional.

4.0 Analysis

4.1 Evaluation of Alternatives

Hydro evaluated the following alternatives:

- Deferral;
- Condition-based refurbishment; and
- Overhaul.

4.1.1 Deferral

Deferral of this project increases the failure risk of the Unit 2 generator and turbine valves while in operation, which could result in collateral damage and loss of 170 MW of generation for several weeks to several months. Data obtained through preventive maintenance activities is not comprehensive enough to allow Hydro to make an accurate prediction regarding the likelihood of failure in advance of the next planned overhaul.

If the generator is not overhauled, critical components such as bearings, hydrogen seals, windings, and rotor retaining rings could fail in service, requiring unplanned, costly repair work and causing a major outage. For example, the generator rotor must be removed from the stator to replace damaged rotor retaining rings.

If the turbine valves are not overhauled, there will be an elevated risk of not functioning as designed. Oxide scale buildup can impede valve movement. Erosion and wear can increase clearances and lead to valve failures. Cracking and other damage may occur and propagate, leading to failures. Proper operation of all of the turbine valves is required to admit steam to the turbine and control the turbine to produce electricity. Any failure will limit production and likely result in a forced outage. Because of the complexity and magnitude of the components, significant outages would be expected if repairs were required. For example, a control valve camshaft failure on Unit 2 in 2019 resulted in a forced outage of 22 days. From a safety perspective, the stop valves, blowdown valve, and non-return valves must function properly during an operational upset condition to prevent overspeed of the turbine and generator rotor. Further, the steam admitted to the turbine, even in the intermediate section, is at very high temperatures and high pressures. The failure of any pressure boundary valve component has the potential to become a serious safety hazard.

The current overhaul intervals for the generators and turbine valves at the Holyrood TGS were recommended by the OEM and third-party consultants and have proven to be an appropriate timeframe based on operational experience. Hydro believes a deferral of this project poses an unacceptable risk to the safe and reliable operations of the Holyrood TGS, consistent with the least cost and environmental responsibility.

4.1.2 Condition-Based Refurbishment

The condition of the generator and turbine valves cannot be adequately determined through external inspection or monitoring instrumentation. To assess the condition of internal components, disassembly of the generator and turbine valves is required. As such, condition-based refurbishment of the generator and turbine valves is not a viable alternative.

4.1.3 Overhaul

This alternative consists of planned disassembly, detailed internal inspection, refurbishment and reassembly of all major internal components of the Unit 2 generator and turbine valves. Components that have been identified as damaged in the inspections are refurbished or replaced. This alternative aligns with Hydro’s experience and external recommendations, and allows Hydro to manage risk within an acceptable level.

4.2 Least-Cost Evaluation

Hydro has not identified any viable alternatives to facilitate a least-cost evaluation.

4.3 Recommended Alternative

Hydro recommends overhauling the Holyrood TGS Unit 2 generator and turbine valves in 2026. Overhauling the Unit 2 generator and turbine valves in accordance with Hydro's established practices, third-party assessments, and OEM recommendations will maintain this asset in good operating condition, contributing to the continued safe and reliable operation of Unit 2, consistent with least cost and environmental responsibility.

4.3.1 Risk of Asset Stranding

The risk of asset stranding is less imminent as a result of the decision to extend Holyrood TGS to remain available through the Bridging Period. As Hydro expects continued operation of all three units at the Holyrood TGS through the Bridging Period until its capacity can be adequately replaced to ensure reliable operation for customers, capital expenditures for this facility to operate as a generator continue to be required. Depreciation is required to be calculated on an accelerated basis (i.e., monthly depreciation = capital investment ÷ remaining months of service life).[13]

4.3.2 Risk Mitigation

Hydro assessed the pre- and post-implementation risk of the scope of work for this project in accordance with Hydro's Capital Risk Assessment process as outlined in Section 7.0 of Schedule 1. The outcome of this assessment is provided in Table 1.

Table 1: Risk Scoring Pre- and Post-Implementation

	Impact	Likelihood	Score
Pre-Implementation	5	4	**20**
Post-Implementation	5	1	**5**
		Risk Mitigated	**15**
		Risk Mitigated per $1 Million	**2.2**

[13] Due to the extension of the Holyrood TGS through the Bridging Period, Hydro submitted an application to the Board to extend the Holyrood Accelerated Depreciation Deferral Account. The extension of the account and related amendments were approved in Board Order No. P.U. 1(2024). Hydro was also directed to file a report on the account in its next general rate application.

5.0 Scope of Work

The overhaul of the Unit 2 generator will consist of dismantling the generator end shields, hydrogen seals and bearings, removal of the rotor from the stator, electrical testing of the stator and rotor windings, inspection, replacement or refurbishment of components as required, re-assembly of generator components, and commissioning. As the turbine and generator rotors are coupled, the balance of the turbine and generator will be checked and adjusted, as required, after re-assembly of the generator components.

The overhaul of the Unit 2 turbine valves will consist of dismantling the turbine valves, including the control valves, main stop valve, combined reheat stop and intercept valves, extraction non-return valves, and blowdown valve, for inspection and detailed measurements. The valves will be refurbished as required through the replacement of damaged parts. The valves will be reassembled and commissioned to ensure proper operation.

5.1 Project Budget

The estimate for this project is shown in Table 2.

Table 2: Project Estimate ($000)

Project Cost	2026	2027	Beyond	Total
Material Supply	220.0	0.0	0.0	220.0
Labour	481.3	0.0	0.0	481.3
Consultant	25.0	0.0	0.0	25.0
Contract Work	5,012.5	0.0	0.0	5,012.5
Other Direct Costs	0.0	0.0	0.0	0.0
Interest and Escalation	350.6	0.0	0.0	350.6
Contingency	880.1	0.0	0.0	880.1
Total	**6,969.6**	**0.0**	**0.0**	**6,969.6**

5.2 Project Schedule

The schedule for this project is shown in Table 3.

Table 3: Project Schedule

Activity	Start Date	End Date
Planning:		
Prepare planning documents.	January 2026	January 2026
Review materials inventory.	January 2026	January 2026
Design:		
Prepare technical specifications for the overhaul contract.	February 2026	March 2026
Procurement:		
Prepare overhaul contract documents.	March 2026	March 2026
Construction:		
Supply construction materials.	March 2026	November 2026
Perform Unit 2 generator and turbine valves overhauls.	May 2026	November 2026
Closeout:		
Prepare closeout documents.	November 2026	December 2026

6.0 Conclusion

The overhaul of the Holyrood TGS Unit 2 generator was last performed in 2020. The overhaul of Unit 2 turbine valves was last performed in 2023. To support the continued safe and reliable operation of Unit 2 at its rated output of 170 MW, consistent with least cost and environmental responsibility, Hydro recommends overhauling the Unit 2 generator and turbine valves in 2026. This planned overhaul is consistent with previous overhaul cycles that have demonstrated that such frequency is appropriate. The project scope is also consistent with the established overhaul frequency based on OEM recommendations, industry standards, and third-party assessments.

$1,000,000 to $5,000,000

Project 4

Upgrade Worst-Performing Distribution Feeders

(2026–2027)

newfoundland labrador hydro

Contents

List of Appendices

Upgrade Worst-Performing Distribution Feeders (2026–2027)

Location: L'Anse-au-Loup, Line 1

Investment Classification: Service Enhancement

Asset Category: Distribution

Estimated Cost: $4,291,200

1.0 Introduction

Newfoundland and Labrador Hydro ("Hydro") owns and operates distribution systems in the rural communities it serves. Each distribution system typically consists of a substation coupled with a wood pole distribution feeder(s) that supply power from the substation to service drops throughout a community. Historically, Hydro used a condition-based assessment approach to identify components of its distribution systems that needed to be refurbished to ensure reliable operation, which is now included under Hydro's Renew Distribution Feeders project.

Since 2019, Hydro has also been prioritizing the refurbishment of distribution feeders that have poor reliability performance. The Upgrade Worst-Performing Distribution Feeders (2026–2027) project includes the refurbishment of distribution feeder L'Anse-au-Loup Line 1 ("LAL-L1"), which has been prioritized through the examination of reliability performance data and confirmed as requiring upgrades to the existing infrastructure based on recent condition assessments.

2.0 Project Description and Justification

Work proposed under Hydro's Upgrade Worst-Performing Distribution Feeders project is prioritized based on five-year average reliability indices: SAIDI,[1] SAIFI,[2] CHI,[3] CHIKM,[4] and CIKM.[5] These metrics are used independently of each other and are intended to identify trending reliability issues. Hydro then uses condition assessment information to validate the issues identified through these indices to finalize the scope of work required to upgrade the system effectively.

SAIDI and SAIFI represent the reliability performance of a distribution feeder based on the impact outages have on that feeder's customers. One of the drawbacks of selecting feeders based on the SAIDI or SAIFI metric alone is that it considers the feeder-level indices and does not consider the impact the feeder has on overall distribution system reliability indices. SAIFI can be improved by reducing the number of interruptions, and SAIDI can be improved by reducing the duration of these interruptions, and both of these reflect reliability improvements. Hydro examines the distribution feeders based on the CHI value as well. CHI measures feeder reliability based on the impact the feeder has on overall reliability indices. CHI value tends to be higher for the feeders serving a large number of customers. Feeders with an elevated CHI value are further analyzed to identify the asset condition, performance, and associated customer impact. While Hydro does not prioritize one reliability metric over another, in instances where feeders have similar performance based on SAIDI and SAIFI, Hydro will consider CHI to target reliability improvements that will provide the largest benefit to the greatest number of customers.

[1] System Average Interruption Duration Index ("SAIDI"). SAIDI indicates the System Average Interruption Duration Index for customers served per year, or the average length of time a customer is without power in the respective distribution system per year. This index is calculated excluding loss of supply outages, planned outages, customer requests, and major events.

[2] System Average Interruption Frequency Index ("SAIFI"). SAIFI is the System Average Interruption Frequency Index per year, which indicates the average of sustained interruptions per customer served per year, or the average number of power outages a customer has experienced in the respective distribution system per year. This index is calculated excluding loss of supply outages, planned outages, and customer requests.

[3] Customer-Hours of Interruption ("CHI") is the sum of the products of the outage duration multiplied by the number of customers affected during the outage for each event within a one-year period. This index is calculated excluding loss of supply outages, planned outages, customer requests, and major events.

[4] Customer Hours of Interruption per Kilometre ("CHIKM") is calculated by dividing the number of customer outage hours by the kilometres of feeder. This index is calculated excluding loss of supply outages, planned outages, customer requests, and major events.

[5] Customers Interrupted per Kilometre ("CIKM") is calculated by dividing the number of customers that have experienced an outage by the kilometres of feeder. This index is calculated excluding loss of supply outages, planned outages, and customer requests.

In 2022, Hydro added two additional indices to its reliability analysis for this program—CHIKM and CIKM. CHIKM and CIKM represent the reliability performance of a distribution feeder based on the circuit length. These indices tend to identify problematic feeders with shorter lengths. Due to the length of the LAL-L1 feeder, the CHIKM and CIKM indices are not relevant and have been removed from this report to simplify the analysis.

Hydro's worst-performing feeder lists by reliability metric and summary of data analysis is provided in Appendix A. Table A-1 to Table A-3 show feeder ranking by reliability metric, and Table A-4 shows the analysis summary.

The top 20 worst-performing feeders on each list are analyzed to identify the root cause of the poor performance. This includes a review of current inspection data, overall system design, work completed on past capital projects, other line dependents, and a site visit to confirm data collected and collect additional asset information. Once the assessment is completed, Hydro selects the capital work that will improve the reliability of the distribution feeder, which is justified by inspection data and feeder assessment. For example, if an issue causing poor performance was due to an isolated incident or was recently addressed by other capital work, Hydro would not undertake any capital work, and the feeder would be identified for continued monitoring.

Hydro's most recent analysis of worst-performing distribution feeders has identified LAL-L1 as requiring upgrades. LAL-L1 is included as one of Hydro's worst-performing feeders from the perspective of all three reliability metrics—SAIDI, SAIFI and CHI, as shown in Appendix A. These results have been validated based on a recent field assessment of the feeder's condition. In addition, as the reliability of LAL-L2 is dependent upon the reliability of L1, Hydro believes it is prudent to prioritize this work as there is currently an ongoing upgrade project on L2. Hydro notes that there are other feeders shown on the CHI, SAIDI and SAIFI lists in Appendix A that are higher or close in priority to the ranking for LAL-L1; however, these have been excluded from the selection process for capital work for the following reasons:

- Capital work has already been completed or is in progress. As the indices are based on five-year performance data, these feeders will continue to be monitored for performance. Examples of these include Farewell Head Line 1, Barachoix Line 1, Bottom Waters Line 1, Fleur-de-Lys Line 1, and LAL-Line 2.

- LAL-L1 and LAL-L2 are interconnected, with L1 providing the power supply for L2 from the Hydro-Québec feed. As such, the overall reliability of the L2 system is tied to the reliability of L1. One of the largest reliability issues with the L'Anse-au-Loup system is loss of supply from Hydro-Québec as a result of a fault on L1, and the associated time to transfer to the diesel plant. Loss of supply is excluded from the analysis to determine the worst-performing feeder(s). As there is an ongoing upgrade to LAL-L2 to improve reliability, it would be prudent to perform the same level of upgrade on LAL-L1, as they are both exposed to the same environmental conditions with similar operating experience.
- The majority of outages are the result of encroaching vegetation issues and not any specific line components. This is typically dealt with through Hydro's ongoing Vegetation Management Program. Examples of these include Jackson's Arm Line 2.
- The majority of outages are the result of failures on larger equipment such as metering tanks, reclosers, power transformers, voltage regulators, etc. These items are being assessed independently and will continue to be monitored.
- The majority of outages are the result of isolated issues and/or prolonged power outages due to remote access. These feeders will continue to be monitored for performance. Examples of these include Black Tickle Line 1 and Happy Valley Line 15.
- The inspections do not yield adequate data to investigate the true source of the reliability issue. This requires additional monitoring to ensure that reliability improvement efforts are being directed at the source of the issues. Additional field investigation is required before a capital project can be proposed to improve reliability.

Following the receipt of the 2025 Capital Budget Application ("CBA") Board of Commissioners of Public Utilities Order No. P.U. 28(2024), Hydro conducted a review of the classification of its programs within the 2025 CBA and determined that, due to the nature of the assets being replaced, the scope of work contained in Upgrade Worst-Performing Distribution Feeders proposals was more appropriately defined as a project. As a result, Hydro has provided the information within this proposal as required by the provisional CBA Guidelines[6] relating to projects.

[6] "Capital Budget Application Guidelines (Provisional)," Board of Commissioners of Public Utilities, January 2022.

3.0 Asset Overview

3.1 Asset Background

LAL-L1 is a three-phase, 25 kilovolt (kV) distribution feeder that originates from the L'Anse-au-Loup Substation. It is connected to Hydro-Québec. Energy is supplied through Hydro's diesel generating station in L'Anse-au-Loup and imported energy from Hydro-Québec. This feeder was constructed over 40 years ago and services approximately 435 customers. The location of the LAL-L1 feeder is shown in Figure 1.

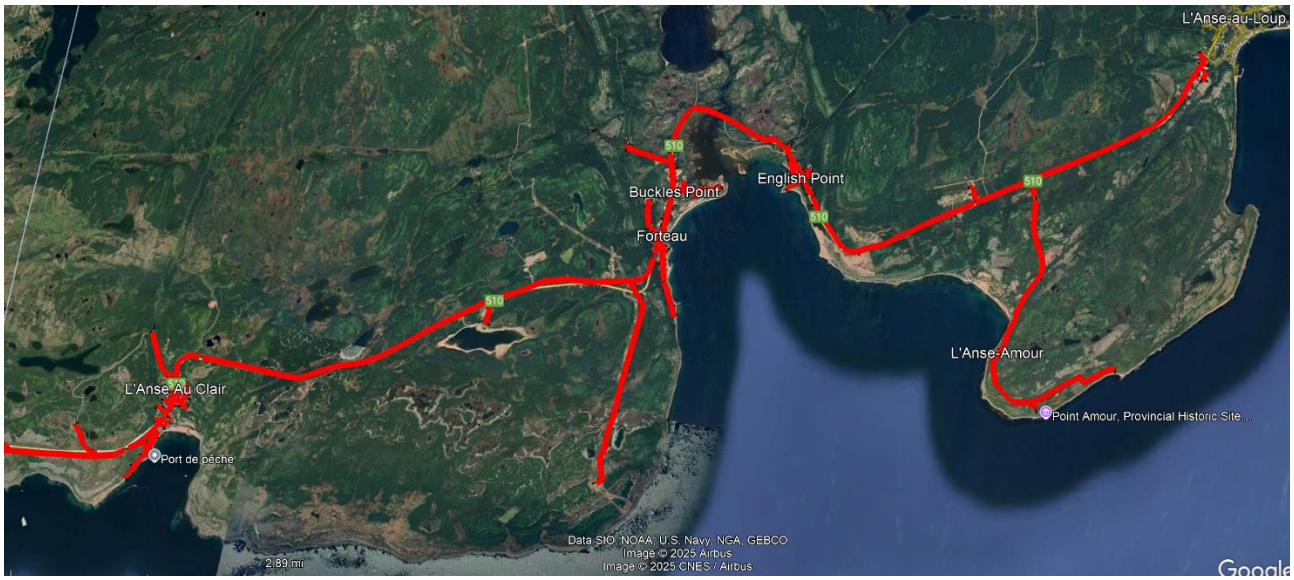

Figure 1: Layout of LAL-L1

LAL-L1 runs from the L'Anse-au-Loup Substation for approximately 27 kilometres (km) along the Trans Labrador Highway, Route 510, as a three-phase overhead feeder supplying customers in the communities of L'Anse-au-Loup, English Point, Buckles Point, Forteau, and L'Anse Au Clair. The line also connects L'Anse-Amour.

3.2 Historical Reliability

Table 1 provides the reliability data for LAL-L1 as well as a comparison to Hydro's average, which indicates that this feeder has performed poorly relative to Hydro averages for SAIDI, SAIFI, and CHI.

Table 1: Five-Year Average Reliability Data for LAL-L1 (2019–2023)

Location	SAIDI	SAIFI	CHI
LAL-L1	7.75	3.18	3,262
Hydro	3.84	1.55	1,121[7]

A Line Inspection completed in 2024 identified that the reliability experienced by customers serviced by this feeder was impacted by hardware failures, such as insulator failures, broken crossarms, and broken conductor incidents. In 2022, a major failure occurred on the L'Anse-au-Loup distribution system as a result of a broken conductor damaged by a severe icing event, which was considered to be non-standard.

3.3 Asset Condition

The feeders covered under this program have numerous types of assets. The age of assets varies as the feeders are continuously updated through planned and unplanned replacement or refurbishment activities. The LAL-L1 feeder was constructed over 40 years ago and has some assets dating back to the 1980s.

Recent inspection records indicate LAL-L1 has deteriorated poles, crossarms, and pole-mounted transformers. As well, this feeder has approximately 17 km of three-phase line consisting of substandard conductor and hardware, which is in poor condition. Due to the wear and stretching of the conductor over its life, it poses a risk of breakage during peak loads, windstorms, and while line work is ongoing.

Insulators on sections of LAL-L1 have insufficient creepage distance for operation in such high levels of salt contamination. When salt and ice build up on insulators, they create a contamination layer, resulting in leakage current from the conductor to the insulator base. Over time, this condition results in a flashover event and equipment failures. Therefore, the replacement of insulators with higher creepage distance units is necessary.

[7] Hydro CHI represents the average number of CHI per feeder. It is calculated by dividing the number of total customer outage hours by the number of distribution feeders.

3.4 Condition-Based Remaining Life

The assets to be replaced under this program have failed, are nearing the point of failure, or are obsolete; as such, they have reached the end of their remaining useful life. The line components not addressed under this project are considered to be in adequate to good condition, and have expected remaining useful lives ranging from six years (until the next preventive maintenance cycle) to 20 years or more. Since the insulators on LAL-L1 are subject to salt contamination damage, they need to be replaced under this project with a more suitable insulator that has a longer life expectancy and a superior performance rating in high salt environments.

4.0 Analysis

4.1 Evaluation of Alternatives

The following alternatives were evaluated:

- Deferral;
- Upgrade LAL-L1; and
- Like-for-like replacement.

4.1.1 Deferral

If the required upgrade work were deferred to a future year, it would further contribute to growing the number of deficiencies, negatively impacting future costs, and would present an increased risk to distribution system reliability. This could potentially result in increased costs associated with unplanned work or outage response. In addition, deferring this project would create a safety hazard for workers and the public, as Hydro does not allow distribution line components to remain in service until failure; therefore, deferral is not a viable option.

4.1.2 Upgrade LAL-L1

Completing the identified refurbishment work for LAL-L1 is consistent with Hydro’s asset management practice of completing upgrade work on feeders identified as having poor reliability performance. The upgrades will ensure potential issues are addressed in a timely manner, thus avoiding excessive customer outages and associated costs related to unplanned work or outage response.

4.1.3 Like-for-Like Replacement

Hydro has considered building a new distribution line as an alternative strategy to completing the proposed upgrades. However, the feeder has existing line components that are still operable, such as poles, conductors, and crossarms. Construction of an entirely new line would result in the premature retirement of those existing, functional assets. The complete replacement of the existing feeder requires a level of investment that is not required for the continuation of safe, reliable, and least-cost service in an environmentally responsible manner, and is not considered a viable option.

4.2 Least-Cost Evaluation

Hydro has not identified any viable alternatives to facilitate a detailed least-cost evaluation.

4.3 Recommended Alternative

Hydro recommends performing the feeder upgrades as outlined above. This work will result in deteriorated line components being replaced, including a more suitable insulator that has a longer life expectancy in high salt environments. The upgrade of LAL-L1 is scheduled to begin in 2026.

4.3.1 Risk of Asset Stranding

Hydro does not anticipate a change in service requirements in these areas; therefore, the risk of asset stranding is low.

4.3.2 Risk Mitigation

Hydro assessed the pre- and post-implementation risk of the scope of work for the 2026 project in accordance with Hydro's Capital Risk Assessment process as outlined in Section 7.0 of Schedule 1. The outcome of this assessment is provided in Table 2.

Table 2: Risk Scoring Pre- and Post-Implementation

	Impact	Likelihood	Score
Pre-Implementation	3	5	**15**
Post-Implementation	3	2	**6**
		Risk Mitigated	**9**
		Risk Mitigated per $1 Million	**2.1**

5.0 Scope of Work

An overview of the work to be completed under this program beginning in 2026 is as follows:

- Install 22 new poles and midspans;
- Replace substandard conductor (approximately 17 kilometres) with 1/0 Aluminum Conductor Steel-Reinforced cable;
- Replace obsolete/deteriorated switches exposed to salt contamination;
- Upgrade all feeder line post insulators to 46 kV polymer;
- Replace two pole-mounted distribution transformers;
- Replace auto-sleeves existing in primary conductor;
- Replace obsolete suspension insulators; and
- Fault indicator installs.

5.1 Project Budget

The estimate for this project is shown in Table 3.

Table 3: Project Estimate ($000)[8]

Project Cost	2026	2027	Beyond	Total
Material Supply	100.2	1,055.5	0.0	**1,155.7**
Labour	406.8	1,610.4	0.0	**2,017.2**
Consultant	20.0	70.0	0.0	**90.0**
Contract Work	62.6	175.0	0.0	**237.6**
Other Direct Costs	57.6	6.9	0.0	**64.5**
Interest and Escalation	44.4	325.3	0.0	**369.8**
Contingency	64.7	291.8	0.0	**356.5**
Total	**756.3**	**3,534.9**	**0.0**	**4,291.2**

[8] Numbers may not add due to rounding.

5.2 Project Schedule

The schedule for the 2026–2027 program is shown in Table 4.

Table 4: Project Schedule

Activity	Start Date	End Date
Planning:		
Resource planning.	January 2026	January 2027
Design:		
Conduct site visits and detailed design.	May 2026	July 2027
Procurement:		
Materials ordered.	June 2026	March 2027
Construction:		
Construction.	May 2027	September 2027
Commissioning:		
Commissioning of refurbished work.	May 2027	September 2027
Closeout:		
Complete closeout documentation.	September 2027	November 2027

6.0 Conclusion

Hydro regularly executes larger feeder refurbishment and replacement work under this program to maintain or improve distribution system reliability performance. These larger upgrades are selected based on reliability performance analysis and condition assessments. Proactive refurbishment of Hydro's distribution system is required to support Hydro's legislated mandate to ensure the delivery of safe, reliable, least-cost electricity in an environmentally responsible manner. Refurbishment of deteriorated assets along a feeder, identified as being at, or close to, the end of their useful service lives, will ensure Hydro is maintaining safety and addressing potential failures such as salt contamination damage on Insulators before they occur and create negative impacts to reliability. This multi-year project is required to improve the reliability of the LAL-L1 feeder, and indirectly improve LAL-L2 reliability as well.

Appendix A

Worst-Performing Feeder List and Summary of Data Analysis

Table A-1: Worst-Performing Feeders Sorted by CHI[1]

Rank	Feeder	CHI
1	English Harbour, Line 1	8,039
2	Happy Valley, Line 7	7,972
3	Barachoix, Line 4	7,108
4	Barachoix, Line 1	6,106
5	St. Anthony, Line 1	5,617
6	L'Anse-au-Loup, Line 2	5,434
7	Bottom Waters, Line 1	4,878
8	Kings Point, Line 1	4,203
9	Jackson's Arm, Line 2	3,824
10	Farewell Head, Line 1	3,729
11	Bay d'Espoir, Line 1	3,581
12	L'Anse-au-Loup, Line 1	3,262
13	South Brook, Line 1	3,113
14	Rocky Harbour, Line 1	2,993
15	Roddickton, Line 1	2,899
16	Hawke's Bay, Line 3	2,864
17	Farewell Head, Line 5	2,767
18	Bottom Waters, Line 4	2,636
19	Bear Cove, Line 6	2,599
20	Cartwright, Line 1	2,443

[1] Data provided is as of December 31, 2023. The next assessment on Hydro’s distribution feeders will be completed in 2026.

Table A-2: Worst-Performing Feeders Sorted by SAIDI[2]

Rank	Feeder	SAIDI
1	Black Tickle, Line 1	21.81
2	Farewell Head, Line 1	15.34
3	Bottom Waters, Line 1	13.50
4	Jackson's Arm, Line 2	13.05
5	Fleur-de-Lys, Line 1	11.36
6	Barachoix, Line 1	10.83
7	English Harbour, Line 1	10.01
8	L'Anse-au-Loup, Line 2	8.84
9	Barachoix, Line 4	8.76
10	St. Anthony, Line 1	8.59
11	Happy Valley, Line 7	8.55
12	Main Brook, Line 2	8.49
13	L'Anse-au-Loup, Line 1	7.75
14	Monkstown, Line 2	7.61
15	Bottom Waters, Line 3	7.45
16	Cartwright, Line 1	7.41
17	Kings Point, Line 1	6.28
18	St. Brendan's, Line 1	5.98
19	Bottom Waters, Line 4	5.85
20	Bottom Waters, Line 2	5.48

[2] Data provided is as of December 31, 2023. The next assessment on Hydro's distribution feeders will be completed in 2026.

Table A-3: Worst-Performing Feeders Sorted by SAIFI[3]

Rank	Feeder	SAIFI
1	Happy Valley, Line 15	3.63
2	Bottom Waters, Line 1	3.43
3	L'Anse-au-Loup, Line 2	3.38
4	L'Anse-au-Loup, Line 1	3.18
5	English Harbour, Line 1	3.11
6	Barachoix, Line 4	2.92
7	Happy Valley, Line 7	2.87
8	Barachoix, Line 1	2.71
9	Happy Valley, Line 6	2.66
10	St. Anthony, Line 1	2.58
11	Jackson's Arm, Line 2	2.52
12	Black Tickle, Line 1	2.49
13	Fleur-de-Lys, Line 1	2.42
14	Farewell Head, Line 6	2.25
15	Farewell Head, Line 5	2.19
16	Happy Valley, Line 1	2.06
17	St. Anthony, Line 7	2.06
18	Farewell Head, Line 1	2.06
19	Farewell Head, Line 4	1.87
20	Bottom Waters, Line 3	1.87

[3] Data provided is as of December 31, 2023. The next assessment on Hydro's distribution feeders will be completed in 2026.

Table A-4: Summary of Data Analysis[4]

Feeder	Summary
Barachoix, Line 1	In 2019–2021, tree contacts impacted the reliability. Overall reliability statistics on this feeder have been impacted by several broken primary conductors, and hardware and equipment failure incidents. This feeder performed well in 2023. No work is required at this time.
Barachoix, Line 4	In 2019–2023, this feeder was impacted by several broken primary conductors, and hardware and equipment failure incidents; however, there was only one notable outage in 2023 on this feeder due to salt contamination, which otherwise performed well. No work is required at this time.
Bay d'Espoir, Line 1	The majority of large outages on this feeder were related to birds building nests on top of distribution structures. Bird deterrents were added to the affected structures. Tree contacts in the past caused frequent outages, but improved in 2022–2023. This feeder will continue to be monitored.
Bear Cove, Line 6	Feeder performed well in 2023. The largest outages were caused by conductor failures and hardware failures. The upgrade project was completed in 2021, and no capital work is required at this time.
Black Tickle, Line 1	Poor reliability statistics were significantly driven by the 2023 storm event. Access issues during the storm led to an extended outage length. In general, the customers of this feeder experienced power outages due to weather-related events or defective line hardware issues during 2019–2023; however, the reliability of this feeder was mainly impacted by the remoteness of the site. No capital work is required at this time but this feeder will continue to be monitored.
Bottom Waters, Line 1	Reliability statistics were impacted by tree contacts, broken insulators and damaged conductor incidents in the 2019–2023 period. Line upgrading work has been completed on this feeder in December 2023 under the Upgrade Worst-Performing Distribution Feeders (2022–2023) Program.
Bottom Waters, Line 2	No outage in 2023. There were a few isolated outages, which placed this feeder on the list. No work is required at this time.
Bottom Waters, Line 3	Only one power outage in 2023, an ice storm downed a conductor over a long span. Overall reliability statistics on this feeder have been impacted by several weather events, broken line component issues and a faulty voltage regulator incident. Line upgrading work was completed on this feeder under the 2019–2020 Distribution System Upgrades Project. Regulator Bank was completely replaced in 2021. No work is required at this time.
Bottom Waters, Line 4	A single tree contact in 2023 impacted overall reliability indices. No capital work is required at this time.
Cartwright, Line 1	No outages in 2023. Previous reliability issues were related to adverse weather and isolated events. No work is required at this time.

[4] Data provided is as of December 31, 2023. The next assessment on Hydro's distribution feeders will be completed in 2026.

Feeder	Summary
English Harbour, Line 1	Poor reliability statistics were driven by several weather events, broken crossarm and other line hardware failures. A feeder assessment of this feeder has been completed recently, and an upgrade of this feeder is recommended. Details are provided in the report "Upgrade of Worst-Performing Distribution Feeders (2025–2027)."
Farewell Head, Line 1	This feeder reliability has been impacted by hardware failures, such as corroded switches, insulator failures, and broken conductor incidents in the 2018–2022 period. This feeder has many other problematic issues. Work is being carried out on this feeder under the Upgrade of Worst Performing Distribution Feeders (2023–2024) Program.
Farewell Head, Line 4	A variety of issues on this feeder contributed to poor reliability statistics. This feeder was upgraded as part of the Upgrade of Worst Performing Distribution Feeders (2021–2022) Program. Feeder performance has improved in 2022–2023.
Farewell Head, Line 5	Feeder performed well in 2023. Previous poor reliability was driven by numerous line component issues. This feeder was upgraded as part of the Upgrade of Worst Performing Distribution Feeders (2021–2022) Program.
Farewell Head, Line 6	Defective protection device events, broken insulator incidents and line slaps impacted the reliability. Protection device repair is scheduled for the summer of 2024. No capital work is required at this time, but this feeder will continue to be monitored.
Fleur-de-Lys, Line 1	Overall reliability statistics on this feeder have been impacted by several defective insulator incidents. No work is proposed at this time, but this feeder will continue to be monitored.
Happy Valley, Line 1	Feeder performed well in 2023. Previous poor reliability was driven by isolated events. No work is required at this time.
Happy Valley, Line 15	Broken conductors and line slaps were the largest outage causes. Human error during the Happy Valley Terminal Station project and overloading of the line when tied together were significant. No capital work is required at this time but this feeder will continue to be monitored.
Happy Valley, Line 6	In the period 2020–2021, tree contacts were the most significant contributors to outages on this feeder. Tree cutting was completed in 2022. HVY L6 has exhibited traits of a feeder requiring a protection investigation, which has been planned for 2024. A new recloser is being prepared for the Mud Lake tap, where tree contacts were occurring most often. No additional work is required at this time.
Happy Valley, Line 7	Poor reliability statistics were mainly driven by tree-related incidents. Tree trimming was completed recently. Other leading causes of outages were feeder overloading, metering tank failure and a broken crossarm. The metering tank was removed and the upgrading work for L7 loading was completed in 2022. Feeder performed well in 2023. No capital work is required at this time.

Feeder	Summary
Hawke's Bay, Line 3	A vehicle-damaged pole incident in 2023 and a primary conductor failure incident in 2022 impacted the reliability statistics. No work is required at this time.
Jackson's Arm, Line 2	Poor reliability statistics were driven mainly by tree-related events. Tree trimming and ground cutting were completed in 2022–2023. This feeder performed well in 2023. No work is required at this time, but the feeder will continue to be monitored.
Kings Point, Line 1	Poor reliability statistics were principally driven by multiple tree-related incidents. Tree trimming and ground cutting were completed in 2022. No work is required at this time.
L'Anse-au-Loup, Line 1	Major outages to this line over the period were associated with salt tracking on multiple components. Insulator failure on a gang switch due to salt was a major outage in 2022. Previously, insulator, surge arrester, and instrumentation transformer flashovers have caused outages related to salt spray.
L'Anse-au-Loup, Line 2	Overall reliability statistics on this feeder have been impacted by several insulator failures, broken conductors and broken pole incidents. Salt contamination and line slap from wind also contributed to the poor reliability. This feeder has many other problematic issues. Work is being carried out on this feeder under the Upgrade of Worst Performing Distribution Feeders (2024–2025) Program
Main Brook, Line 2	Insulator failure and tree contacts were the greatest causes of outages. The coordination and functionality of protection devices on this system caused issues; a protection study was completed. No work is proposed at this time, but the feeder will continue to be monitored.
Monkstown, Line 2	No outages for 2023. Overall reliability statistics on this feeder have been impacted by an ice storm in 2022. No work is required at this time.
Rocky Harbour, Line 1	A substation hardware failure incident in 2022 and a defective recloser incident in 2023 impacted the reliability significantly. No capital work is required at this time.
Roddickton, Line 1	Feeder performed well in 2023. Previous poor reliability was driven by tree contacts, failed voltage regulator and broken primary conductor issues. The regulator has been replaced. No capital work is required at this time, but this feeder will continue to be monitored.
South Brook, Line 1	Overall reliability statistics on this feeder have been impacted by trees falling across the line during wind/snow storms. Recloser CLPU issues and burned recloser bypass switches were also significant causes. The switches were replaced in 2021, and the recloser was upgraded in 2022. No capital work is required at this time.

Feeder	Summary
St. Anthony, Line 1	Overall reliability statistics on this feeder have been impacted by several broken primary conductor incidents in 2019–2022 and one damaged insulator incident in 2021. In 2023, there were a couple of outages of unknown cause that are suspected to be related to the fusing on the tap to Quipon Island due to a line slap, which has since been resolved by installing the correct fuse. There was also a regulator that failed and caused a large event, but it has been replaced. No capital work is required at this time, but this feeder will continue to be monitored.
St. Anthony, Line 7	A variety of issues on this feeder over the period 2019–2023. A saddle clamp failed, leading to the largest outage in 2023. Nesting birds, tree contacts and insulator failure are the other causes of trouble on this feeder. Continue to monitor.
St. Brendan's, Line 1	Poor reliability statistics were mainly driven by an isolated event in 2022. No work is required at this time.

Replace Heavy-Duty Mobile Equipment

(2026–2028)

Contents

Replace Heavy-Duty Mobile Equipment (2026–2028)

Location: Various

Investment Classification: General Plant

Asset Category: Tools and Equipment

Estimated Cost: $4,095,700

1.0 Introduction

Newfoundland and Labrador Hydro ("Hydro") operates a fleet of mobile equipment comprised of 34 heavy-duty assets. The fleet is utilized daily to support staff engaged in the operation and maintenance of the electrical system. The heavy-duty group includes mainly track-equipped units used to service transmission and distribution lines in remote areas, as well as wheeled heavy construction equipment, including excavators, loaders, etc.

Hydro employees work throughout the province, including many locations that require alternative modes of transportation. Hydro uses an array of heavy-duty mobile equipment in the provision of safe, reliable power, consistent with least cost and environmental responsibility for the people of Newfoundland and Labrador. This equipment includes aerial devices or radial boom derricks mounted on heavy-duty track machines, excavators and maintenance equipment, including front-end loaders, graders, and backhoes.

Under this project's scope, Hydro will replace three older heavy-duty assets: two heavy-duty off-road track machines equipped with aerial device units and one track machine with a dump body.

2.0 Project Description and Justification

Hydro's mobile equipment fleet is strategically distributed across Hydro's operating areas throughout the province. This equipment is utilized daily by staff engaged in the maintenance and repair of the electrical system and shared amongst work groups as required. As equipment ages, it experiences increased downtime that could negatively impact emergency outage response times or planned maintenance. Hydro's replacement criteria for the heavy-duty mobile asset equipment include an average age at replacement of 15 years. In addition to age, Hydro considers the equipment's condition before its replacement, as usage of mobile equipment will vary considerably, resulting in retention and continued use of some assets well beyond the average age criteria. Replacement is based on equipment condition, reliability, age, and availability of spare parts and service. In addition, Hydro reviews equipment utilization, functionality and appropriateness, as part of its long-term asset planning. Given the lengthy lifecycle and service time of heavy equipment, an exact like-for-like replacement may not meet current-day needs. Electrical system demands and evolving safety requirements are but a few variables that need to be considered to ensure the replacement vehicle fully meets operational demands.

Under this project's scope, Hydro will replace three older heavy-duty off-road assets consisting of two heavy-duty off-road track machines with aerial device units, and one medium-duty track machine with a dump body. Operational and fleet reviews have highlighted a need to bolster the lifting and reach capability of track units that support the bulk transmission system. A reliable fleet of off-road track units with appropriate reach and lifting capability is critically important for the provision of safe, reliable power. Without addressing this need, the existing aerial equipment will continue to age, be overworked, and result in increased downtime and decreased reliability.

Historically, the replacement of heavy-duty mobile equipment was part of a larger program scope that also included light-duty mobile equipment, such as ATVs[1] and snowmobiles. In Board of Commissioners of Public Utilities ("Board") Order No. P.U. 28(2024), wherein the Board approved Hydro's 2025 Capital Budget Application ("CBA"), the Board had noted concerns with including scopes of light- and heavy-duty mobile equipment in the same program, stating:

> The Board finds that Hydro has not provided sufficient justification for the combining of light- and heavy-duty vehicles/assets. While there may be some efficiencies gained in grouping the different types of vehicles/assets together, the Board finds that separation will allow for greater transparency, clarity, and better reflect delivery time and cost.[2]

Upon further review of the program scopes and consideration of the Board's request, Hydro has separated light- and heavy-duty mobile equipment into separate proposals, beginning in this CBA.

Also, following the receipt of Board Order No. P.U. 28(2024), Hydro conducted a review of the classification of its programs within the 2025 CBA and determined that due to the nature of the assets

[1] All terrain vehicles ("ATV").
[2] Board Order No. P.U. 28(2024), p. 7/19–22.

being replaced (i.e., individual asset values higher than the lowest materiality threshold), the scope of work contained in Replace Heavy-Duty Mobile Equipment proposal was more appropriately defined as a project. As a result, Hydro has provided the information within this proposal as required by the provisional CBA Guidelines[3] relating to projects.

Hydro has maintained the light-duty mobile equipment capital expenditures within a program, as the components have smaller individual asset costs.

3.0 Asset Overview

3.1 Asset Background

Hydro's fleet of mobile equipment is essential to performing planned and unplanned work on critical transmission and distribution systems, in particular the extensive off-road sections that cannot be reached or serviced by the regular highway-driven fleet of light- and heavy-duty vehicles.

3.2 Historical Reliability

The three assets Hydro is replacing are track machines, two of which are equipped with aerial devices, which have been in service for 16 to 24 years and are all beyond their proposed replacement ages.

V7206 has been in service since 2009. In addition to meeting the replacement age criteria, the condition of this unit is poor, with the undercarriage very near the end of life, as shown in Figure 1 and Figure 2. To maintain this unit and upgrade the undercarriage would require an extensive rebuild. This would not be prudent as body fatigue is also present, which limits its viability due to the increased risk of other operational issues. This unit will be replaced with a modern, comparable version.

[3] "Capital Budget Application Guidelines (Provisional)," Board of Commissioners of Public Utilities, January 2022.

Figure 1: V7206

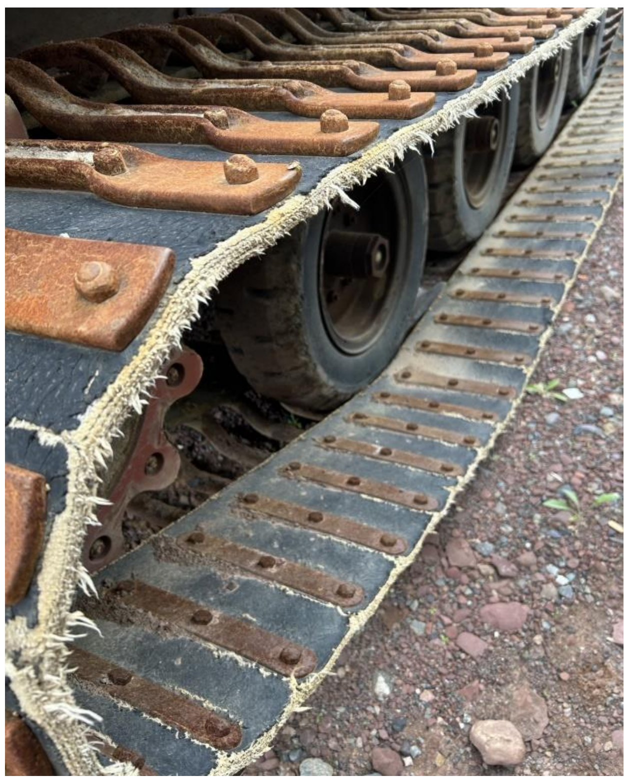

Figure 2: V7206 Undercarriage

V7117, as shown in Figure 3, has been in service since 2007 and is at the end of its useful life. This unit will be 20 years old, five years beyond the replacement age criteria-when a replacement unit is received. Any further service extension will pose significant reliability risks and increased maintenance costs. This unit will be replaced with a modern aerial device-equipped track unit with increased reach and lifting capabilities.

Figure 3: V7117

V7698 has been in service since 2001, is at the end of its useful life, and is considerably beyond replacement age criteria. The current functionality of this aged unit is no longer required, and the age and condition of this unit pose a reliability and maintenance risk, as shown in Figure 4 and Figure 5. This unit will be replaced with a modern, aerial device-equipped track unit. Replacing this with an aerial device-equipped tracked unit helps to meet current and future demands, which require Hydro to increase its lifting and reach capabilities within its track unit fleet.

Figure 4: V7698

Figure 5: V7698 Final Drive and Sprocket Condition

3.3 Asset Condition

As equipment ages, it experiences increased downtime that could negatively impact emergency outage response times or planned maintenance. In many cases, heavy-duty mobile equipment is regularly operated under rough conditions and is subject to accelerated wear and tear. The condition of unit

V2706 is poor, as discussed in Section 3.2. Mobile equipment is routinely inspected in accordance with the preventive maintenance schedule, and all maintenance and repairs are performed by Hydro maintenance personnel or third-party service providers as needed to ensure that maximum potential reliable service life is attained.

3.4 Condition-Based Remaining Life

The scope of this project includes three assets, which are at the end of their service life and are being replaced due to both age and condition. Hydro evaluates assets as they are near the retirement criteria to determine if it is appropriate to extend the life of the assets or replace them. This could include reassignment to an area with less or different usage, or usage in easier terrain, among other considerations. Hydro has found it appropriate to maintain some mobile assets beyond the average replacement age, as those units are both in adequate condition, and the risk of their failure is considered to be a manageable event. For some assets, failure risk is much less tolerable, and a fixed lifecycle period endpoint is more prudent.

4.0 Analysis

4.1 Evaluation of Alternatives

Hydro evaluated the following alternatives:

- Deferral;
- Upgrade life extension;
- Like-for-like replacement; and
- Alternative strategies.

4.1.1 Deferral

Deferral is not considered a viable option. The equipment Hydro has identified for replacement is integral to generation and transmission operations. The assets are at the end of their useful service life, and waiting to replace them past this project scope's scheduled in-service date will risk failure, mis-operation, or increased out-of-service times. This could lead to safety issues, delayed response to customer service requests, longer and more frequent outages, and deferral of work to extend and maintain the generation and transmission work within the province.

4.1.2 Upgrade Life Extension

Hydro's annual long-term asset planning review incorporates asset condition and risk review that permits the lifecycle extension of some units. In the case of the three assets proposed for replacement in this project's scope, Hydro has examined opportunities to extend the life of the assets with upgrades and maintenance. In each case, it has been determined that extending the life of either of these units is not functional or prudent. Heavy-duty equipment is exposed to rough conditions that increase wear and tear, and in most cases, extending past the typical lifecycle is not appropriate or possible. In addition, after a 15-to-20-year lifecycle, equipment functionality and appropriateness has to be considered to ensure new track equipment can meet the demands of today.

4.1.3 Like-for-Like Replacement

Hydro has determined that the assets proposed for replacement as part of this project's scope are appropriate based on industry standards, the condition and age of the units upon replacement, and vehicle usage statistics. This approach allows Hydro to balance cost with the reliability of Hydro's mobile equipment fleet. The mobile equipment is required to facilitate required maintenance and timely response to system events and, as such, is required to be available and in appropriate, reliable working condition.

Hydro notes that given the lengthy lifecycle and service time of heavy equipment, electrical system demands, and evolving safety requirements, exact like-for-like replacement may not meet current-day needs. Operational and fleet reviews have highlighted a need to bolster the lifting and reach capability of track units that support the bulk transmission system. A reliable fleet of off-road track units with appropriate reach and lifting capability is critically important for the provision of safe, reliable power. Under this project's scope, Hydro will replace three older heavy-duty off-road assets with two heavy-duty off-road track machines with aerial device units and one medium-duty track machine with a dump body.

4.1.4 Alternative Strategies

Hydro regularly conducts utilization and optimization reviews to ensure equipment is functionally appropriate and available to ensure reliability of the electrical system. Many of the heavy-duty mobile equipment assets Hydro depends on, such as tracked units with aerial devices, are highly specialized with no alternative procurement strategy available. To ensure that Hydro will have the right equipment to maintain its system when needed, Hydro does not consider there to be any viable alternative for this project.

4.2 Least-Cost Evaluation

Hydro has not identified any viable alternatives to facilitate a least-cost evaluation.

4.3 Recommended Alternative

Hydro's recommended alternative is to proceed with the identified replacements based on its replacement criteria. Replacement of mobile equipment, based on Hydro's replacement age criteria along with asset condition, is necessary to ensure the safe and reliable operation of mobile equipment, which is required to safely and reliably operate Hydro's electrical system, consistent with least cost, in an environmentally responsible manner.

4.3.1 Risk of Asset Stranding

This project is necessary to maintain a safe and reliable mobile equipment fleet. Failure to replace this equipment will lead to increased maintenance costs, less-reliable equipment, delays in scheduled and unscheduled work, and possible safety risks for operators. Hydro does not foresee any changes in its requirements for mobile equipment; therefore, the risk of asset stranding is low.

4.3.2 Risk Mitigation

Hydro assessed the pre- and post-implementation risk of the scope of work for the project in accordance with Hydro's Capital Risk Assessment process, as outlined in Section 7.0 of Schedule 1. The outcome of this assessment is provided in Table 1.

Table 1: Risk Scoring Pre- and Post-Implementation

	Impact	Likelihood	Score
Pre-Implementation	3	4	**12**
Post-Implementation	3	1	**3**
		Risk Mitigated	**9**
		Risk Mitigated per $1 Million	**2.2**

5.0 Scope of Work

The 2026–2028 project proposes the replacement of three older heavy-duty assets: two heavy-duty off-road track machines with aerial devices units and one medium-duty track machine with a dump body.

In accordance with Hydro's replacement criteria, one track machine with a dump body is anticipated to be delivered in 2027, and two tracked machines with aerial devices are anticipated to be delivered in 2028. This project also includes $100,000 in 2026 to address in-service failures for mobile equipment. Hydro will evaluate the cost of repair or refurbishment versus replacement prior to executing in-service failure repairs.

5.1 Project Budget

The estimate for the project is shown in Table 2.

Table 2: Project Estimate ($000)[4]

Project Cost	2026	2027	Beyond	Total
Material Supply	100.0	1,400.0	1,615.0	**3,115.0**
Labour	45.3	35.6	26.3	**107.2**
Consultant	0.0	0.0	0.0	**0.0**
Contract Work	0.0	0.0	0.0	**0.0**
Other Direct Costs	0.0	15.0	15.0	**30.0**
Interest and Escalation	3.9	74.0	128.9	**206.8**
Contingency	24.5	285.1	327.1	**636.7**
Total	**173.8**	**1,809.7**	**2,112.2**	**4,095.7**

For the purchase of mobile equipment, Hydro includes cost contingency in its budget, typically about 10%, to accommodate potential price increases relating to an array of socioeconomic factors. Recent implementation and adjustments of tariffs on mobile equipment, as well as the components and materials used to fabricate mobile equipment, have increased uncertainty and potential volatility in the end unit price of these assets. To accommodate a larger range of price possibilities, Hydro has increased the amount of contingency included within this proposal to about 20%. As price effects relating to tariffs become more apparent, and in cases where tariffs are adjusted in the future, Hydro will re-evaluate the amount of contingency included in future mobile equipment proposal budgets.

[4] Numbers may not add due to rounding.

5.2 Project Schedule

The schedule for this project is shown in Table 3.

Table 3: Project Schedule

Activity	Start Date	End Date
Planning:		
Open work orders and plan and develop detailed schedules.	January 2026	February 2026
Procurement:		
Tender and award contracts.	February 2026	April 2026
Receive and commission short-lead equipment.	January 2027	April 2027
Receive and commission long-lead equipment.	April 2028	December 2028
Closeout:		
Close work orders, complete all documentation, and complete lessons learned.	November 2028	December 2028

6.0 Conclusion

Hydro utilizes a fleet of reliable mobile equipment to maintain the electrical system. Failure to replace and adjust the mobile equipment fleet will lead to increased maintenance costs, less reliable equipment, and safety concerns for all users. The established replacement guidelines have been determined to be appropriate. Hydro proposes to replace three heavy-duty mobile equipment assets under the scope of this project.

Relocate Section of Line – TL220

(2026–2028)

newfoundland labrador hydro

Contents

Relocate Section of Line (2026–2028)

Location: TL220

Investment Classification: Service Enhancement

Asset Category: Transmission

Estimated Cost: $4,091,400

1.0 Introduction

Transmission Line TL220 is a 69 kV wooden pole transmission line that runs from the Bay d'Espoir Hydroelectric Generating Station ("Bay d'Espoir") to the Barachoix Terminal Station ("BCXTS"), a distance of approximately 63 kilometres as shown in Figure 1.

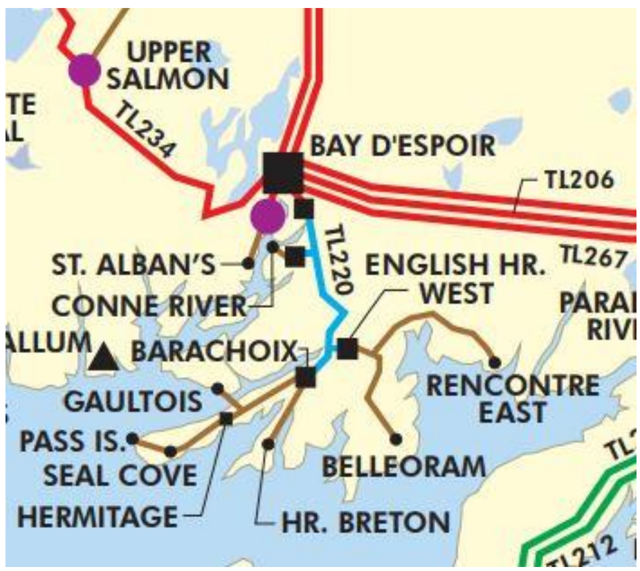

Figure 1: TL220 Location

Newfoundland and Labrador Hydro ("Hydro") is proposing to reroute the southern section of TL220, which contains deteriorated poles and is located in a challenging area that is inaccessible by current-day transmission line construction equipment, as shown in Figure 2. The section of line in question is between Structures 288 to Structure 334, from the English Harbour West Terminal Station ("EHWTS") to BCXTS. The proposed reroute is approximately 10.6 km in length alongside Route 360 and will consist of approximately 120 poles, with most of the line being constructed in a single-pole configuration.

Figure 2: TL220 Helicopter Patrol: Southern Section

2.0 Project Description and Justification

Access to much of the southern section of TL220 is arduous, with some structures located on cliff edges that are inaccessible by current-day transmission line construction equipment. These structures are not maintainable using standard, current-day construction methods for pole replacement without significant work to improve access. As per recent inspections completed under the Wood Pole Line Management ("WPLM") Program, 23 of the 109 poles in this section are currently deteriorated and would require imminent replacement under the program. Based on governing life expectancy criteria used in the WPLM Program to manage assets, an estimated 17 additional poles are expected to require replacement within the program scope by 2030. Access constraints to the particular structures for replacement along this line lead to Hydro's decision to perform this work outside of the WPLM Program.

Many of the structures in question are dead ends[1] or have shield wire, contributing to heavier structure loading. Heavier structures have an increased risk of failure in extreme weather events, and if one of these critical structures were to fail, it could result in a cascade effect, causing widespread line failure and damage to multiple structures.

The deteriorated poles pose a risk to the reliability of TL220, and the locations of these poles currently pose a risk to the resiliency of the line. The deteriorated poles have a high risk of failure that would

[1] Dead ends are critical structures that are used to limit catastrophic failure associated with longitudinal failure.

cause a forced customer outage, while the challenging locations would cause the duration of such an outage to potentially be days or weeks in length. TL220 is a radial transmission line with no backup generation, and therefore, without redundancy, the impacts to customers of such an extended unplanned outage would be significant, especially during winter weather conditions.

The southern section of TL220 is proposed to be relocated to run alongside Route 360. The increased accessibility along Route 360 improves access and safety for maintenance, reduces the cost to maintain the section of line moving forward and also shortens the response time in the event of a customer outage, particularly during severe weather events. The length of the rerouted section of the line is 10.6 km between the EHWTS and BCXTS. Figure 3 illustrates the existing southern section of TL220.

Figure 3: TL220 - Southern Section

Hydro does not believe continuing to replace poles on TL220 under the WPLM Program to be prudent. The inaccessible structure locations of the section, combined with TL220 being a non-redundant line, combine to make relocation of the line section the most cost-effective option, in tandem with reliability and environmental responsibility.

The project is proposed to be completed as a multi-year project, commencing in 2026 and concluding in 2028.

3.0 Asset Overview

3.1 Asset Background

TL220 is a radial 69 kV wood pole transmission line that runs from the Bay d'Espoir plant to the BCXTS for a distance of approximately 63 km. It was originally constructed in 1970. In 1999, a major reroute was performed between Structure 78 and Structure 288 at the EHWTS as a result of repetitive service interruptions associated with extreme weather events. The section of the line was rerouted alongside Route 360. TL220 is a radial transmission line connecting the Connaigre Peninsula to the electrical grid; it is expected to remain in service for the foreseeable future. It is currently maintained under Hydro's WPLM Program.

3.2 Historical Reliability

During the winter of 2020, significant ice accumulation in the area resulted in the conductor on TL220 sagging to the ground between Structures 68 and 69, resulting in a fault that caused an unplanned outage to approximately 2,600 customers on the Connaigre Peninsula. As a result of this incident, a clearance assessment determined additional clearance issues on the line, and a capital project commenced in 2025[2] to rectify the 11 locations between Structure 3 and Structure 73.[3] Table 1 summarizes the outage frequencies and durations on TL220 from 2018 to 2024. The additional 7.85 hours of outage duration in 2020 were due to a terminal station transformer issue (approximately 5.80 hours), a lightning strike (approximately 1.65 hours) and an emergency repair of deteriorated hardware on a wood pole structure (approximately 0.4 hours).

Table 1: TL220 Outage Summary

Year	Number of Outages	Total Forced Outage Duration (Hours)
2018	0	0.00
2019	1	0.02
2020	3	17.85
2021	1	0.05
2022	0	0.00
2023	0	0.00
2024	0	0.00

[2] As outlined in the Install Mid-Span Structures – TL220 (2025–2026) project, which was approved in Hydro's 2025 Capital Budget Application in Board of Commissioners of Public Utilities Order No. P.U. 27(2024).
[3] The portion of TL220 recommended for relocation within this proposal is not the section that was proposed for mid-span structure installation.

3.3 Asset Condition

As per recent inspections completed under the WPLM Program, 23 of the 109 poles in this section are currently rated as 4 and are considered to be deteriorated and deemed to require replacement under the program. In total, based on WPLM replacement criteria, 40 of these poles were already planned to be replaced by 2030.[4]

Table 2: WPLM Rating System

Condition	Rating	Post-Inspection and Treatment Action
Severe/Hazardous to Climb	5	Refurbishment required as soon as practicable.
Poor	4	Engineering analysis and subsequent refurbishment if deemed necessary.
Moderate	3	Monitor.
No issues	2	None.
New (<10 Years)	1	Climbing inspection and treatment not required.

3.4 Condition-Based Remaining Life

Chart 1 presents the poles in the section of TL220 in question by expected remaining life, as of April 2025. This projection is based on Hydro’s transmission pole survival curves developed under the WPLM Program. The 40 poles shown with an expected life of less than ten years include the 23 poles that have been rated 4, plus an additional 17 expected to be rated 4 during the next inspection cycle.

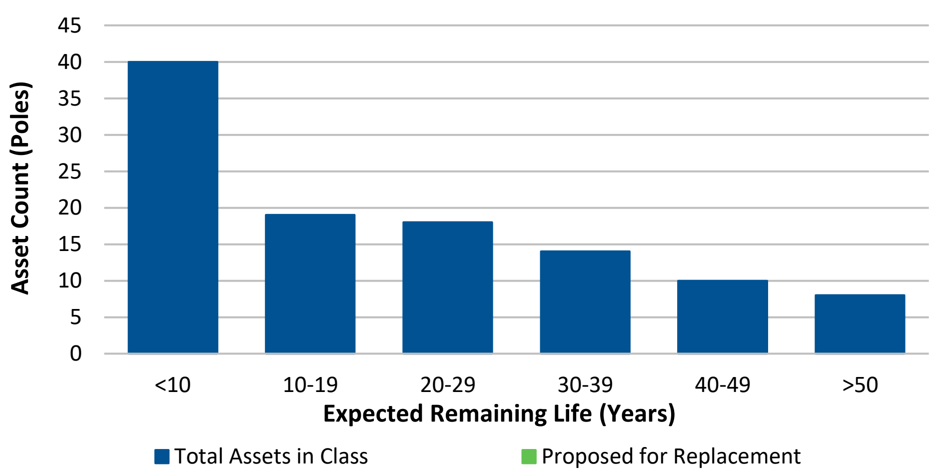

Chart 1: Condition-Based Expected Remaining Life

[4] Based on governing life expectancy criteria used in the WPLM Program to manage assets, an estimated 17 additional poles are expected to require replacement within the program scope by 2030.

4.0 Analysis

4.1 Evaluation of Alternatives

Hydro has evaluated the following alternatives:

- Deferral;
- Like-for-like replacement; and
- Relocate a section of the line.

4.1.1 Deferral

Deferral is not a viable alternative for this project. Deferring the proposed reroute of TL220 alongside Route 360 and maintaining the status quo would result in an unacceptable risk to customer reliability and public/worker safety. The high likelihood of failure on this line in an extreme weather event due to the reduced structural integrity of the poles reduces reliability for the customers serviced throughout this line, and could result in a cascade effect causing widespread line failure and damage to multiple structures.

4.1.2 Like-for-Like Replacement

TL220 is non-redundant; therefore, to replace the deteriorated poles in place, mobile generation must be established at the English Harbour West Substation (Alternative 1) or a combination of live-line work methods and planned customer outages must be used (Alternative 2). Both alternatives will require substantial upgrades for access to complete the refurbishment work safely. Through least-cost evaluation analysis, replacing the deteriorated poles in place was not found to be the least-cost viable option.

4.1.3 Relocate Section of Line

The proposed reroute of TL220 alongside Route 360 was determined to be the least-cost, viable option (Alternative 3). This option will also provide shorter customer outages in the event of a failure and improve access for future inspections and safe maintenance work.

4.2 Least-Cost Evaluation

A Cumulative Present Worth ("CPW") calculation was completed for the three alternatives.

For both Alternative 1 (Replace Poles with Mobile Generation) and Alternative 2 (Replace Poles Using Live Line Techniques), further maintenance will be required on the southern section of TL220 for decades to come. Hydro's survival curves for wooden transmission lines estimate that approximately 17+ additional poles will require replacement by 2030. To complete the least-cost analysis conservatively, estimated replacement costs for the work scopes in 2026 and 2027 were used and escalated for the poles projected for replacement in 2030. The CPW cost associated with Alternative 1 is $6,605,099.

Hydro notes that a live-line contractor determined that it is difficult and costly to replace approximately half of the structures in question using standard live-line techniques. To account for these structures, Alternative 2 would require approximately five to ten days of customer outages per maintenance cycle. The CPW cost associated with Alternative 2 is $4,473,636.

For Alternative 3, no additional refurbishment is expected to be required until 2057 or later. The CPW cost associated with Alternative 3 is $3,900,690, which is the lowest-cost option.

Table 3 shows a comparison of all three alternatives, with the difference between the least cost alternative shown.

Table 3: Least Cost Evaluation Summary[5]

Alternative	CPW	CPW Difference between Alternative and Least Cost Alternative
Alternative 1: Replace Poles with Mobile Generation	6,605,099	2,704,409
Alternative 2: Replace Poles Using Live-Line Techniques	4,473,636	572,946
Alternative 3: Relocate Section of Line	3,900,690	-

[5] For the least cost evaluation exercise, any costs deemed to be shared across alternatives such as overheads for project support for example, project contingency, etc. have not been included.

4.3 Recommended Alternative

Based on the least-cost evaluation, it is recommended to proceed with Alternative 3 – Relocate Section of Line, as it is the least-cost alternative, while also providing additional benefits such as easier access for inspection and safe maintenance activities in the future.

4.3.1 Risk of Asset Stranding

Assets replaced or refurbished under this project have an inherently low risk of asset stranding. The assets covered under this project, including TL220, are critical to Hydro's ability to meet customer requirements on the Connaigre Peninsula.

4.3.2 Risk Mitigation

Hydro assessed the pre- and post-implementation risk of the scope of work for this project in accordance with Hydro's Capital Risk Assessment process, as outlined in Section 7.0 of Schedule 1. The outcome of this assessment is provided in Table 4.

Table 4: Risk Scoring Pre- and Post-Implementation

	Impact	Likelihood	Score
Pre-Implementation	5	3	**15**
Post-Implementation	3	1	**3**
		Risk Mitigated	**12**
		Risk Mitigated per $1 Million	**2.9**

5.0 Scope of Work

The southern section of TL220 is proposed to be relocated to run alongside Route 360 using Hydro standard 69 kV wooden pole transmission structures. The length of the rerouted section of the line is 10.6 km between the EHWTS and BCXTS.

A short, planned outage of approximately six hours will be required on TL220 to tie in the newly constructed section. The project is proposed as a three-year project. Design and material procurement will take place over the first two years, with construction occurring in years two and three.

5.1 Project Budget

The estimate for this project is shown in Table 5.

Table 5: Project Estimate ($000)

Project Cost	2026	2027	Beyond	Total
Material Supply	0.0	1,071.0	0.0	**1,071.0**
Labour	70.3	367.8	180.1	**618.2**
Consultant	0.0	0.0	0.0	**0.0**
Contract Work	0.0	944.3	472.2	**1,416.5**
Other Direct Costs	0.0	55.3	58.2	**113.5**
Interest and Escalation	5.9	309.6	271.4	**586.9**
Contingency	3.5	222.7	59.1	**285.3**
Total	**79.7**	**2,970.7**	**1,041.0**	**4,091.4**

5.2 Project Schedule

The schedule for this project is shown in Table 6.

Table 6: Project Schedule

Activity	Start Date	End Date
Planning:		
Resource planning.	January 2026	February 2026
Site visits.	May 2027	June 2027
Design:		
Engineering design (using LiDAR)[6].	January 2026	March 2026
Survey Staking Design (after Right of Way clearing).	May 2027	June 2027
Procurement:		
Tendering and ordering materials.	August 2026	December 2026
Construction:		
Construction of Line (2027).	June 2027	September 2027
Construction of Line (2028).	June 2028	September 2028
Closeout:		
Complete closeout documentation.	October 2028	November 2028

[6] Light detection and ranging ("LiDAR").

6.0 Conclusion

The deteriorated poles on TL220 pose a risk to customer reliability and public safety. These structures are not maintainable using standard, current-day construction methods for pole replacement without significant work to improve access and an extended customer outage. The southern section of TL220 is proposed to be relocated to run alongside Route 360 as it is the least-cost alternative, while also providing additional benefits in the form of easier access for inspection and safe maintenance activities in the future.

Renew Distribution Feeders

(2026–2027)

Contents

Renew Distribution Feeders (2026–2027)

Location:	Various
Investment Classification:	Renewal
Asset Category:	Distribution
Estimated Cost:	$4,068,300

1.0 Introduction

Newfoundland and Labrador Hydro ("Hydro") owns and operates distribution systems in the rural communities it serves. Each distribution system typically consists of a substation coupled with a wood pole distribution feeder(s) that supply power from the substation to service drops throughout a community.

This project targets the distribution feeders for capital upgrades based on asset conditions. For 2026–2027, Hydro is proposing to refurbish Bay d'Espoir Line 1 ("BDE-L1"), located in the Bay d'Espoir system.

This feeder was identified for refurbishment using inspection data, engineering assessment, and asset management strategies. The components selected for replacement include deteriorated poles, crossarms, insulators, transformers, and conductors that have been identified as being at, or close to, the end of their useful service lives. It has also been identified that some of the existing line components are substandard, no longer conforming to Hydro's standard for line applications. This could lead to unplanned power outages upon their failure.

The continued deterioration of the components identified for replacement creates a risk of line component failure. Failure of such components will negatively affect the reliability performance of the line, potentially resulting in unplanned power outages to customers. These line components also create safety hazards, specifically the danger of working on or around deteriorated poles.

2.0 Project Description and Justification

Hydro completes annual inspections to identify deteriorated structures, line components, and equipment throughout its distribution systems. This inspection is completed by Hydro personnel, and any corrective maintenance required is reported, analyzed, scheduled, and completed. Hydro's inspection grading system for distribution equipment is ranked on a scale of 1 to 5, as shown in Table 1.

Table 1: Distribution Asset Grading System

Condition	Grading
New Condition	1
Seasoned	2
Aging	3
Deteriorating	4
Critical	5

Following inspections, localized service deficiencies are addressed and small-scale infrastructure replacements are accommodated through the Distribution System In-Service Failures, Miscellaneous Upgrades, and Street Light program; however, this program is generally not intended to cover large-scale scopes of work, such as feeder replacement or refurbishment.

Hydro also completes an annual Upgrade Worst-Performing Distribution Feeders project, which addresses poor reliability performance; it is not based on the condition of components. Historically, Hydro used a condition assessment-based approach to identify components of its distribution systems that needed to be refurbished to ensure reliable operation; however, with the introduction of the Worst-Performing Distribution Feeders program, the former condition-based refurbishment program was terminated as a cost management measure. As a result, prior to the implementation of the Renew Distribution Feeders project in Hydro's 2024 Capital Budget Application ("CBA"), the number of distribution components graded as 4 or "deteriorating" continued to grow, as they were not being addressed under the existing projects or programs, with many of these components anticipated to be assessed as Grade 5 or "critical" over the next several years.

Therefore, Hydro proposes to undertake the Renew Distribution Feeders project in 2026 to address the need to upgrade or replace deteriorated assets. Work proposed under this project includes individual refurbishment plans for feeders where deterioration is most pronounced. Hydro will also endeavour to group work in areas where there is a concentration of deteriorated assets to avail of execution efficiencies.

Following the receipt of the 2025 CBA Board of Commissioners of Public Utilities Order No. P.U. 28(2024), Hydro conducted a review of the classification of its programs within the 2025 CBA and determined that due to the nature of the assets being replaced (i.e., individual assets value higher than the lowest materiality threshold), the scope of work contained in Renew Distribution Feeders proposals was more appropriately defined as a project. As a result, Hydro has provided the information within this proposal as required by the provisional CBA Guidelines[1] relating to projects.

3.0 Asset Overview

3.1 Asset Background

BDE-L1 is a three-phase, 25 kV distribution feeder originating from the Bay d'Espoir Terminal Station and was constructed in the 1960s. Currently it supplies power to 1297 customers. The feeder extends from the Bay d'Espoir Terminal Station toward Camp Boggy and St. Veronica, where it splits into two branches. One branch continues toward Head of Bay d'Espoir, Milltown, and Morrisville, while the other serves the communities of St. Joseph's Cove and St. Alban's. The location of the BDE-L1 feeder is shown in Figure 1.

Figure 1: Layout – BDE-L1

[1] "Capital Budget Application Guidelines (Provisional)," Board of Commissioners of Public Utilities, January 2022.

3.2 Historical Reliability

As this project will function as a condition-based asset renewal project, the analysis of reliability data is not applicable. Hydro will use the data collected during the execution of this project to determine appropriate tracking metrics and, where appropriate, will provide this information as required in future iterations of this project. Hydro's overall system reliability, as well as reliability segmented by the Labrador and Island systems, is provided in Hydro's Capital Budget Overview.

If the refurbishment work proposed in this project is not completed, the condition of the assets will continue to deteriorate to the point of failure, resulting in unscheduled power outages and impacting reliability. Hydro anticipates that the continued execution of this project will demonstrate a decrease in the Distribution In-Service Failures and Miscellaneous Upgrades Program, as well as the future iterations of projects related to upgrades of Hydro's worst-performing feeders.

3.3 Asset Condition

The BDE-L1 feeder was constructed over 50 years ago. Recent inspection records indicate BDE-L1 has deteriorated poles, crossarms, pole-mounted transformers and substandard insulators.

The majority of the insulators on this feeder are non-standard and have insufficient creepage distance for a 25 kV system. When salt and ice build up on insulators, it creates a contamination layer, resulting in leakage current from the conductor to the insulator base. Over time, this condition results in a flashover event and equipment failures.

Additionally, approximately 1 km of the line has been identified for rerouting closer to St. Alban's Road, improving accessibility for maintenance and future upgrades.

Examples of a deteriorated pole, crossarms, and transformer tank, such as those observed during recent inspections of BDE-L1, are provided in Figure 2, Figure 3, and Figure 4

Figure 2: Example of a Deteriorated Pole

Figure 3: Example of a Deteriorated Crossarm

Figure 4: Example of a Deteriorated Transformer Tank

3.4 Condition-Based Remaining Life

The assets to be replaced under this project have failed, are nearing the point of failure, or are obsolete and have reached the end of their remaining useful life. The remaining line components not addressed under this project are deemed to be in adequate to good condition and have expected remaining useful lives ranging from a minimum of 6 years (next preventive maintenance cycle) to 20 years or more.

4.0 Analysis

4.1 Evaluation of Alternatives

Hydro has evaluated the following alternatives:

- Deferral;
- Upgrade BDE-L1;
- Like-for-like replacement; and
- Alternative strategies.

4.1.1 Deferral

If the required upgrade work were deferred to a future year, it would further contribute to the growing number of deficiencies, negatively impacting future costs and would present an increased risk to distribution system reliability. This could potentially result in increased costs associated with unplanned work or outage response. In addition, deferring this project would create a safety hazard for workers and the public, as Hydro does not allow distribution line components to remain in service until failure. Therefore, deferral is not a viable option.

4.1.2 Upgrade BDE-L1

Replacing the deteriorated line components identified in this project ensures that the concentration of deteriorated assets at or close to the end of their useful service lives on BDE-L1 is addressed in a timely manner. This would allow for large-scale refurbishment of deteriorated assets to address potential failures before they occur, increasing safety and avoiding customer outages and costs related to unplanned work or outage responses.

4.1.3 Like-for-Like Replacement

Hydro has considered building a new distribution line; however, the feeder has existing line components that are still operable, such as poles, conductors, insulators, and crossarms. Construction of an entirely new line would result in the premature retirement of those existing, functional assets. The complete replacement of the existing feeder requires a level of investment that is not required for the continuation of safe, reliable, and least-cost service and is not considered a viable option.

4.1.4 Alternative Strategies

Hydro also considered expansion of its Upgrade Worst-Performing Feeders project to target more feeders based on reliability rather than condition. Hydro determined that this approach is not appropriate, as feeder performance can be impacted by numerous factors and is not limited to asset condition. Hydro must proactively address deteriorating distribution infrastructure to prevent negative reliability impacts on its customers and to prevent public safety hazards associated with failing infrastructure.

4.2 Least-Cost Evaluation

Hydro has not identified any viable alternatives to facilitate a detailed least-cost evaluation.

4.3 Recommended Alternative

Hydro recommends renewing the deteriorated line components, with the upgrade of BDE-L1 beginning in 2026.

4.3.1 Risk of Asset Stranding

Hydro does not anticipate a change in service requirements in these areas; therefore, the risk of asset stranding is low.

4.3.2 Risk Mitigation

Hydro assessed the pre- and post-implementation risk of the scope of work for the 2026–2027 project in accordance with Hydro's Capital Risk Assessment process as outlined in Section 7.0 of Schedule 1. The outcome of this assessment is provided in Table 2.

Table 2: Risk Scoring Pre- and Post-Implementation

	Impact	Likelihood	Score
Pre-Implementation	3	4	**12**
Post-Implementation	3	2	**6**
		Risk Mitigated	**6**
		Risk Mitigated per $1 Million	**1.5**

5.0 Scope of Work

An overview of the work to be completed under this project, beginning in 2026, is as follows:

- Replace 82 deteriorated poles;
- Replace 31 deteriorated crossarms;
- Replace 3 pole-mounted distribution transformers;
- Replace 1,590 substandard insulators;
- Re-route approximately 1 km of line closer to the road; and
- Temporary generation for approximately 12 days in total.

5.1 Project Budget

The estimate for the 2026–2027 project is shown in Table 3.

Table 3: Project Estimate ($000)[2]

Project Cost	2026	2027	Beyond	Total
Material Supply	646.5	277.1	0.0	**923.5**
Labour	209.8	1170.7	0.0	**1380.5**
Consultant	0.0	0.0	0.0	**0.0**
Contract Work	2.5	264.7	0.0	**267.2**
Other Direct Costs	13.3	800.2	0.0	**813.5**
Interest and Escalation	56.0	289.0	0.0	**345.0**
Contingency	87.2	251.3	0.0	**338.5**
Total	**1015.3**	**3053.0**	**0.0**	**4068.3**

5.2 Project Schedule

The schedule for the 2026–2027 project is shown in Table 4.

Table 4: Project Schedule

Activity	Start Date	End Date
Planning:		
Resource planning.	January 2026	January 2027
Design:		
Conduct site visits and detailed design.	January 2026	May 2027
Procurement:		
Materials order.	April 2026	May 2027
Construction:		
Construction.	July 2026	September 2027
Commissioning:		
Refurbish work commissioned.	July 2026	September 2027
Closeout:		
Complete closeout documentation.	September 2027	November 2027

[2] Numbers may not add due to rounding.

6.0 Conclusion

Proactive refurbishment of Hydro's distribution feeders is required to support Hydro's legislated mandate to ensure the delivery of safe, reliable, least-cost electricity in an environmentally responsible manner. Hydro proposes to continue with the Renew Distribution Feeders project in 2026, which would function as a condition-based asset renewal program, allowing for large-scale refurbishment of deteriorated assets along a feeder, identified as being at, or close to, the end of their useful service life and thereby maintaining safety and addressing potential failures before they occur, creating negative impacts to reliability. This proposed project is aimed at ensuring that preventative maintenance required to refurbish the BDE-L1 feeder and to maintain customer reliability is completed in a planned and cost-effective manner.

Widen Right of Way

(2026–2028)

Gros Morne National Park

Contents

List of Attachments

Widen Right of Way (2026–2028)

Location: Gros Morne National Park

Investment Classification: Service Enhancement

Asset Category: Transmission

Estimated Cost: $2,663,700

1.0 Introduction

TL226, TL227, and TL229 are 69 kV transmission lines ("TL") that run through Gros Morne National Park ("Park"). TL226 and TL227 are redundant lines serving the greater Northern Peninsula, while TL229 is a non-redundant line serving the communities of Glenburnie, Trout River, and Woody Point.

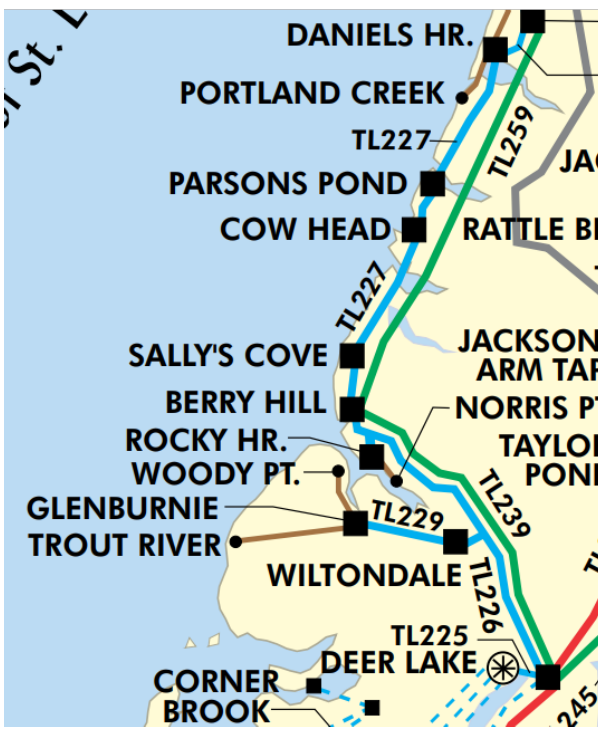

Figure 1: Locations of TL226, TL227 and **TL229**

TL easements, more commonly known as rights of way ("ROW"), are the areas of land cleared of vegetation that TLs are located within. The ROWs of lines that run through the Park are currently narrower than those of all other Newfoundland and Labrador Hydro ("Hydro") TLs by approximately 40–

50%. The TLs were constructed with narrowed ROW widths to minimize the quantity of vegetation cleared within the Park, as demonstrated in Figure 2.

Figure 2: Narrowing of the ROW at the Southern Park Boundary

Trees at the edges of ROWs tend to fall toward TLs when they become unstable due to erosion of the cleared area. In narrow ROWs, these trees often fall onto the energized lines, resulting in forced outages, potential forest fires, and risks to public safety. Such occurrences are known as tree contacts. Hydro proposes to widen the ROWs within the Park to reduce the number of tree contacts on the lines in question, thereby reducing forced outages and mitigating risks to public safety.

2.0 Project Description and Justification

As a result of their narrow ROWs, the TLs within the Park have exhibited high frequencies of outages due to tree contacts as outlined in Section 3.2. In addition to forced outages, tree contacts pose an electrical safety hazard to anyone travelling the ROWs, as well as a significant forest fire risk. No major forest fires have resulted from these tree contacts to date; however, Hydro has observed evidence of burned trees associated with these contacts.

Hydro currently leases its ROWs within the Park from Parks Canada. The proposed widening will require clearing trees outside of the existing ROW leases; however, Parks Canada has indicated that the newly-widened footprint would be included in the ROW area during the next easement lease renewal in 2027. A Memorandum of Understanding has been signed by Hydro and Parks Canada to document this agreement.[1] A Detailed Impact Assessment ("DIA") for this project was submitted to Parks Canada in 2024, as per the *Impact Assessment Act* and the Parks Canada Directive on Impact Assessment (2019).[2]

3.0 Asset Overview

3.1 Asset Background

Table 1 lists the years of construction for the lines of concern, as well as the lengths of ROWs that require widening.

Table 1: Asset Information

Line	Year Constructed	Length of ROW to be Widened (km)
TL226	1970	17.5
TL227	1970	15.5
TL229	1976	13
	Total	**46**

3.2 Historical Reliability

Table 2 lists outages experienced on TL226, TL227 and TL229 due to tree-to-phase contact from 2015 to 2024. These TLs are among the worst-performing in Hydro's system, with a total of 16 outages from 2015 to 2024 for a total duration of approximately 153 hours.[3] A list of the incidents and duration from 2015 to 2024 is provided in Table 2, Table 3, and Table 4 for TL226, TL227, and TL229, respectively.

[1] The Memorandum of Understanding and a Notice of Determination with Parks Canada are provided as Attachments 2 and 3, respectively.

[2] The DIA is provided as Attachment 1 to this application. The ROWs for TL239 and TL259, also located within the Park, were included in the DIA. Work on TL239 and TL259 was completed in 2025 as a supplemental project under $750,000 and internally approved by Hydro as reported in "Quarterly Regulatory Report for the Quarter Ended December 31, 2024," Newfoundland and Labrador Hydro, February 14, 2025, tab 1, p. 14, Table 11 [Titled Widen Rights-of-Way of Transmission Lines TL239 and TL259 (2024)].

[3] Of this total, approximately 77 outage hours were associated with TL226, 11 hours with TL227, and 65 hours with TL229.

Table 2: Outages Due to Tree Contacts on TL226 (2015–2024)

Incident Number	Date	Outage Duration (Hr:Min)
1	January 27, 2015	2:56
2	December 25, 2015	21:21
3	July 13, 2017	15:26
4	August 16, 2018	4:04
5	September 8, 2019	5:04
6	September 9, 2019	15:52
7	November 7, 2019	12:01

Table 3: Outages Due to Tree Contacts on TL227 (2015–2024)

Incident Number	Date	Outage Duration (Hr:Min)
1	November 4, 2018	2:46
2	March 2, 2021	3:16
3	April 12, 2021	3:06
4	April 26, 2021	1:49

Table 4: Outages Due to Tree Contacts on TL229 (2015–2024)

Incident Number	Date	Outage Duration (Hr:Min)
1	May 21, 2017	23:10
2	August 28, 2017	1:20
3	January 13, 2018	25:30
4	May 5, 2019	11:39
5	April 26, 2021	3:52

4.0 Analysis

4.1 Evaluation of Alternatives

Hydro has evaluated the following alternatives:

- Deferral; and
- Widen ROWs.

4.1.1 Deferral

Deferral is not a viable alternative for this project. Deferring the widening of the ROWs would result in unacceptable risk to public safety due to continued contact between trees and the transmission lines of concern. This would also result in reduced reliability for the customers serviced through these lines, due to the high likelihood of electrical fault reoccurrence.

4.1.2 Widen ROWs

Widening the ROWs in the Park is the only viable alternative to eliminate tree contacts and minimize the associated risks of forest fire, as well as the risks to public safety and reliability.

4.2 Least-Cost Evaluation

Hydro has not identified any viable alternatives to facilitate a least-cost evaluation.

4.3 Recommended Alternative

Hydro recommends the widening of the ROWs of TL226, TL227, and TL229.

4.3.1 Risk of Asset Stranding

TL226, TL227, and TL229 are expected to remain in service indefinitely to provide electricity to customers on the Northern Peninsula; therefore, the risk of asset stranding associated with this project is low.

4.3.2 Risk Mitigation

Hydro assessed the pre- and post-implementation risk of the scope of work for this project in accordance with Hydro's Capital Risk Assessment process, as outlined in Section 7.0 of Schedule 1. The outcome of this assessment is provided in Table 5.

Table 5: Risk Scoring Pre- and Post-Implementation

	Impact	Likelihood	Score
Pre-Implementation	5	5	**25**
Post-Implementation	5	1	**5**
		Risk Mitigated	**20**
		Risk Mitigated per $1 Million	**7.5**

5.0 Scope of Work

Approximately 46 km of transmission lines will have their ROWs widened as per Table 1 in Section 3.1. Widening of ROWs will be completed manually using chainsaws, with access on foot or by all-terrain vehicles. No heavy equipment, such as mulchers, will be used to maintain compliance with Parks Canada. Surveying of the new ROW widths will also be completed for the 2027 easement lease renewal with Parks Canada.

5.1 Project Budget

The estimate for this project is shown in Table 6.

Table 6: Project Estimate ($000)

Project Cost	2026	2027	Beyond	Total
Material Supply	0.0	0.0	0.0	**0.0**
Labour	114.5	83.6	98.7	**296.8**
Consultant	9.0	9.0	9.0	**27.0**
Contract Work	938.3	450.4	537.0	**1,925.7**
Other Direct Costs	58.1	43.2	51.5	**152.8**
Interest and Escalation	44.1	40.3	56.9	**141.3**
Contingency	56.0	29.3	34.8	**120.1**
Total	**1,220.0**	**655.8**	**787.9**	**2,663.7**

5.2 Project Schedule

The schedule for this project is shown in Table 7.

Table 7: Project Schedule

Activity	Start Date	End Date
Planning.	February 2026	March 2026
Procurement:		
Tendering.	April 2026	May 2026
Construction:		
ROW surveying.	June 2026	September 2026
TL226 clearing.	September 2026	November 2026
TL229 clearing.	September 2027	November 2027
TL227 clearing.	September 2028	November 2028
Closeout		
Prepare closeout documentation.	November 2028	December 2028

6.0 Conclusion

Transmission line ROWs in the Park are currently narrower than those of all other Hydro transmission lines. As a result, the transmission lines within the Park exhibit high frequencies of outages due to trees contacting the lines. In addition to forced outages, these tree contacts pose an electrical safety hazard to anyone travelling the ROWs, as well as a significant forest fire risk. Hydro proposes to widen the ROWs within the Park to reduce the number of forced outages on the lines of concern, as well as minimize the safety and fire risks that result from these tree contacts.

Attachment 1

Detailed Impact Assessment

Newfoundland and Labrador Hydro

Transmission Lines Modification Project

Detailed Impact Assessment

FINAL, Revision 1.0

July 26, 2024

EXECUTIVE SUMMARY

Newfoundland and Labrador Hydro ("Hydro") operates and maintains five transmission lines that pass through Gros Morne National Park ("Park"). These transmission lines are critical infrastructure, delivering electricity to more than 10,000 customers. The transmission right-of ways ("ROW") within the Park are generally 50-60% as wide as those outside the Park and, as a result, higher service disruption rates are experienced due to tree contact with the lines. Hydro has also observed evidence of burned trees associated with line contacts, indicating an elevated risk of forest fire initiation.

To improve service reliability and worker safety Hydro proposes to selectively widen the transmission line ROWs, in prioritized high-risk areas, over a 5-year period, commencing in the fall of 2024 ("Project"). The total proposed area for widening is approximately 33 hectares.

The Park is recognized for its exceptional natural beauty and is inscribed on the UNESCO[1] World Heritage List. Parks Canada has determined that a Detailed Impact Assessment ("DIA") is required based on the following Project attributes:

- potential to affect environmental and visitor experience values;
- is likely to change the nature and experience of unique, iconic or otherwise valued components characteristic of the natural environment;
- involves the expansion of an existing ROW; and
- is likely to result in significant interest or controversy among Indigenous Peoples, members of the public or stakeholders.

The objective of this DIA is to document project interfaces with the environment and identified Valued Components ("VC"). The DIA process also facilitates engagement and consultation with stakeholders and partners, including indigenous communities, to ensure that Project concerns are identified and adequately addressed. Improved electrical service reliability and increased access to firewood and sawlogs, as a result of the Project, are expected to result in a positive response from local communities and stakeholders.

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[1] United Nations Educational, Scientific and Cultural Organization.

Valued Components are key ecological or cultural resources that are characteristic of the environment, unique or outstanding features, and/or are important to visitor experience objectives. While low-risk VCs are discussed in the DIA, the DIA focuses on the interactions and potential effects of the Project on high and medium risk VCs identified by Parks Canada:

- Vegetation - Communities and Species (High);
- Visitor Experience - Viewscapes (High); and
- Outstanding Universal Value - Exceptional Natural Beauty (Medium).

In 2023, in collaboration with Parks Canada, a vegetation survey and a visual impact assessment were completed to better understand potential Project-VC interactions and inform the development of mitigation strategies. Hydro has also committed to implementing a new two-zone approach to vegetation management. With this two-zone approach, proposed widening areas, or “border zones”, will be selectively cleared of tall trees that pose a risk to the lines, while shorter trees and shrubs will be retained and future tree removal from this zone will be limited to tall trees as they reach a height of concern.

During Project planning, Hydro used a risk-based approach to minimize the scope of the Project and its potential impacts to VCs. With the implementation of specific mitigation measures contained herein, significant adverse effects of the Project on identified VCs are not anticipated and desired outcomes are expected to be achieved.

Hydro values its working relationship with Parks Canada and commits to continued collaboration in an effort to continually improve its practices over the course of this multi-year Project.

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1.0 INTRODUCTION

Newfoundland and Labrador Hydro ("Hydro") operates and maintains five transmission lines that pass through Gros Morne National Park ("Park"). These transmission lines are critical infrastructure, delivering electricity to more than 10,000 customers, including Park facilities, enclave communities, and all Northern Peninsula communities north of the Park (Figure 1).

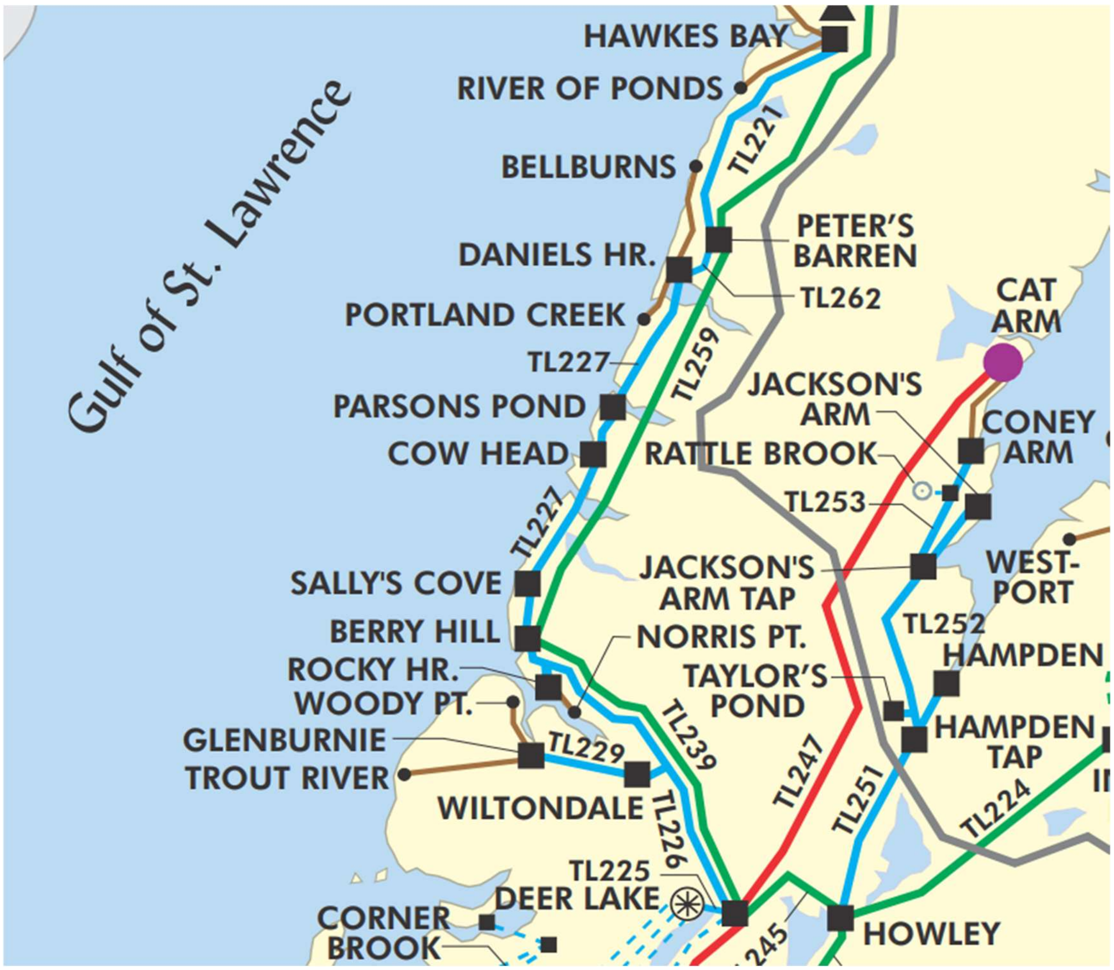

Figure 1. Northern Peninsula Transmission Lines

The Project involves widening of existing transmission line right-of-ways ("ROW") that were constructed 30 to 50 years ago. Hydro has managed vegetation on the existing ROWs since construction to reduce the likelihood of unplanned service disruptions, associated with tree contact with the lines, and to allow a safe ROW for Hydro personnel to access the lines to perform inspections, maintenance, and repairs.

Generally, the transmission line ROWs within GMNP are 50-60% as wide as ROWs outside[2] the Park and, as a result, these transmission lines experience higher service disruption rates[3]. Hydro has also observed evidence of burned trees associated with line contacts, indicating an elevated risk of forest fire initiation.

Hydro proposes to selectively widen the existing transmission line ROWs in identified, high-risk areas within the Park over a five-year period, commencing in the fall of 2024. To reduce the impacts of ROW widening, the project will utilize manual clearing methods and include the implementation of a new two-zone approach to vegetation management in the Park. With this new two-zone approach, widened areas, identified as "border zones", will be selectively cleared of tall trees that pose a risk to the lines, while shorter trees and shrubs will be retained (Figure 2). The existing width of the ROW corridors, identified as "wire zones", will continue to be cleared of all trees and shrubs, consistent with current vegetation management practices.

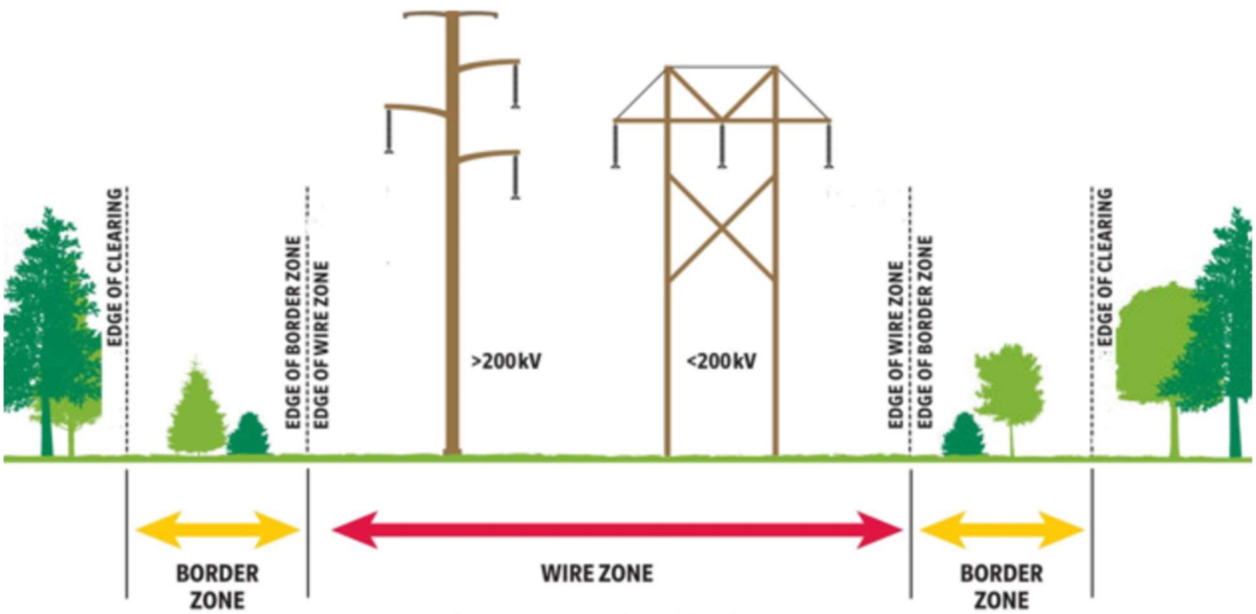

Figure 2. Illustration of Two-Zone Vegetation Management Approach

Parks Canada has determined that a Detailed Impact Assessment ("DIA") is required for this proposed Project as per the *Impact Assessment Act* and the *Parks Canada Directive on Impact Assessment (2019)*. This report presents the DIA for the project.

[2] When comparing lines of the same voltage class.
[3] For the period January 2017 to January 2024, tree contact incidents on these lines resulted in 20 unplanned service disruptions. There were no service disruptions due to tree contact on all other transmission lines on the Island during this period.

2.0 LEGISLATIVE AND POLICY CONTEXT

2.1 **Legislation, Mandate, and Policy**

2.1.1 Canada National Parks Act

The *Canada National Parks Act* (S.C. 2000, c.32) guides the management of national parks. Section 8 (2) of the Act stipulates that "Maintenance or restoration of ecological integrity, through the protection of natural resources and natural processes, shall be the first priority of the Minister when considering all aspects of the management of parks."

Section 15 (1) (a) (iii) of the Act stipulates "The Minister may enter into leases of, and easements or servitudes over, public lands in a park that are used for the right-of-way of an existing telecommunication or electrical transmission line". Section 15 (1) (b) further stipulates that "The minister may enter into leases of, and easements or servitudes over, public lands in a park that are required for any alteration to or deviation from a right-of-way referred to in paragraph (a) or for the relocation of any station or installation referred to in that paragraph".

2.1.2 Impact Assessment Act and Parks Canada Directive on Impact Assessment

According to the *Impact Assessment Act* (S.C. 2019, c.28, s.1) Parks Canada may only undertake a Project on federal lands if Parks Canada determines the project 82 (a) "is not likely to cause significant adverse environmental effects; or" that (b) "…..the Governor in Council decides, under subsection 90(3), that those effects are justified in the circumstances." Furthermore, the Act dictates in subsection 84 (1) that Parks Canada must make this determination based on Indigenous rights, Indigenous knowledge, community knowledge, public consultation, and mitigation measures.

The Parks Canada Directive on Impact Assessment (2019) describes the legislative and policy requirements to assess the impacts of proposed projects within Parks Canada protected areas and reflects the requirements of Parks Canada's federal authority under the *Impact Assessment Act*. It requires that an impact assessment occur when a project may have adverse effects on natural resources, cultural resources, visitor experience, and the rights and interests of Indigenous peoples. As part of the impact assessment process, several guiding principles are followed; including, transparency and meaningful participation, Indigenous leadership opportunities and partnership, and robust evidence from rigorous scientific study and Indigenous knowledge.

2.1.2.1 Parks Canada Impact Assessment Pathway Decision

There are multiple impact assessment pathways that are considered for any given project. The detailed impact assessment (DIA) pathway is the most comprehensive level of assessment and is appropriate for complex projects requiring an in-depth analysis.

The rationale for selecting a DIA as the impact assessment pathway for this Project is based on the following Project attributes:

- potential to affect environmental and visitor experience values;
- is likely to change the nature and experience of unique, iconic or otherwise valued components characteristic of the natural environment;
- involves the expansion of an existing ROW; and
- is likely to result in significant interest or controversy among Indigenous Peoples, members of the public or stakeholders.

While significant public interest is expected, that interest is likely to be positive as the primary Project objective is to improve the reliability of electrical service to communities.

2.1.3 Gros Morne National Park Management Plan (2019)

The Gros Morne National Park Management Plan provides clear and strategic direction for the management and operations of the Park through a vision, key strategies, and objectives. The Plan also includes specific area management approaches, where multiple interests and stakeholders exist, and acknowledges that not all Park uses conform to its zoning plan, including utility corridors that are critical to serving customers in the Park area and the Northern Peninsula.

2.1.4 Strategic Environmental Assessment of Gros Morne National Park Management Plan, 2019

A strategic environmental assessment ("SEA") was conducted on the Gros Morne National Park Management Plan to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decision making. Valued Components evaluated in the SEA included marine and coastal habitat, Piping Plover, seabirds, freshwater, Atlantic Salmon, other salmonids, wetlands, forest vegetation, American Marten, Woodland Caribou, Arctic Hare, Rock Ptarmigan, and alpine vegetation and terrain. The SEA also considers the Outstanding Universal Value criteria for which Gros Morne National Park was inscribed as a UNESCO World Heritage site in 1987, to ensure these are adequately protected.

The SEA considers a range of stressors potentially impacting each VC over the next decade and identifies mitigation strategies and priorities to manage cumulative effects and residual impacts.

Parks Canada has identified the VCs to be assessed as part of the DIA for this Project. Further information on the scope of the assessment, analysis of impacts, mitigations, and monitoring requirements are contained herein.

2.1.5 Species at Risk Act and Multi-Species Action Plan for Gros Morne National Park (2016)

The *Species at Risk Act* (S.C. 2002, c.29), ("SARA"), was established in 2002 to prevent wildlife species in Canada from disappearing, provide for the recovery of species that are extirpated, endangered, or threatened as a result of human activity, and to manage species of special concern to prevent them from becoming endangered or threatened.

Consistent with SARA requirements, the Park maintains a Multi-Species Action Plan for Gros Morne National Park to implement recovery strategies for 14 species[4] that exist within the Park. Some of these species, and related habitats, may be present in, or near, the Project area and mitigation measures must align with the Multi-Species Action Plan.

2.1.6 Migratory Birds Convention Act and Migratory Birds Regulations

The *Migratory Birds Convention Act* (S.C. 1994, c.22) and regulations protect and conserve migratory bird populations and individuals, as well as their eggs and nests. As the Project involves the removal of vegetation where migratory birds and their nests and/or eggs may be present, consideration of the timing of activities and development of an appropriate mitigation strategy are necessary.

2.1.7 Public Utilities Act, P-47 and Electrical Power Control Act, 1994

As a Crown public utility, Hydro has obligations regarding the provision of electrical service in the province. The *Public Utilities Act*, section. 37.1 states "a public utility shall provide service and facilities which are reasonably safe and adequate". Section 3(b) of the *Electrical Power Control Act* stipulates that "all sources and facilities for the production, transmission and distribution of power in the province should be managed and operated in a manner (iii) that would result in power being delivered to consumers in the province at the lowest possible cost, in an environmentally responsible manner, consistent with reliable service".

This Project proposal is consistent with these obligations.

2.2 Additional Hydro Requirements

There are other legislative, policy, and best practice requirements that may be, or may become, applicable to the Project. In conjunction with Parks Canada staff, Hydro developed and maintains an *Environmental Protection Plan for Federal Lands and Other Sensitive Areas on the Northern Peninsula* ("EPP"). Originally drafted in 1993, and last revised in 2020, this EPP provides recent standards, regulations, legislation, policies, codes of practice, protection measures, and commitments for activities relating to Hydro's transmission and distribution lines within the Park. For this Project for example, requirements associated with the protection of various species at risk (both flora and fauna) and nesting migratory birds, as well as practices

[4] Eleven SARA-listed species and three species of conservation concern.

associated with access and travel, vegetation clearing, and stream and wetland protection will be particularly relevant.

Hydro maintains a registered[5] Environmental Management System ("EMS"), committing Hydro to adhere to environmental legal requirements and continually improve its environmental performance. This Project falls under the scope of Hydro's EMS and will be managed accordingly.

3.0 PROJECT DESCRIPTION

3.1 Background and Scope

Hydro operates and maintains five transmission lines that run through the Park. These transmission lines are critical infrastructure, delivering electricity to more than 10,000 customers, including Park facilities, enclave communities, and all Northern Peninsula communities north of the Park. The transmission lines currently have higher unplanned service disruption rates than lines outside the Park. Many service disruptions are attributed to ROWs within the Park being 40-50% narrower than outside the Park, resulting in more frequent tree contact and tree encroachment incidents. Narrower ROWs also make repairs more difficult and dangerous and increase the risk of wildfire initiation.

To improve service reliability, worker safety, and reduce the risk of wildfire initiation, Hydro proposes to selectively widen the transmission line ROWs, in prioritized high-risk areas, over a 5-year period (2024-2028). Depending on terrain and vegetation type, ROWs may be widened from 9-15 meters up to 19-29 meters (i.e. 5-7 meters either side) in the selected areas. Total clearing is estimated at 33 hectares[6], distributed across approximately 80 kilometers of transmission lines (Figure 3). The transmission line area in the Park will increase from approximately 157 hectares to 190 hectares as a result of the widening project.

[5] Registered to the International Standards Organization ("ISO") 14001 standard. ISO 14001 is the internationally recognized standard for Environmental Management Systems.
[6] Representing less than 0.02% of the Park area.

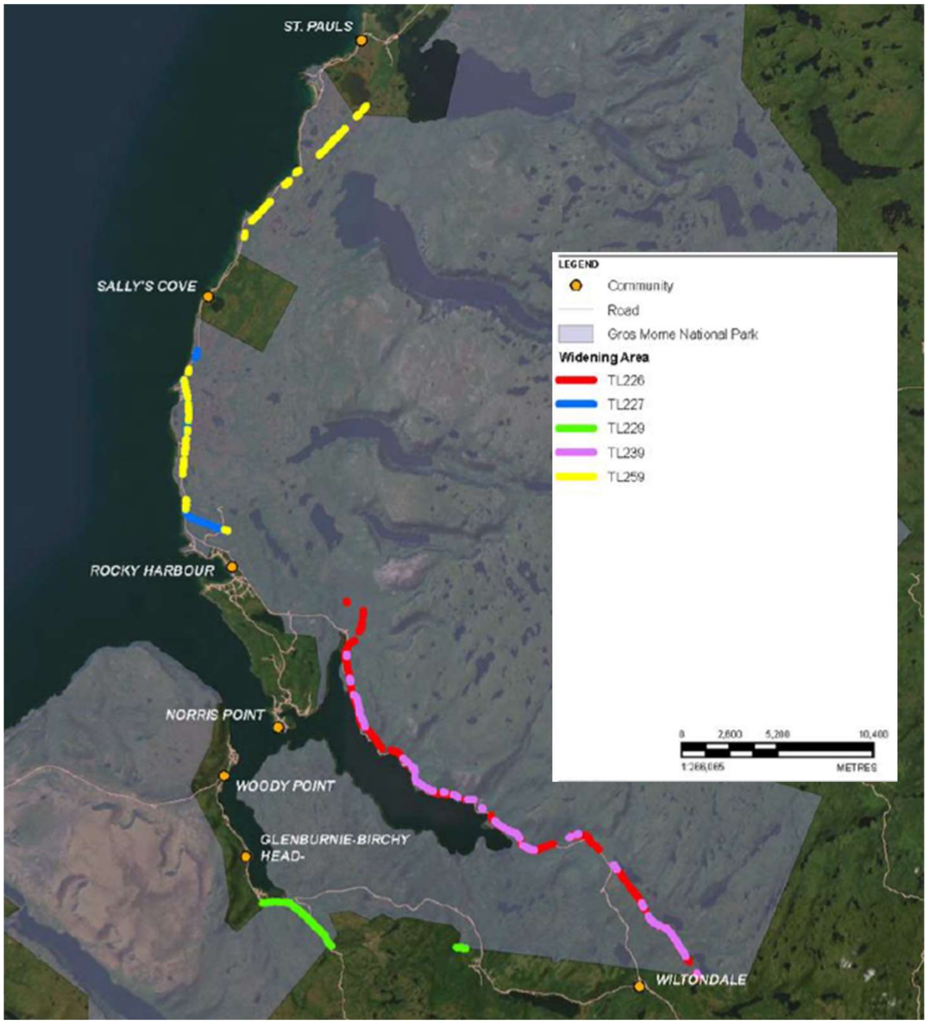

Figure 3. Transmission Line Widening Locations

3.2 Vegetation Removal Requirements and Utilization

In 2016, Hydro used remote sensing techniques (LidAR) and field reconnaissance to identify areas of vegetation encroachment and danger trees (Figure 4). This study identified the high risk areas where tree removal is required, forming the basis for this Project.

Based on the LiDAR survey, Hydro prepared a ROW widening plan to address risk across the five transmission lines. Approximately 33 hectares are identified for removal of tall vegetation, primarily balsam fir and black spruce, based on a clearing width of 5-7 meters per side. As the clearing is selective in nature, total volume removed is anticipated to range from 1200 - 2000 m^3, depending on terrain, vegetation, and worker safety considerations. Vegetation clearing requirements for the Project are summarized below (Table 1). A more detailed plan is included in Appendix D.

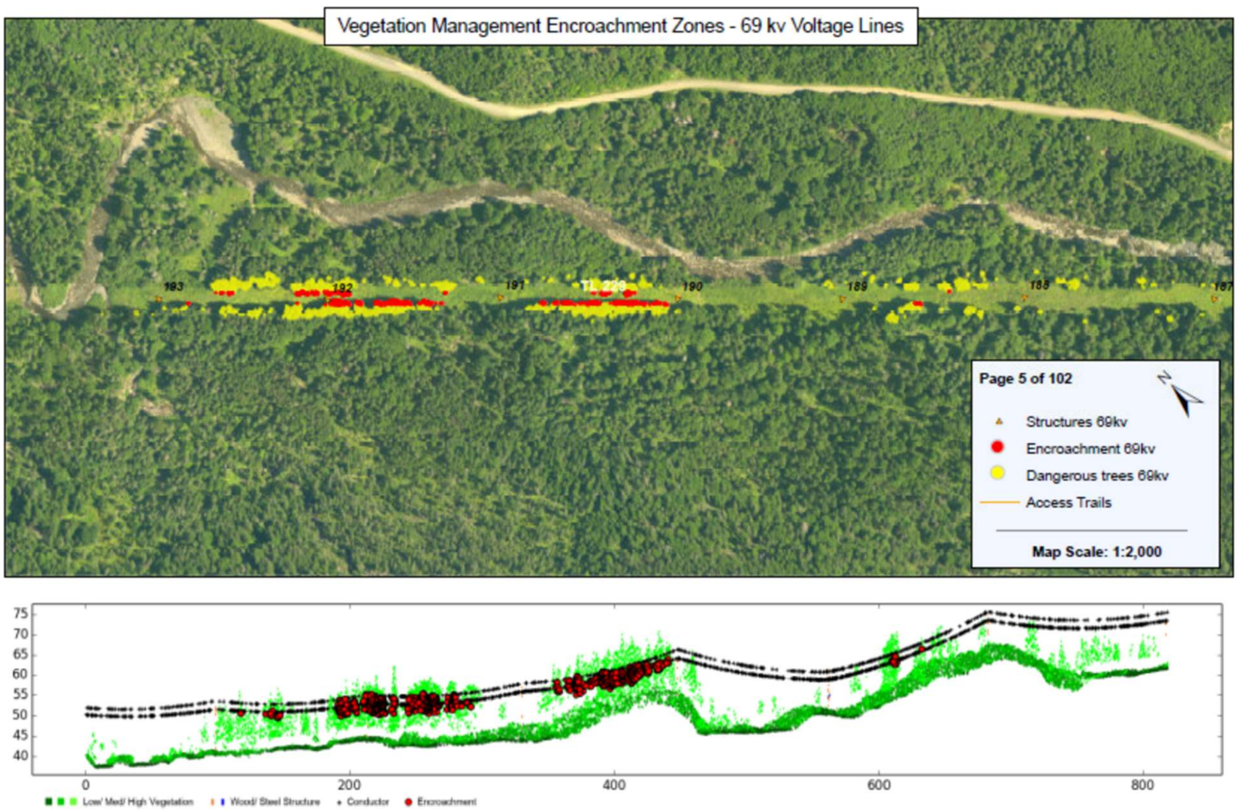

Figure 4. Sample Illustration of High Risk Area with Encroachment and Danger Trees

In close coordination with Parks Canada's domestic timber harvest program representatives and local requirements, utilizable wood (i.e firewood and sawlog material) removed from proposed widening areas will be cut to 8 foot lengths and piled into small stacks (0.5 cord or greater) for use by eligible domestic timber harvesters. Hydro will allow access to the wood once work in an area is complete and the site is safe for public access. Hydro recognizes that access to the wood generated by this Project is important to local communities and to Parks Canada.

Table 1. Vegetation Removal Requirements by Transmission Line

Transmission Line	General Location	Total Area (ha)
TL 226	Southern Park Boundary to Eastern Arm	13.0
TL 239	Southern Park Boundary to Eastern Arm	3.8
TL 227	Berry Hill Substation to Shallow Bay	6.9
TL 259	Berry Hill Substation to Shallow Bay	7.1
TL 229	Lomond to Glenburnie	2.5
Total	-	33.3

3.3 Project Planning and Schedule

Project planning and development has been ongoing for more than a decade. The 2016 LiDAR study led to the development of a detailed widening plan and, with the addition of a new two-zone approach to vegetation management and ongoing collaboration with Parks Canada, a multi-year Project was defined in 2022. In 2023, work to support a DIA commenced and additional studies were undertaken to support the Project. Additional studies to assess potential Project impacts included: (1) a vegetation assessment to identify species at risk or species of concern in areas planned for widening, and (2) a visual impact assessment to identify areas where Project activities may impact viewscapes.

The Project is proposed as a 5-year Project (2024 – 2028) commencing in September 2024, subject to approval. Work will be scheduled annually from approximately September 1 to December 15, subject to weather conditions. Higher voltage lines (i.e. TL 239 and TL 259) are scheduled for the first two years of the Project as they have the largest impact on service reliability.

3.4 Project Execution Approach

Vegetation clearing will be performed by experienced contractors utilizing manual methods (i.e. chainsaws, brush saws, pruning saws). Trees may be removed entirely or, near sensitive locations, may be trimmed and/or topped. Understory vegetation will be retained in the widened areas where safe to do so. Hydro representatives will oversee the work and ensure environmental protection and mitigation measures are implemented. Hydro will identify Environmental constraints (e.g. waterbodies, rare plants) in each work area and review with the crews prior to commencement of work in the area. Biodegradable ribbon may be used to delineate buffers or special treatment areas (e.g. species of concern location).

Three crews will be dispatched to selected work sites on a daily basis. Each crew will consist of 6-7 manual cutters, 2-3 laborers, a supervisor, and a Hydro inspector/monitor. Merchantable timber will be cut to 8 foot lengths and piled in one to two cord stacks (minimum 0.5 cord) along the edge of the ROW and brush and debris will be spread along the ROW as required. Stumps will be no higher than 15 cm.

Crews will access the work areas by ATV and on foot, utilizing the ROW corridors and previously approved[7], existing Hydro access trails and fording sites[8]. No heavy equipment use or new trail development are planned. Limiting ATV travel to existing trails and ROWs minimizes the potential for incremental Project impacts associated with access. Parking of crew support

[7] Previously approved by Parks Canada to facilitate maintenance of transmission infrastructure.
[8] Fisheries and Oceans Canada issues an annual "Letter of Advice" to Hydro that applies to temporary watercourse crossings and other minor works near water.

vehicles along the highway, or at local designated parking areas, is anticipated and will be planned to minimize disruption to the public and ensure the safety of all road users.

3.4.1 Interface Planning and Collaboration

Hydro is committed to working collaboratively with Parks Canada throughout the multi-year Project. Annual Project planning workshops will be scheduled well in advance of commencement of seasonal cutting operations to ensure operational interfaces are identified and plans are confirmed. Collaboration and advanced planning are important to proactively address interfaces such as: public safety, moose hunting, temporary access restrictions or closures, domestic tree harvest program, permitting requirements, and visually sensitive locations.

Hydro will liaise regularly with Parks Canada personnel during the execution phase as necessary to provide Project updates and coordinate activities (e.g. temporary access restrictions, domestic tree harvesting).

3.5 ROW Maintenance and Two-Zone Vegetation Management

Following completion of the proposed widening, Hydro will continue to maintain the ROWs using the new two-zone approach to vegetation management (Figure 2). The "wire zone" represents the existing, pre-project ROW width where herbs and grasses will be retained and manual cutting of shrubs and trees will continue as needed. The widened areas, or "border zones", where shrubs and small trees will be retained, will be monitored and scheduled for selective cutting or trimming once trees approach a height where they become an encroachment concern[9].

4.0 CONSIDERATION OF ALTERNATIVES

The objective of the Project is to improve the reliability of electrical service to Hydro's customers on the Northern Peninsula. Widened ROWs will also improve working conditions for Hydro line crews and reduce risk of wildfire initiation. Hydro and Parks Canada have worked closely over many years to establish and adapt vegetation management practices in the Park. This multi-year Project and approach is reflective of this collaboration.

4.1 Alternative Approaches

Alternative approaches considered include:

No Action

Hydro is obligated to provide reliable service to its customers and provide a safe work environment for its employees. The nature of the existing ROWs in the Park compromises

[9] Generally 3-4 meters.

Hydro's ability to meet these obligations and thus, Project deferral or cancellation is not a viable alternative. Reacting to ongoing tree contact incidents, and related unplanned outages, under emergency circumstances is not a prudent approach to manage risk.

Status Quo – Routine Annual Vegetation Management

Hydro completes annual vegetation management in transmission ROWs in the Park, including limited removal of danger trees along the ROWs, under the Preapproved Routine Impact Assessment ("PRIA") process. The identified scope of ROW widening required to effectively mitigate service reliability and safety risks cannot be achieved in an acceptable timeframe under this limited, routine program and does not allow Parks Canada to properly assess the impact of all the work that is required.

ROW Widening Project

To improve service reliability, worker safety, and reduce risk of wildfire initiation, Hydro proposes to selectively widen the transmission line ROWs, in prioritized high-risk areas, over a 5-year period. No other viable alternatives exist to effectively mitigate these risks.

4.1.1 Alternative Methods for ROW Widening

The following alternative ROW widening methods were considered:

Widening of ROWs to Utility Standard

Rather than focus on the selective removal of vegetation (i.e. primarily danger trees) from identified high-risk areas, ROWs could be widened to standard widths, with all vegetation removed from the ROWs, similar to Hydro's practices outside the Park. This method would achieve Hydro's objective but could potentially have a greater impact on vegetation communities, visual quality, visitor experience, and Outstanding Universal Value ("OUV") - exceptional natural beauty.

Selective Widening and Two-Zone Approach

A selective, risk-based approach is proposed. In areas selected for widening, vegetation removal will be limited to danger trees/taller trees, with understory vegetation retained where safe to do so. In conjunction with selective widening, Hydro is proposing to implement a new two-zone approach to vegetation management in the Park, with the existing ROW footprint comprising the "wire zone" and the "border zone" representing the area beyond the existing ROW where widening is planned. This approach will allow vegetation to be retained and establish in the "border zone" and future tree removal from this zone will be limited to tall trees as they reach a height of concern. This two-zone approach will mitigate risk to service reliability, safety, and wildfire initiation while ensuring that impacts to visual quality and visitor experience are mitigated and proactively managed.

5.0 INDIGENOUS CONSULTATION

Parks Canada is working to enable Indigenous stewardship across Parks Canada administered places, strengthening connection to place, supporting Indigenous leadership, and respecting Indigenous knowledge. Growing and strengthening relationships with Miawpukek First Nation and Qalipu First Nation communities is a priority for Parks Canada.

Initial discussions regarding the proposed Hydro ROW corridor widening project began with Miawpukek and Qalipu First Nations in November 2023. In April 2024, both First Nations were provided the opportunity to review and provide feedback on the project. In May 2024, the draft DIA was provided for review and comment, with no comments received to date.

Parks Canada will continue to work with Indigenous communities and stakeholders throughout the DIA process, addressing any issues and concerns that may arise.

6.0 PUBLIC ENGAGEMENT

The Project will reduce the risk of unplanned power outages to Park facilities, enclave communities, and Hydro's customers north of the Park. Improved electrical service reliability and increased access to firewood are expected to result in a positive response from local communities. Work will be scheduled in the fall period(s) to avoid peak tourism season; however, some work areas may be visible from travel corridors, hiking trails, and other locations of interest. The annual moose hunt will also attract hunters to the Project area in the fall when widening activities are ongoing. A strong communication effort and implementation of temporary restrictions will be necessary to ensure the safety of hunters and Project personnel. There are no anticipated significant traffic impacts but Project vehicles may temporarily occupy designated parking areas. Maintaining public safety will be paramount throughout the Project.

The public engagement plan undertaken by Parks Canada for the DIA reflects the nature of the Project and potential stakeholder interest. A notice of intent was posted on the Canadian Impact Assessment Registry[10] on December 21, 2023, inviting comments from the public on the Project's potential effects on the environment. An information letter was sent to all stakeholders[11] on April 5, 2024, referencing the opportunity to request a copy of the DIA for review and submit comments by May 31, 2024. Although there were several requests for a copy of the DIA, no public comments were received during the review period.

In addition, Parks Canada and Hydro representatives met with municipal councils of enclave communities in parallel with development of the draft DIA. These sessions provided an

[10] https://iaac-aeic.gc.ca/050/evaluations/proj/87180
[11] Parks Canada maintains a stakeholder register. Approximately 100 stakeholders were identified for this DIA.

overview of the Project and the DIA process and offered an opportunity for discussion and questions. Meetings took place during the week of February 19-23, 2024 as follows:

- Tuesday, February 20, 2024. Location: Woody Point Community Center. Attending: Town of Woody Point, Town of Trout River, Town of Glenburnie-Birchy Head-Shoal Brook;
- Wednesday, February 21, 2024. Location: Norris Point Community Center. Attending: Town of Norris Point, Town of Rocky Harbour;
- Thursday, February 22, 2024. Location: St. Paul's Community Center. Attending: Town of St. Paul's, Town of Cow Head.

The meetings were positive with discussion focused on service reliability, prioritization of work, and access to firewood. A summary of these discussions and feedback is provided in Appendix A. There are no outstanding actions from these meetings.

7.0 DESCRIPTION OF ENVIRONMENT

7.1 **Biophysical Landscape Description**

Gros Morne National Park encompasses more than 1800 km2, protecting a range of ecosystems within the Western Newfoundland Highlands and St. Lawrence Lowlands natural regions. An extensive diverse coastline, unique and varied geology, topographic complexity, and a marine influenced climate produce a broad range of habitats and physical features in the Park. The Park is a designated UNESCO World Heritage Site recognized for its exceptional natural beauty and outstanding examples of the major stages in the earth's geological evolution, illustrated by formations found within the Park.

The Park falls within three of the nine ecoregions for Newfoundland, as described by Damman – the Western Newfoundland Forest Ecoregion, Northern Peninsula Forest Ecoregion, and Long Range Barrens Ecoregion. Ecoregions have distinctive recurring patterns of vegetation and soil development driven by regional climate.

The Coastal Plain Subregion of the Northern Peninsula Ecoregion dominates the Project area (Figure 5), with terrestrial ecosystems ranging from coniferous forests to open barrens and wetlands. Numerous watercourses and aquatic habitats are present in this subregion including many streams and salmon rivers, ponds, fjords, and deep glacial lakes.

The Park includes significant coastline and low-lying areas west of the Long Range Mountains. As such, the Park landscape also includes many communities and modern infrastructure, such as provincial highways and utility corridors, which provide critical services to residents on the Northern Peninsula and beyond into Labrador.

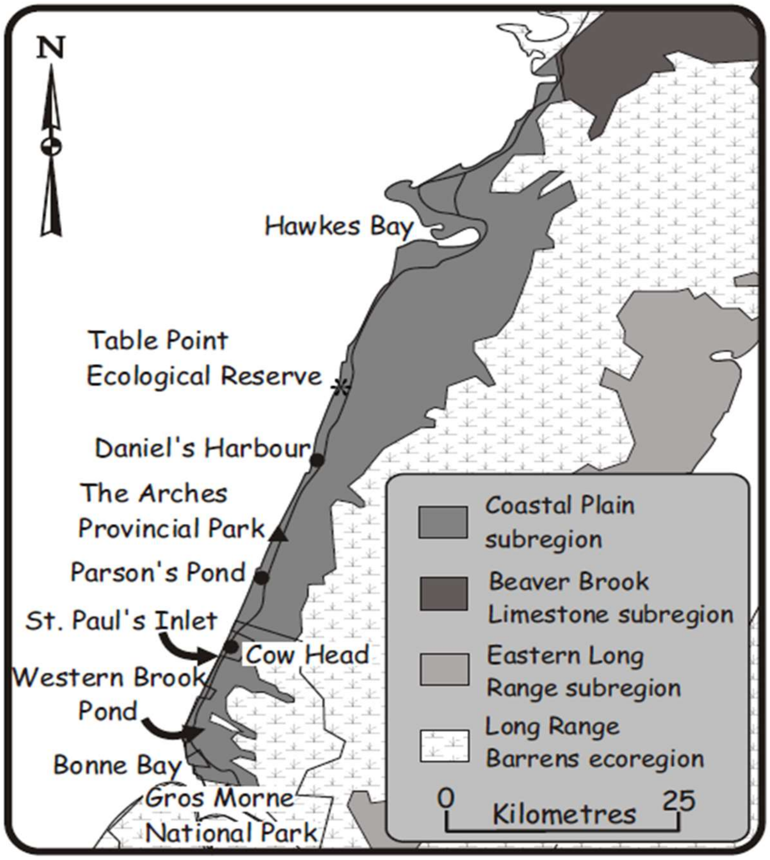

Figure 5. Ecoregions and Subregions in the Project Area

7.2 Site Scale Description

Hydro operates and maintains five transmission lines that run through the Park. Transmission line 229 ("TL229") runs in an east-west direction, delivering power from Wiltondale to the Glenburnie substation. The remaining transmission lines (TL226, TL239, TL227, and TL259) run in a south-north direction generally within 3km of the provincial highway corridor. Significant portions of TL226 and TL239 share a common ROW corridor, as do TL227 and TL259, and there are a number of previously established access trails to facilitate inspections and maintenance. The transmission lines generally traverse low elevation forested habitats and wetlands in close proximity to highway routes (Figure 6).

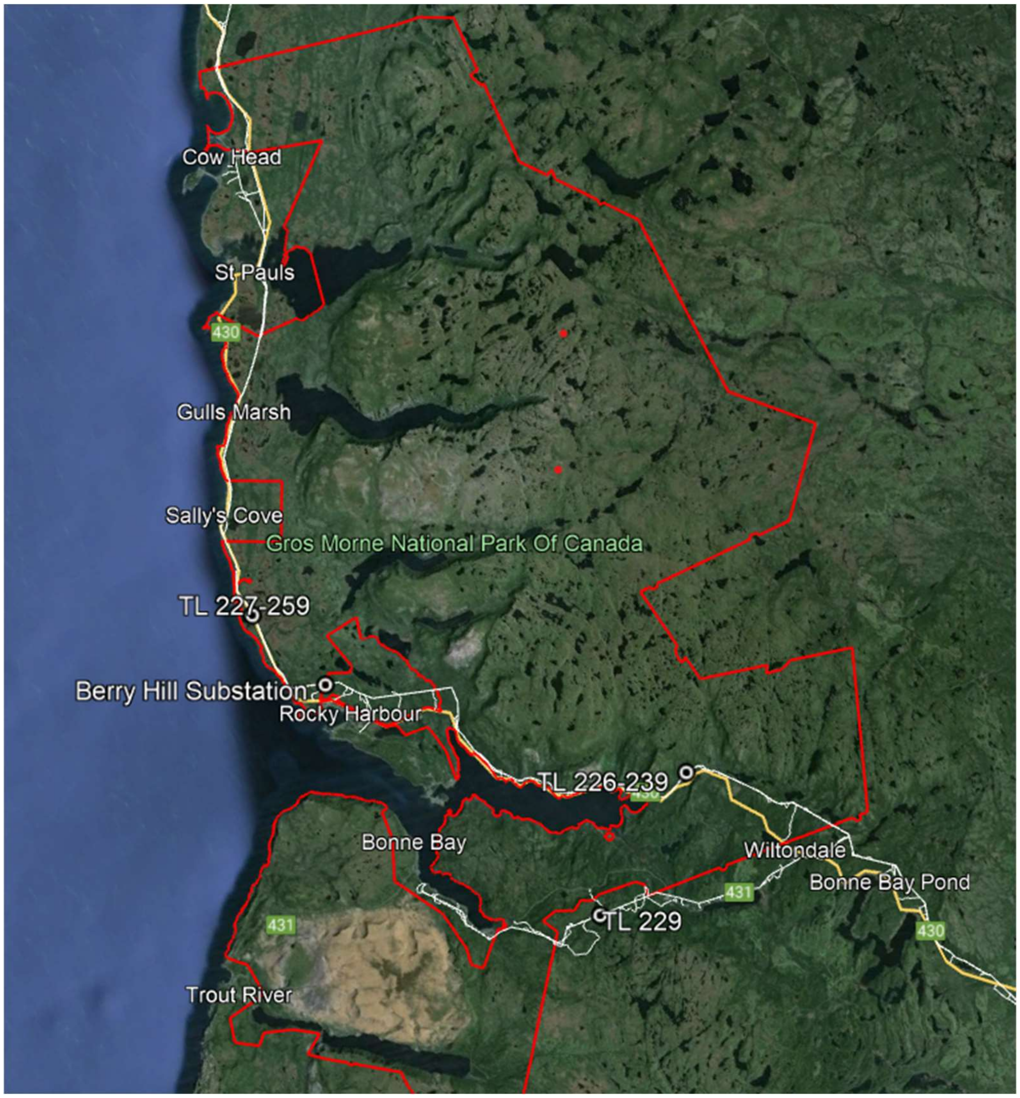

Figure 6. Transmission Infrastructure and the Environmental Setting

ROW corridor widening is generally limited to locations where tall trees encroach on the transmission lines or where they would contact the lines should they fall or become structurally compromised. As such, Project impacts to vegetation are generally limited to mature forested ecosystems while Project access requirements may interface with a broader range of habitats, including wetlands and riparian areas. Figure 7 illustrates the typical environmental setting where vegetation removal, trimming, or topping are required to mitigate risk.

Figure 7. Typical Widening Location (TL 229)

8.0 SCOPE OF ASSESSMENT

The objective of this DIA is to document Project interfaces with the environment and identified VCs. Valued Components are key ecological or cultural resources that are characteristic of the environment, unique or outstanding features, and/or are important to visitor experience objectives. The VCs identified for assessment are: Indigenous rights and values, cultural resources, natural resources - ecological integrity (e.g. vegetation communities and species); visitor experience and safety, and World Heritage Site – Outstanding Universal Value.

The spatial scope of the assessment is the local study area which includes portions of the 5 existing transmission line ROWs, and their neighboring environments, as well as various established viewpoints, trails, and travel corridors in the Park. The transmission ROWs traverse the Park, generally within 3 kilometers of highway routes 431 and 430.

The temporal scope of this assessment includes the proposed 5-year execution phase of the Project (2024 to 2028), as well as the long-term presence of the ROWs and their continued operation and maintenance.

While low risk VCs will be discussed, this DIA will focus on the effects of the Project on high and medium risk VCs[12]. The DIA incorporates site-specific data collected by, or provided to, Hydro along with the outcomes of public and Indigenous engagement[13] led by Parks Canada.

8.1 Valued Components

The VCs selected by Parks Canada for assessment in this DIA are summarized below.

Table 2. Summary of Selected Value Components and Risk Category

Selected Valued Components	Risk Category
Indigenous Rights and Values VCs	
None identified to date (see 8.1.1)	Not Applicable
Cultural Resource VCs	
Archaeological Sites	Low
Natural Resource - Ecological Integrity VCs	
Vegetation – Communities and Species	High
Habitat Connectivity	Low
Aquatic Habitats/Water Quality	Low
Migratory Birds (including Species at Risk)	Low
Red Crossbill (Threatened)	Low
American Marten (Threatened)	Low
Woodland Caribou (Special Concern)	Low
Bats (Endangered – Little Brown Myotis, Northern Myotis)	Low
Moose	Low
Soils	Low
Visitor Experience VCs	
Viewscapes	High
Visitor Experience and Safety (e.g. interruption to access)	Low
World Heritage Site	
Outstanding Universal Value (OUV) – Exceptional Natural Beauty	Medium

[12] Valued Components and risk designations were provided by Parks Canada in the Terms of Reference for the DIA.
[13] No comments were received.

8.1.1 Indigenous Rights and Values

Parks Canada did not identify specific Indigenous rights and values VCs in the DIA Terms of Reference. Should Indigenous rights and values VCs be identified through the course of the DIA process, the scope of the DIA may be modified by Parks Canada to ensure identified VCs are addressed in the final DIA by the proponent.

8.1.2 Cultural Resources

There are no known archaeological sites in the Project area and the transmission lines are not located in areas of high archaeological potential[14]. The proposed Project involves minor expansion of existing transmission ROWs through vegetation removal only - no earth works or excavations are required. Work will be completed manually utilizing existing access points and trails.

There could be a chance, however low, that cultural resources are encountered during Project activities. Cultural features or artifact concentrations may include artifacts or structural remains that are either Indigenous or European in origin. This includes, but is not limited to: tools made of stone, ceramics, glass, and/or features related to logging, trapping, and fishing activities (i.e. tools, barrel hoops, sled runners, traps, tilts, rock alignments, etc.). If cultural resources are encountered, work will cease in the immediate area and the Parks Canada Impact Assessment Practitioner (“IAP”) will be informed. The work area, in relation to the finding(s), will be photo documented and geo-referenced. The IAP will contact Parks Canada's Terrestrial Archaeology section for advice and assessment of significance to determine what actions will be required to mitigate the chance find. Hydro will work with the IAP to implement the required mitigation and adjust Project activities accordingly.

8.1.3 Natural Resources – Ecological Integrity

Widening and future maintenance of the ROWs requires the removal of vegetation and may negatively impact vegetation communities and species. Tree/plant species of concern include: Black Ash, Vreeland’s Striped Coralroot, Yellow Birch, White Pine, and Red Maple. Habitat connectivity may also be impacted by widened utility ROW corridors.

Vegetation removal may impact the habitats of migratory birds and species at risk, including: Red Crossbill, American Marten, Woodland Caribou, and endangered bat species. Widened ROWs and two-zone vegetation management may also promote the establishment and presence of vegetation that may be desirable as browse for the abundant moose population.

The use of gas-powered tools (e.g. chainsaw), and associated fuels and lubricating oils, and motorized equipment for travel (i.e. ATVs) may impact aquatic habitats, water quality, and soils.

[14] As per correspondence with Parks Canada staff.

8.1.4 Visitor Experience and Safety

Widening of the ROWs requires the removal of tall trees within forested communities. Vegetation removal may affect viewscapes within the Park, which could negatively impact visitor experience. During execution of the Project, crew vehicles and equipment may park along public roadways or in designated parking lots, causing temporary congestion or disruption to traffic flow. Tree trimming or cutting activities may be required in close proximity to publicly accessible areas (e.g. hiking trail) requiring temporary access/use restrictions to ensure public safety, including the safety of hunters and Project personnel during the annual moose hunt.

8.1.5 World Heritage Site – Outstanding Universal Value

This DIA considers impacts on Outstanding Universal Value ("OUV") associated with the World Heritage Site criteria that Gros Morne National Park was inscribed under. The widening of the ROWs requires the removal of tall trees within forested communities, which may change viewscapes within the Park and has the potential to affect the Park's UNESCO OUV for exceptional natural beauty (Criterion vii). This VC has a medium risk designation.

9.0 IMPACT ANALYSIS

The analysis of impacts is organized by risk category and focuses on high and medium risk VCs. For high and medium risk VCs, a desired outcome is provided as predetermined by Parks Canada. Low risk VCs are grouped where appropriate for discussion.

9.1 High and Medium Risk Valued Components

9.1.1 Vegetation – Communities and Species (High)

Introduction

Widening of the existing ROWs requires the removal of vegetation and subsequent maintenance of those widened areas over the long term. Vegetation removal, trimming, or topping has the potential to impact local plant communities and individual species. Black Ash and Vreeland's Striped Coralroot are known to exist in the Project area and have Threatened and Endangered status under Provincial and/or Federal legislation, respectively. In addition, several local species of concern may be present in the Project area, including: Yellow Birch, Red Maple, and White Pine. Removal of, or inadvertent damage to, these species is a potential Project-VC interaction.

The impacts of non-native, invasive plant species on native plant communities is a concern for Parks and other natural areas across Canada. The mobilization of equipment (e.g. ATVs) to the Park, and movement of equipment within the Project area, provides a potential opportunity for the introduction, spread, or establishment of non-native, invasive plant species.

Desired Outcome

The goal is to conserve healthy vegetation communities that maintain a native and biodiverse species composition.

Analysis of Potential Effects

Vegetation removal, tree trimming, or tree topping are common activities associated with transmission ROW corridor maintenance. Vegetation management of transmission line ROWs utilizes many standard, generic mitigations to minimize environmental impacts; however, the known presence of threatened, endangered, and other species of concern in the Park requires a Project-specific management approach.

To improve the available baseline information and better understand potential Project impacts on vegetation communities and species, Hydro engaged a consultant to complete a vegetation assessment[15] of the Project area. The vegetation assessment targeted locations planned for widening and was completed during August/September, 2023. The vegetation assessment identified:

- five areas where Black Ash is present, two of which were not previously known;
- six confirmed instances of Vreeland's Striped Coralroot, and 12 potential occurrences[16] of Vreeland's Striped Coralroot; and
- over 600 occurrences of Yellow Birch, primarily in the vicinity of Eastern Arm and near Glenburnie.

During completion of the vegetation assessment, approximately 10 Red Maples were observed in a localized area on TL 229 and one White Pine was observed on TL 226. Widening is not proposed in either of these areas and the observations were incidental to travel through the area.

The risk of impact to Black Ash trees may include damage resulting from travel through the work area or physical impacts from felled or piled trees and debris. Black Ash in the Project area has a small stature and is unlikely to encroach the lines or be considered a danger tree requiring removal. Hydro does not anticipate significant impacts to Black Ash trees.

The risk of physical impacts to Vreeland Striped Coralroot plants could be associated with travel or tree removal, trimming, or topping activities. Vreeland Striped Coralroot relies on ectomycorrhizal fungi to derive nutrients from the soil. These fungi, in turn, are engaged in a mutualistic relationship with the surrounding trees. Removal of vegetation in close proximity to

[15] The vegetation assessment report is available upon request.
[16] There are several coralroot species present in the Project area, with Vreeland's Striped Coralroot being the only endangered species. At the time of the assessment, flowers were not present on the plants and the species was not positively confirmed in all cases.

Vreeland Striped Coralroot individuals/clumps could compromise this mycorrhizal network and be detrimental to the plants.

In the case of Yellow Birch, due to its height and growth potential, removal, trimming, or topping of some individual trees may be unavoidable to reduce the risk of unplanned power disruptions. Although regionally rare, Yellow Birch was found to be locally abundant where present in the Project area, with most occurrences comprised of multiple trees and clusters of more than 10 individuals.

The Project requires the use ATVs to transport crews on existing trails to the work locations. This equipment may originate from outside the region and will leave and return to the area over the course of the Project. If equipment from outside the region is contaminated with seeds or other invasive plant material, it may provide an opportunity for the introduction or spread of invasive species in the Park. Similarly, ATV travel within the Park could provide the means to spread invasive species from one area to another.

Mitigations

During Project planning, Hydro considered opportunities to minimize the scope of the Project and its potential impacts, including to plant communities and species. Extensive analysis of the Project area allowed Hydro to identify high risk areas of concern and limit the widening Project scope to approximately 33 hectares. Within the widening areas, Hydro's proposed two-zone approach to vegetation management will significantly reduce the impacts on plant communities and species in the near term but, more importantly, will allow the establishment and retention of shrubs and small trees in these areas in the future. Hydro values its working relationship with Parks Canada and commits to continued collaboration in an effort to continually improve its practices in the Park.

Hydro's EPP will be applicable to the Project. The EPP provides recent standards, regulations, legislation, policies, codes of practice, protection measures, and commitments for activities relating to Hydro's transmission and distribution lines within the Park. In addition, Hydro has developed specific mitigation measures for this Project to address the risk of negative impacts to the species of concern as summarized below.

Table 3. Mitigation Measures for Plant and Tree Species of Concern

Species	Mitigation Measures
All - General	• crew education/awareness • plant ID field card for crew • Pre-identification and flagging of area and/or management zone as applicable • Fall away/yard away; winching/directional felling as needed • Where it is not safe or feasible to retain a tree(s) as prescribed, contact your supervisor. Hydro's representative will confirm required action.
Black Ash	• Establish 10 meter radius management zone prior to commencement of work • Prevent damage to individuals • Remove introduced debris from management zone • No wood piling inside management zone • Other trees may be removed from management zone
Vreeland's Striped Coralroot	• assume the 18 potential occurrences are Vreeland's Striped Coralroot, unless verified otherwise during flowering period • Establish 10 meter radius management zone prior to commencement of work • All vegetation must be retained in the management zone • Trees in the management zone may be topped and/or trimmed • Where trees are being topped/trimmed in the management zone, and debris may impact the plants, temporarily protect plants with a physical barrier (e.g. inverted plastic totes, 5-gallon buckets) • Remove introduced debris from management zone • No wood piling inside management zone • Trees with branches extending into the management zone can be removed as required

Species	Mitigation Measures
Yellow Birch[17]	• Individual occurrence – retain tree; trim and/or top as needed • "Regular" (2-10 trees) – remove up to 50% of trees; trim and/or top remaining trees as needed • "Cluster" (>10 trees) – remove up to 80% of trees; trim and/or top remaining trees as needed
Red Maple and White Pine[18]	• Retain tree(s); trim and/or top as needed

As Hydro conducts similar work activities within the Park on a routine basis, the management of the risk for the introduction, spread, and establishment of non-native, invasive plant species is a familiar requirement and not unique to the Project. Applicable mitigation requirements include:

- construction equipment originating from outside the area must be effectively washed (i.e. high pressure water) outside the area prior to mobilizing;
- confirm known infested areas with Parks Canada and complete work in low risk areas (e.g. power lines further from roadways and human activities) before moving to higher risk areas (e.g. areas adjacent to community enclaves, campgrounds, highway pull-offs) where possible;
- minimize ground disturbance, vegetation removal, and bare soil exposure;
- stabilize and re-vegetate disturbed areas as soon as possible;
- ensure Project personnel are aware of invasive species of concern; and
- notify Parks Canada if an invasive species is identified (i.e. giant hogweed).

Residual Effects

With the completion of a vegetation assessment, application of the noted specific mitigation measures, and implementation of a two-zone approach to vegetation management allowing the retention of vegetation in the Project area, significant adverse effects of the Project on vegetation communities and species are not anticipated.

[17] Occurrence type (individual, regular, cluster) corresponds with the descriptions in the vegetation assessment.
[18] These species were not identified as a species of concern prior to completion of the vegetation assessment. One occurrence of White Pine, and approximately 10 red maple trees, were observed during completion of the survey in areas where widening is not planned.

Uncertainties
Hydro acknowledges that there may be additional occurrences of species of concern in the Project area that were not identified during the vegetation assessment and that new occurrences of species of concern may become established in the future.

Conclusion
The Project is not expected to have a significant adverse effect on vegetation communities and species and the achievement of the desired outcome to *conserve healthy vegetation communities that maintain a native and biodiverse species composition* is likely.

9.1.2 Visitor Experience – Viewscapes (High)

Introduction
The existing transmission ROWs are generally visible from various roadways, hiking trails, and other viewpoints in the Park. The transmission ROW corridors are linear features with similar prominence as the primary roadways that traverse the Park. Visitor experience is important to Parks Canada and minimizing the distraction and impact of operational infrastructure has long been a concern.

The removal and/or modification of vegetation associated with the Project could increase the visibility of transmission infrastructure and impact the prominence of the ROW corridors in the landscape. The visibility of some transmission lines, or portions thereof, may be limited where natural vegetation buffers exist between the ROW and the viewer. In some cases these buffers are narrow and modification to vegetation in these areas could have an adverse affect.

In the past, Hydro has collaborated with Parks Canada when planning routine vegetation management activities near sensitive locations (e.g. Mattie Mitchell Trail). Consistent with past practice, Hydro will collaborate with Parks Canada to develop site-specific cutting prescriptions for the identified visually sensitive areas as noted below (Table 4). These assessments will be conducted annually in advance of cutting operations once the annual plan is finalized.

Desired Outcome
The goal is to minimize the creation of new, and expansion of existing, undesirable visual impacts while supporting the safety and reliability of power delivery infrastructure.

Analysis of Potential Effects
Vegetation removal, trimming, or topping are common activities associated with transmission ROW maintenance. While some ROW sections are remote and not readily visible to visitors, many are visible depending on viewing distance, line-of-sight, elevation, and proximity of the viewer/viewpoint. In the absence of a formal visual resource inventory for the Park, Hydro

worked closely with Parks Canada to complete a Visual Impact Assessment[19] ("VIA") to identify visually sensitive areas to facilitate mitigation planning. The VIA was completed by a Parks Canada Geomatics Coordinator in August, 2023.

The VIA identified the following visually sensitive areas:

- Southeast Brook Valley;
- Lomond campground/wharf viewpoint;
- Southeast Brook Falls Trail;
- Mattie Mitchell Trail;
- Gros Morne Approach Trail;
- Berry Hill Look-off;
- Berry Head Pond Trail;
- Highway corridor/buffers (new line-of-sight risk); and
- Lookout Trail (Woody Point).

The figure below identifies the sensitive areas, targeted viewsheds, and observer points from the VIA. The VIA identifies portions of the ROWs that are of concern and recommends further collaborative review of activities in these areas to develop site specific prescriptions to minimize Project impacts.

The completed analysis has served to identify the Project locations where careful planning and site specific mitigation is necessary to minimize potential adverse effects. While worker safety and the need to mitigate the risk to service reliability requires vegetation management in these sensitive areas, Hydro acknowledges its responsibility to minimize undesirable impacts.

[19] The VIA is available upon request.

Figure 8. Visually Sensitive areas, Viewsheds, and Observer Points (stars)

Mitigations

During Project planning, Hydro considered opportunities to minimize the scope of the Project and its potential impacts, including to viewscapes. Extensive analysis of the Project area allowed Hydro to identify high risk areas of concern and limit the widening Project scope to approximately 33 hectares. Hydro's proposed two-zone approach to vegetation management will significantly reduce the visual impacts of the widening Project in both the near and long-term by allowing the establishment and retention of shrubs and small trees in these areas.

Hydro commits to collaborating with Parks Canada to develop site-specific prescriptions for identified areas of concern prior to commencement of cutting activities. General mitigation measures to address the risk of negative impacts to viewscapes are summarized for each area below. Where reference is made to "detailed prescription required", this could be specific to individual trees and very localized groups of trees.

Table 4. Mitigation Measures for Identified Visually Sensitive Areas[20]

Sensitive Location	Line Location Reference	Mitigation Measures
All - General	n/a	• review during annual, and ongoing, project planning and collaboration with Parks Canada personnel • finalize site-specific prescriptions/plans for areas of concern with Parks Canada personnel as required • crew education/awareness and plan review • remove vegetation consistent with 2-zone approach (i.e. retain shrubs and understory vegetation where safe to do so) • minimize impact to the effectiveness of visual buffers, particularly along the highway, trails and other points of interest • work with Parks Canada to explore tree planting as an option to enhance important visual buffers for the long term
Southeast Brook Valley	TL226 - Str. 431-432; 481-501	• minimize vegetation removal where possible • minimize impact to visual buffer between highway and ROW
Lomond campground/wharf	TL226 – Str. 513-551; TL239 – Str. 333-376	• minimize vegetation removal where possible

[20] Additional visually sensitive locations may be identified over the course of the Project. Such locations will be addressed in collaboration with Parks Canada staff.

Sensitive Location	Line Location Reference	Mitigation Measures
Southeast Brook Falls Trail	TL226 – Str. 412-413; TL239 – Str. 233-295; 264-273	• minimize vegetation removal where possible
Mattie Mitchell Trail	TL226 – Str. 657-667; TL239 – Str. 478-489	• impact to existing visual buffer to be minimized • detailed prescription required
Gros Morne Approach Trail	TL226 – Str.672-501; 677-681 TL239 – Str. 494-514;499-501	• minimize cutting near visible structures • impact to visual buffers to be minimized • detailed prescription required
Berry Hill Look-off	TL227 – Str. 1-39 TL259 – Str. 1-22	• distant view; adhere to plan and two-zone approach
Berry Head Pond Trail	TL227 – Str. 43-50 TL259 – Str. 26-32	• impact to existing buffers to be minimized • detailed prescription required
Berry Hill Road/Campground[21]	TL227 – Str. 2-3 TL259 – Str. 2-3	• impact to existing buffers to be minimized • detailed prescription required
Highway corridor/buffers (new line-of-sight risk)	Multiple, where buffer is narrow, including: TL227 – Str. 208-215 TL259 – Str. 137-139	• minimize impact to existing vegetated buffers • trimming and topping preferred • consider more frequent minor intervention versus less frequent but more significant tree modification • detailed prescription required
Lookout Trail (Woody Point)	Various – distant view	• distant view from outside Park; adhere to plan and two-zone approach

[21] Not initially identified as a sensitive location but subsequently added in response to draft DIA review comments from Parks Canada.

Residual Effects

With the completion of a VIA, application of the noted mitigation measures, development of site-specific plans and detailed prescriptions, and implementation of a two-zone approach to vegetation management, the effects of the Project on viewscapes are expected to be localized and temporary. Temporary impacts will vary depending on the current abundance of danger trees and encroachment issues in each area and the nature of existing understory vegetation. With the two-zone approach, the retention and establishment of shrubs and small trees will reduce the Project impact on viewscapes over time.

Uncertainties

Hydro acknowledges that the rate of re-establishment and growth of shrubs and trees in the border zone (widened areas) may vary and be influenced by factors such as moose browsing.

Conclusion

The desired outcome for this Project is that expansion of existing undesirable visual impacts is minimized while supporting safe and reliable service. Hydro has planned the Project to minimize the widening scope and introduce a two-zone approach to future vegetation management to balance these objectives. The desired outcome is therefore likely to be achieved.

9.1.3 World Heritage Site – OUV: Exceptional Natural Beauty (Medium)

Introduction

Gros Morne National Park's inscription on the UNESCO[22] World Heritage List in 1987 recognizes its exceptional natural beauty (Criterion vii) and outstanding examples of major stages in the earth's geological evolution (Criterion viii). Sites that are included on the World Heritage List are considered to be cultural and natural heritage places that are of outstanding interest on a global scale and therefore need to be conserved as part of the heritage of humanity as a whole.

The OUV - criterion vii for the Park describes *an area of exceptional natural beauty having an outstanding wilderness environment of spectacular landlocked, freshwater fjords and glacier-scoured headlands in an ocean setting.*

The Project requires the removal of tall trees within forested communities. Vegetation removal may change viewscapes and affect the exceptional natural beauty of the Park.

Desired Outcome

The goal is to maintain the OUV of the Park in relation to its scenic beauty (Criterion vii) and that the Park *continues to be a wilderness environment including landlocked, freshwater fjords*

[22] United Nations Educational, Scientific and Cultural Organization.

and glacier-scoured headlands in an ocean setting and evidence of human intervention does not distract from the natural beauty.

Analysis of Potential Effects
The Project will not interfere with the continuation of the Park as a wilderness environment with landlocked, freshwater fjords and glacier-scoured headlands.

The major transmission line ROW corridors were established in the Park prior to its inscription on the World Heritage list and, while ROW widening will increase the evidence of human intervention, it is not expected to materially increase the level of distraction from the Park's natural beauty. The Park's management plan includes specific area management approaches, where multiple interests and stakeholders exist, and acknowledges that not all Park uses conform to its zoning plan, including utility corridors that are critical to serving customers in the Park area and the Northern Peninsula.

During execution of the Project there will be an increase in human activity in the Park; however, activities will be scheduled outside peak tourism season (i.e. in the fall and early winter) to minimize the interface with Park visitors and potential for distraction.

Mitigations
During Project planning, Hydro considered opportunities to minimize the scope of the Project and its potential impacts to a range of valued components. The mitigations described in previous sections will serve to mitigate Project impacts on the Park's scenic natural beauty. The key mitigations include the selective nature of the work, the implementation of a two-zone vegetation management approach, and the development of site-specific prescriptions in areas of visual concern. Hydro is committed to working collaboratively with Parks Canada and continually improving its practices and approach to work in the Park.

Residual Effects
With adherence to the Project plan and the implementation of the mitigation measures described in this DIA, significant residual adverse effects to OUV - Criterion vii are not expected.

Uncertainties
There are no uncertainties associated with potential Project impacts to OUV - Criterion vii.

Conclusion
The desired outcome for this VC is likely to be achieved.

9.2 Low Risk Valued Components

9.2.1 Visitor Experience and Safety – Interruption of Access

Introduction

The Park attracts large numbers of local, national, and international visitors each year. While some transmission ROWs, or portions thereof, are remote and well removed from common use areas, others are located in close proximity to roads, hiking trails, and other points of interest. The annual moose hunt will also attract hunters to the Project area in the fall when widening activities are ongoing. Utility corridors are popular locations for hunting due to improved accessibility and sightlines.

It is Hydro's objective to ensure the safety of the public at all times and to plan work to minimize potential disruption to visitor activities.

Analysis of Potential Effects

There are two potential Project impacts to this VC:

1. interrupted visitor/hunter access due to temporary access restrictions to trails, side roads, viewing areas, ROW corridors, etc., that may be necessary to ensure public safety, and
2. interrupted visitor/hunter access due the presence of Project vehicles and equipment in the Park that may temporarily reduce available visitor parking and/or require vehicular traffic to reduce speed where Project vehicles and equipment are parked on the shoulder of a roadway.

Temporary restrictions to the use of trails, side roads, viewing areas etc., are expected to be of short duration (i.e. 1 to 4 hours) as needed to ensure a safe work area for Project personnel and to ensure the safety of the public. Once work is complete in the immediate vicinity of the publicly accessible location, and Hydro deems the area to be safe for public use, the restriction will be removed. The duration of hunting access restrictions to specific ROW corridors, or sections of ROW corridors, will vary with the amount of work required but may last for multiple days. As this is a multi-year project, the extent and impact of hunting restrictions in a given year will be limited. Hydro will ensure that such restrictions are well planned and known in advance to stakeholders.

The potential impact of Project vehicles on parking area capacity and traffic flow may persist in a particular location for multiple days until work is completed in an area. The presence of Project vehicles and equipment will not preclude public access from the area. Completing work after peak tourist season (i.e. in the fall and early winter) will help minimize this issue.

Mitigations
To mitigate potential impacts to visitor access during Project execution, Hydro will:

- work with Parks Canada to develop a protocol for informing visitors and residents of Project activities and how visitation and traffic flow may be impacted;
- deploy temporary signage, pylons, or barricades as required;
- utilize spotters and/or traffic control personnel if necessary;
- plan the work to minimize the number of vehicles required in areas with limited parking;
- plan access disruptions with consideration of low visitation times (e.g. fall/winter period, weekdays, early morning hours, poor weather days);
- provide Project information to moose license holders in the information package provided to license holders by Parks Canada; and
- implement additional measures during moose hunting season as needed to maintain the safety of Project personnel and hunters (i.e. implement temporary restrictions, install signage, ongoing communication on Hydro social media, etc.).

Residual Effects and Conclusion
With work planned outside peak tourist season, and the implementation of the noted mitigation measures, adverse impacts to visitor/tourist access are expected to be of short duration and minor in nature. No significant residual adverse effects are expected.

Advanced communication with potentially impacted hunters will allow hunters to plan their activities to minimize potential conflict with Project activities. Ongoing communication of the location of Project activities and implementation of temporary access restrictions during Project execution will ensure adverse effects are minimized and the safety of hunters and Hydro personnel is maintained.

9.2.2 Natural Resources (habitat, wildlife, soils)

Introduction
Park Canada has identified a number of low risk natural resource VCs that the Project may interact with. These VCs include habitat (connectivity, aquatic/water quality), wildlife (migratory birds, Red Crossbill, American Marten, Woodland Caribou, Bats - Little Brown Myotis and Northern Myotis, moose), and soils. While Hydro has taken measures to minimize the scope of the Project and its overall impact on all VCs, the Project will take place generally in a forested environment across a large area over multiple years and includes the use of power equipment and travel by ATVs. Potential Project interactions with these VCs are discussed below.

It is Hydro's objective to minimize the potential adverse impacts to natural resource VCs through the use of standard mitigation measures and application of its EPP.

Analysis of Potential Effects

Due to the limited, selective nature of vegetation removal, and implementation of a two-zone approach to vegetation management, a significant adverse effect on habitat connectivity is not expected.

The use of gas-powered equipment and ATVs for crew travel has the potential to impact aquatic habitats and water quality at stream crossings and in riparian areas. These activities are subject to extensive standard mitigations to minimize potential for adverse impacts, including a restriction on servicing or refueling equipment within 30 meters of a waterbody. Proper management (i.e. handling, storage) of fuels, adherence to refueling procedures, and implementation of an Environmental Emergency Response Plan will be strictly enforced by Hydro.

Similarly, there are many standard mitigations that apply to reduce the risk of adverse impacts to wildlife populations. The timing of Project activities in the fall and early winter significantly reduces the risk of adverse impacts to all wildlife, but especially to migratory birds , bats, and the American Marten, by avoiding more sensitive time periods and life stages. Widened areas could potentially increase the availability of preferred browse species for ungulates in the Project area.

The use of ATVs for crew travel has the potential to impact soils in the Project area by causing rutting and compaction. Limiting ATV travel to designated access trails and previously disturbed/established access routes will minimize the potential for additional adverse Project impacts.

Mitigations

In addition to the measures outlined in this DIA and implementation of Hydro's EPP, any additional, or more stringent, environmental management and mitigation measures outlined in Parks Canada's Preapproved Routine Impact Assessment ("PRIA") for Overhead Power lines will apply. The PRIA document includes an extensive list of more than 70 mitigation measures grouped in the following categories:

- Pre-project planning;
- Work Site Conditions/Staging/Laydown;
- Equipment Operations;
- Site Clean-up and Waste Management;
- Spill Response Plans and Hazardous Materials Management;

- Soil/Land Resources;
- Water Quality and Fish Habitat;
- Wildlife and Vegetation;
- Visitor Experience and Safety; and
- Cultural Resources.

Appendix B includes further detail on these standard PRIA mitigation measures.

Residual Effects and Conclusion
With work planned in the fall and winter period, and the implementation of the noted mitigation measures, adverse impacts to low-risk natural resource VCs are expected to be of short duration and minor in nature. No significant residual adverse effects are expected.

10.0 FOLLOW UP AND MONITORING

Hydro personnel will direct and monitor Project activities full-time. Hydro will continue to work collaboratively with Parks Canada throughout the Project execution phase and incorporate lessons learned and opportunities for improvement. Joint annual Project reviews are recommended in addition to routine collaboration throughout the life of the Project.

Hydro recognizes the importance of existing, narrow visual buffers between roadways and the transmission ROWs. Hydro is interested in exploring the opportunity with Parks Canada to support the planting of trees in critical locations along, or within, these existing buffers to enhance their effectiveness in the long term.

11.0 AUTHORIZATIONS AND PERMITTING

The Project requires the following authorizations and permits:

- Research and Collections Permit (2023 Vegetation Assessment - Parks Canada);
- Detailed Impact Assessment approval (Parks Canada);
- Permit to take flora or natural objects from Gros Morne National Park (Parks Canada);
- Over Snow Vehicle Permit (Parks Canada);
- All Terrain Vehicle Permit (Parks Canada); and
- Letter of Advice – Watercourse Crossings and Minor Works Near Water (Fisheries and Oceans Canada).

Hydro will review Project permitting requirements on an annual basis to ensure any changes to requirements are identified and permits amended or acquired accordingly.

Coincidental to the proposed Project timeline, the easement agreements for the existing transmission lines expire in 2027. Hydro will work with Parks Canada to incorporate ROW widening and the two-zone vegetation management approach in the new, or amended, easement agreements as required.

12.0 REFERENCES

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Parks Canada. 2023. Detailed Impact Assessment for the Highway 431 and Tablelands Trail Access Road and Parking Lot Renovations in Gros Morne National Park.

APPENDIX A

Compilation of Public Comments[23]

[23] No public comments were received during the review period. Included are the notes from meetings with municipal councils of enclave communities.

Parks Canada/NL Hydro meeting with
Town of Woody Point,
Glenburnie-Birchy Head-Shoal Brook (GBS) & Trout River
Woody Point Community Center
February 20, 2024
2:00-3:30 p.m

RE: Transmission Line Widening -Detailed Impact Assessment Process

In Attendance:

Town of Woody Point:	**Town of Glenburnie-Shoal Brook-Birchy Head**	**Town of Trout River**
Sherry Avery, Town manager	Myrna Goosney, Town manager	Nelson Barnes, ROLE
Terry Young, Deputy mayor	William Anderson, councillor	Sharrel MacLean via tel.

Parks Canada Representatives:
Holly Lightfoot, Park Ecologist
Sarah Kennedy-Dyson, Impact Assessment Officer
Cynthia Nicolle, Partnering and Engagement Officer

NL Hydro representatives:
Craig Parsons, Vegetation Control Advisor
Jim Peyton, Senior Manager, TRO Services
Ken Sparkes via tel., Environmental Specialist

1.0 Introductions

2.0 Welcome and brief overview by Sarah

3.0 'Gros Morne Management Strategy' by NL Hydro, Craig Parsons

- Hydro's mandate
- Commitment to safe reliable operations on the Great Northern Peninsula (GNP)
- Five transmission lines in Gros Morne National Park
- All power for the GNP is transmitted on the two lines which run through the park
- The transmission lines right of way in the park are the narrowest from 9.1 m to 15 m whereas outside of the park, they run to 30 m.
- Multi power outages due to trees falling across hydro lines
- Two phase approach to widen the corridor over five-year period

- Viewscape analysis has been completed; bird nesting taken into consideration therefore project will start in September; and plant species of concern have been identified
- There will be wood supply for residents under the Timber Harvest program

4.0 'NL Hydro Detail Impact Assessment, Transmission Line Widening' by Sarah Dyson-Kennedy

- Parks Canada mandate
- UNESCO significance
- Why a Detailed Impact Assessment (DIA)
- Impact Assessment Pathway
- What triggers a DIA?
- Next steps
- We want to hear from you! Provided an e-mail address, telephone number and Canadian Impact Assessment Registry information.

5.0 Any Questions?

- Timelines of when the DIA would be ready; NL Hydro should have a draft ready by April then it'll be reviewed by Parks Canada and returned to NL Hydro for final copy by July. The work will begin after Labour day weekend in September 2024
- September start date for two reasons: bird nesting season is over and lower number of visitors at this time.
- Timber available for residents through the Timber Harvest Program-question on who's liable if resident is hurt gathering timber on PC land. Follow up required to send to the Southside Joint Council - We are still looking at this and are unsure if we need to

Parks Canada/NL Hydro meeting with
Town of St.Paul's, Town of Cow Head
St.Paul's Community Center
February 22, 2024
7:00-8:30 p.m

RE: Transmission Line Widening -Detailed Impact Assessment Process

In Attendance:

Town of St. Paul's:	**Town of Cow Head**
Brandon Bennett, councillor	Deanna Hutchings, Mayor
Note: two council members stranded in Labrador due to ferry crossing cancelled.	Charlotte Crydermen, councillor

Parks Canada Representatives:
Holly Lightfoot, Park Ecologist
Sarah Kennedy-Dyson, Impact Assessment Officer
Cynthia Nicolle, Partnering and Engagement Officer

NL Hydro representatives:
Craig Parsons, Vegetation Control Advisor

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- Multi power outages due to trees falling across hydro lines
- Two phase approach to widen the corridor over five-year period
- Viewscape analysis has been completed; bird nesting taken into consideration therefore project will start in September; and plant species of concern have been identified

- There will be wood supply for residents under the Timber Harvest program

Any Questions?
Q 1) Are you doing this project to increase power supply to households because of the future power demand for electric vehicles?
A1) This project is to prevent power outages and for safety.

Q2) Is there a concern GMNP will have a forest fire?
A2) No this is not a major concern as GMNP is not a fire driven ecosystem.

Q3) Why not cut all the trees now rather than wait until later?
A3) The trees in the park are not as high as in other places therefore the requirement of 5 m on each side of the transmission line is adequate.

Q4) What are the cones used for?
A4) Parks Canada has a Forest Restoration Project. As a part of this program, we grow seedlings from the cones which are used to restore moose meadows. It's better to reforest with native trees. We have a Youth Ambassador program with the schools and as a part of that program, the students plant seedlings.

Q5) Will there be job opportunities for locals as a part of the tree restoration program? It would be nice to hire locals to do this work.
A5) We will check with the project manager and get back to you.

Most tree planting is done by a contractor, so staffing is at their discretion. That said, in 2023 we provided them with the names of some local people who had experience with tree planting and they did hire one of them, while the others declined the opportunity due to other commitments. Parks Canada has also staffed a number of positions for the project that were open to local applicants and some of those positions have been filled by people living in the area, while others have moved to the area to take up these jobs. We will continue to seek opportunities to create opportunities for local residents through this project, for example in our staffing of summer student positions.

Q6) We discussed the sunset clause for Timber Harvest with you. Where is that?
A6) We did discuss this at the Mayor's Forum and there will be a Timber Harvest presentation at our next meeting in the Spring. This is a detailed conversation and should continue at a later date.

Q7) When will this project happen?
A7) in September, after labour day

Q8) Where are we with our UNESCO designation?

A8) The World Heritage Committee understand that fracking is not a huge concern in GMNP and has taken us off their biennial reporting list. We're still responsible for completing periodic reporting to UNESCO (approximately once every eight years)
Q9) How do you deal with the plants that are on the list of 'species of concern'?
A9) Hydro will build a strategy to save as many rare plants as possible.

Q10) Can the trees such as Black Ash and Yellow Birch be re-located?
A10) These trees are difficult to relocate because of their size.

4.0 'NL Hydro Detail Impact Assessment, Transmission Line Widening' by Sarah Dyson-Kennedy

- Parks Canada mandate
- UNESCO significance
- Why a Detailed Impact Assessment (DIA)
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- What triggers a DIA?
- Next steps
- We want to hear from you! Provided an e-mail address, telephone number and Canadian Impact Assessment Registry information.

Any questions?
Q1) Why come out to communities now if you have already decided to do this project?
A1) The project planning involved land managers from Parks Canada and experts from NL Hydro to find the best solution and that's what we are presenting to you. Consulting with the public is a part of the DIA process as Sarah explained. We ask for input from the communities because you know the local terrain and where there may be an issue. The priority here is two-fold-we need reliable power but we also need to protect our national park.

Q2) There will be timber available from this project but how come we lose from our regular allotment when we get an opportunity like this to receive additional firewood? It's not fair!
A2) This is being discussed and looked at. Follow up required.
This question has been discussed in the Resource Conservation team and it was determined that moving forward if wood is coming from a construction project or other park management action (e.g., clearing blowdowns, hydroline work) then it would not count towards a harvester's total. That is a harvester would still be able to cut 10 cord in the park and obtain additional wood from these types of projects.

Q3) Where will the project start?

A3) The plan is to start at the Wiltondale boundary and work north, with another crew working in the north. The priorities are to secure the higher voltage lines which carry the bulk of the load.

Comments:

1) Timelines of when the DIA would be ready; NL Hydro should have a draft ready by April then it'll be reviewed by Parks Canada and returned to NL Hydro for final copy by July. The work will begin after Labour day weekend in September 2024
2) It's important for us not to lose our electricity for many reasons; more and more people have moved away from burning wood and have installed heat pumps.

Parks Canada/NL Hydro meeting with
Town of Norris Point, Town of Rocky Harbour
Norris Point Community Center
February 21, 2024
7:00-8:00 p.m

RE: Transmission Line Widening -Detailed Impact Assessment Process

In Attendance:

Town of Norris Point:
Sheralyn Rumbolt, Deputy Mayor
Jeffrey Reid, councillor

Town of Rocky Harbour
Leah Laplante, Town manager
Mandy Payne, Town clerk

Parks Canada Representatives:
Geoffrey Hancock, FU Superintendent
Holly Lightfoot, Park Ecologist
Sarah Kennedy-Dyson, Impact Assessment Officer
Cynthia Nicolle, Partnering and Engagement Officer

NL Hydro representatives:
Craig Parsons, Vegetation Control Advisor

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- The transmission lines right of way in the park are the narrowest from 9.1 m to 15 m whereas outside of the park, they run to 30 m.
- Multi power outages due to trees falling across hydro lines.
- Two phase approach to widen the corridor over five-year period
- Viewscape analysis has been completed; bird nesting taken into consideration therefore project will start in September; and plant species of concern have been identified
- There will be wood supply for residents under the Timber Harvest program

4.0 ‘NL Hydro Detail Impact Assessment, Transmission Line Widening’ by Sarah Dyson-Kennedy

- Parks Canada mandate
- UNESCO significance
- Why a Detailed Impact Assessment (DIA)
- Impact Assessment Pathway
- What triggers a DIA?
- Next steps
- We want to hear from you! Provided an e-mail address, telephone number and Canadian Impact Assessment Registry information.

5.0 Any Questions?

- Comments: Timelines of when the DIA would be ready; NL Hydro should have a draft ready by April then it’ll be reviewed by Parks Canada and returned to NL Hydro for final copy by July. The work will begin after Labour day weekend in September 2024
- Question: Will there be any PC reports available to share with the public?
  Answer: May be able to share the Visual Analysis plus there will be a lot of information in the DIA. Follow up: check with Geoff and Trevor to see if the V.A is a document we can share with the public.

APPENDIX B

Compilation of Mitigation Measures

<u>Project Planning Phase</u>

Project planning and development has been ongoing for more than a decade. The 2016 LiDAR study led to the development of a detailed widening plan and, with the addition of a two-zone approach to vegetation management and ongoing collaboration with Parks Canada, a multi-year Project was defined in 2022. In 2023, work to support a DIA commenced and additional studies were undertaken to support the Project. Additional studies to assess potential Project impacts included: (1) a vegetation assessment to identify species at risk or species of concern in areas planned for widening, and (2) a visual impact assessment to identify areas where Project activities may impact viewscapes.

During Project planning, Hydro considered opportunities to minimize the scope of the Project and its potential impacts to Valued Components. Extensive analysis of the Project area allowed Hydro to identify high risk areas of concern and limit the widening Project scope to approximately 33 hectares. Within the widening areas, Hydro's proposed two-zone approach to vegetation management will significantly reduce Project impacts in the near and long term.

Hydro values its working relationship with Parks Canada and commits to continued collaboration in an effort to continually improve its practices in the Park.

<u>Project Execution Phase</u>

Hydro's Environmental Protection Plan for Federal Lands and Other Sensitive Areas on the Northern Peninsula ("EPP") will apply to the Project. This EPP provides recent standards, regulations, legislation, policies, codes of practice, protection measures, and commitments for activities relating to Hydro's transmission and distribution lines within the Park.

Below is a summary of specific mitigation measures for the VCs identified for the Project as described in the DIA. The Preapproved Routine Impact Assessment ("PRIA") for Overhead Power Lines is also included in this appendix for reference.

1. Valued Component: Vegetation – Communities and Species

Species	Mitigation Measures
All - General	• crew education/awareness • plant ID field card for crew • Pre-identification and flagging of area and/or management zone as applicable • Fall away/yard away; winching/directional felling as needed • Where it is not safe or feasible to retain a tree(s) as prescribed, contact your supervisor. Hydro's representative will confirm required action.
Black Ash	• Establish 10 meter radius management zone prior to commencement of work • Prevent damage to individuals • Remove introduced debris from management zone • No wood piling inside management zone • Other trees may be removed from management zone
Vreeland's Striped Coralroot	• assume the 18 potential occurrences are Vreeland's Striped Coralroot, unless verified otherwise during flowering period • Establish 10 meter radius management zone prior to commencement of work • All vegetation must be retained in the management zone • Trees in the management zone may be topped and/or trimmed • Where trees are being topped/trimmed in the management zone, and debris may impact the plants, temporarily protect plants with a physical barrier (e.g. inverted plastic totes, 5-gallon buckets) • Remove introduced debris from management zone • No wood piling inside management zone • Trees with branches extending into the management zone can be removed as required

Species	Mitigation Measures
Yellow Birch[24]	• Individual occurrence – retain tree; trim and/or top as needed • "Regular" (2-10 trees) – remove up to 50% of trees; trim and/or top remaining trees as needed • "Cluster" (>10 trees) – remove up to 80% of trees; trim and/or top remaining trees as needed
Red Maple and White Pine[25]	• Retain tree(s); trim and/or top as needed

Invasive Species

- construction equipment originating from outside the area must be effectively washed (i.e. high pressure water) outside the area prior to mobilizing;
- confirm known infested areas with Parks Canada and complete work in low risk areas (e.g. power lines further from roadways and human activities) before moving to higher risk areas (e.g. areas adjacent to community enclaves, campgrounds, highway pull-offs) where possible;
- minimize ground disturbance, vegetation removal, and bare soil exposure;
- stabilize and re-vegetate disturbed areas as soon as possible;
- ensure Project personnel are aware of invasive species of concern; and
- notify Parks Canada if an invasive species is identified (i.e. giant hogweed).

[24] Occurrence type (individual, regular, cluster) corresponds with the descriptions in the vegetation assessment.
[25] These species were not identified as a species of concern prior to completion of the vegetation assessment. One occurrence of White Pine, and approximately 10 red maple trees, were observed during completion of the survey in areas where widening is not planned.

2. Valued Component: Visitor Experience – Viewscapes

Sensitive Location	Line Location Reference	Mitigation Measures
All - General	n/a	• review during annual, and ongoing, project planning and collaboration with Parks Canada personnel • finalize site-specific prescriptions/plans for areas of concern with Parks Canada personnel as required • crew education/awareness and plan review • remove vegetation consistent with 2-zone approach (i.e. retain shrubs and understory vegetation where safe to do so) • minimize impact to the effectiveness of visual buffers, particularly along the highway, trails and other points of interest • work with Parks Canada to explore tree planting as an option to enhance important visual buffers for the long term
Southeast Brook Valley	TL226 - Str. 431-432; 481-501	• minimize vegetation removal where possible • minimize impact to visual buffer between highway and ROW
Lomond campground/wharf	TL226 – Str. 513-551; TL239 – Str. 333-376	• minimize vegetation removal where possible
Southeast Brook Falls Trail	TL226 – Str. 412-413; TL239 – Str. 233-295; 264-273	• minimize vegetation removal where possible
Mattie Mitchell Trail	TL226 – Str. 657-667; TL239 – Str. 478-489	• impact to existing visual buffer to be minimized • detailed prescription required

Sensitive Location	Line Location Reference	Mitigation Measures
Gros Morne Approach Trail	TL226 – Str.672-501; 677-681 TL239 – Str. 494-514;499-501	• minimize cutting near visible structures • impact to visual buffers to be minimized • detailed prescription required
Berry Hill Look-off	TL227 – Str. 1-39 TL259 – Str. 1-22	• distant view; adhere to plan and two-zone approach
Berry Head Pond Trail	TL227 – Str. 43-50 TL259 – Str. 26-32	• impact to existing buffers to be minimized • detailed prescription required
Berry Hill Road/Campground[26]	TL227 – Str. 2-3 TL259 – Str. 2-3	• impact to existing buffers to be minimized • detailed prescription required
Highway corridor/buffers (new line-of-sight risk)	Multiple, where buffer is narrow, including: TL227 – Str. 208-215 TL259 – Str. 137-139	• minimize impact to existing vegetated buffers • trimming and topping preferred • consider more frequent minor intervention versus less frequent but more significant tree modification • detailed prescription required
Lookout Trail (Woody Point)	Various – distant view	• distant view from outside Park; adhere to plan and two-zone approach

3. Valued Component: World Heritage Site – OUV: Exceptional Natural Beauty

During Project planning, Hydro considered opportunities to minimize the scope of the Project and its potential impacts to a range of valued components. The mitigations described in previous sections will serve to mitigate Project impacts on the Park's scenic natural beauty. The key mitigations include the selective nature of the work, the implementation of a two-zone vegetation management approach, and the development of site-specific prescriptions in areas of visual concern. Hydro is committed to working collaboratively with Parks Canada and continually improving its practices and approach to work in the Park.

[26] Not initially identified as a sensitive location but subsequently added in response to draft DIA review comments from Parks Canada.

4. Valued Component: Visitor Experience and Safety – Interruption of Access

To mitigate potential impacts to visitor access during Project execution, Hydro will:

- work with Parks Canada to develop a protocol for informing visitors and residents of Project activities and how visitation and traffic flow may be impacted;
- deploy temporary signage, pylons, or barricades as required;
- utilize spotters and/or traffic control personnel if necessary;
- plan the work to minimize the number of vehicles required in areas with limited parking;
- plan access disruptions with consideration of low visitation times (e.g. fall/winter period, weekdays, early morning hours, poor weather days);
- provide Project information to moose license holders in the information package provided to license holders by Parks Canada; and
- implement additional measures during moose hunting season as needed to maintain the safety of Project personnel and hunters (i.e. implement temporary restrictions, install signage, ongoing communication on Hydro social media, etc.).

5. Valued Component: Natural Resources (habitat, wildlife, soils)

In addition to the measures outlined in this DIA and implementation of Hydro's EPP, any additional, or more stringent, environmental management and mitigation measures outlined in Parks Canada's Preapproved Routine Impact Assessment ("PRIA") for Overhead Power lines will apply. The existing PRIA document is included below for reference.

Post-Project ROW Maintenance Phase

Hydro is committed to the two-zone vegetation management approach for transmission lines in the Park. Future vegetation management activities involve similar methods and potential VC interactions and will therefore be subject to the mitigation measures contained herein. It is anticipated that future ROW maintenance activities, in wire zones or new border zones, will be subject to annual review and approval through the PRIA process.

Gros Morne
National Park

Preapproved Routine Impact Assessment Overhead Power Lines

Western Newfoundland and Labrador Field Unit
IAA 2019

Preapproved Routine Impact Assessments (PRIA) are pre-determined environmental management and mitigation measures for a defined class of routine, repetitive projects or activities with well understood and predictable effects. Approved PRIAs are an acceptable Impact Assessment pathway as they fulfill Parks Canada's obligations under the *Impact Assessment Act* (IAA) as a manager of federal lands.

This PRIA applies to the operation, maintenance, or repair of overhead electrical transmission or distribution lines or related infrastructure within existing rights-of-way (RoW) in Gros Morne National Park, Port au Choix National Historic Site, L'Anse aux Meadows National Historic Site, and Red Bay National Historic Site. Maintenance includes vegetation management necessary to maintain the safety and integrity of the electrical transmission or distribution line.

Removal or use of natural objects (e.g., vegetation removal or use of brush for erosion control) and the use of all-terrain vehicles and over snow vehicles for construction purposes are prohibited activities under the *Canada National Parks Act* National Parks General Regulations Section 11(1), 41 (1), and 41 (2), and therefore require permits authorized by the Field Unit Superintendent (FUS). The mitigation measures outlined in this PRIA shall form part of the conditions of the permit.

This PRIA does *not* apply to decommissioning existing power lines, expansion, relocation, or construction of new power lines, ROWs, or related infrastructure**.**

Right of Way (RoW) is an area where power lines and/or related structures already exist, out to the existing cleared limit. The RoW also includes previously approved access routes from highways, campgrounds or parking lots.

Related infrastructure includes guy wires; gabions or wooden cribbing anchoring poles; access routes, including existing crossing structures and signage; power sub stations, distribution sheds, and telecommunication lines attached to existing electrical transmission or distribution line infrastructure.

Expansion is an increase in the exterior dimensions or the production capacity of a physical work, or an increase in the extent of the existing cleared right of way.

Water body includes a lake, pond, a river and its tributaries, wetland and the ocean, up to the annual high-water mark, or any fish habitat as defined in subsection 2(1) of the *Fisheries Act*.

High water mark is the usual or average level to which a body of water rises at its highest point and remains for a sufficient time so as to leave a mark on the land. (Fisheries and Oceans Canada, 2015.)

<table>
<tr><td>Scope of Application:</td><td>This PRIA includes the operation, maintenance or repair of overhead electrical transmission or distribution lines or related infrastructure. Specific activities included are as follows:
• Permitted mechanical clearing or removal of danger trees, hazardous vegetation (i.e., trees that are structurally unsound, dead, or diseased and could fall and strike the power line) or woody debris based on the utility provider's safety and maintenance standards within the RoW;
• All clearing activities must pre-approved by designated Parks Canada staff and requires a permit approved by the FUS;
• Travel along the RoW via permitted all-terrain or over-the-snow vehicles for visual ground or climbing inspections and for other line maintenance activities listed here;
• Use of existing access routes from highway pull-offs, parking areas and/ or day-use or campground areas;
• Pole replacement where the new pole is placed in the exact spot of the removed pole, and no excavation of undisturbed soils is required;
• Emergency response to infrastructure damage from an adverse weather event, which includes: access by staff, cutting and/or removing fallen and/or broken trees, and/or replacement of a pole, anchor, cross arm, insulator, or repair of a damaged conductor;
• Replacement of hardware such as eyebolts, insulators, guy grips and guards, bolt tightening.</td></tr>
<tr><td>Conditions and Exceptions:</td><td>Some projects do not meet the PRIA requirements of being routine, repetitive activities with known, easily mitigated environmental effects. These projects could have the potential to cause greater ecological impacts, result in residual effects that could contribute to cumulative effects, or have different legislated assessment requirements, and therefore, will need to be reviewed under a separate assessment process by the Western Newfoundland and Labrador Field Unit to determine the appropriate pathway.

This PRIA does not apply under the following exceptions or conditions:

• Construction of new power lines or associated infrastructure, relocation and decommissioning of power lines or associated infrastructure; and expansion of power lines, including the ROW, and existing infrastructure;
• Projects that alter the purpose or function of, or results in an expansion of a physical work;
• Use of any herbicide or chemical substance for vegetation management;
• Project results in residual adverse effects to sensitive natural or cultural resources (e.g., nests, dens and roosts, fish spawning areas, cultural resources, riparian areas, wildlife corridors, rare ecotypes, or areas of management concern);
• Projects that involve known archaeological resources, unless the work has been pre-approved by a Parks Canada Archaeologist;
• The project permanently alters the characteristics of a water body (e.g., temperature, pH, turbidity, flow, water level, water body bed);</td></tr>
</table>

	• The project results in **residual** adverse effects on migratory birds or their nests;
	  ○ Vegetation clearing between May 15- August 15, the primary nesting season for migratory birds.
	• The project results in **residual** adverse effects on an individual, a residence or the critical habitat of a listed species at risk under the *Species at Risk Act*;
	  ○ Work that takes place in critical habitat for Piping Plover (*Charadrius melodus*), Fernald's Braya (*Braya fernaldii*) or any newly listed species and their critical habitat, where it occurs within the RoW (see Appendix C).
	  ○ Determine if mitigations are needed to ensure no residual adverse effects to species at risk. Such mitigations should be included in the Supplementary Mitigations section.
	
	• The project is likely to require an authorization[1] under the *Fisheries Act* (s.35(1) or 36(3));
	• The project involves the removal of or causes damage to cultural resources of heritage value, for example, heritage buildings designated by the Federal Heritage Buildings Review Office, archaeological sites, historical and archaeological objects, or cultural landscapes;
	• The project adversely impacts sites of significance to Indigenous peoples or current access and use of areas where hunting, fishing or gathering rights are exercised by Indigenous peoples;
	• Projects that may impact Outstanding Universal Values at designated World UNESCO sites.

Other Considerations:	Use of the PRIA may not be appropriate in circumstances such as: • If the power line is in a zone susceptible to natural hazards such as a land slide zone, floodplain, or area vulnerable to storm surge and sea level rise or in natural, previously undeveloped areas.
Approved Geographic Areas of Application:	This PRIA applies to Gros Morne National Park, Port au Choix National Historic Site, L'Anse aux Meadows National Historic Site, and Red Bay National Historic Site.

[1] Check if your projects needs a review: http://www.dfo-mpo.gc.ca/pnw-ppe/reviews-revues/request-review-demande-d-examen-003-eng.html

Valued Components and Effects Analysis

Soil/Land Resources	• Soil contamination from wastes, equipment leaks, or accidental spills (e.g., garbage, fuel); • Soil compaction and rutting; • Soil erosion, loss of topsoil and exposure of subsoil; • Ground instability, due to settling of the area around removal and/ or replacement of transmission poles, and/ or surface water entering the hole and adversely affecting landslide mobility; • Vehicle traffic and other forms of human disturbance can cause long-term damage to the unique fine-scale patterning, sorting and structure of limestone barrens gravels and soils, which develop slowly (decades to centuries) through processes such as frost action.
Air/Noise Quality	• Temporary decreased ambient air quality (e.g., equipment emissions); • Increased ambient noise level.
Water Quality and Fish Habitat	• Reduced water quality due to contamination (i.e. from leaks and accidental spills, sedimentation from stream fording, etc.); • Localized changes to surface water hydrology; • Localized changes in streambed due to one-time only fording of permitted equipment; • Increased light from vegetation removal could lead to changes in water temperature and chemistry in a water body; • Fording streams can disturb fish at critical life stages (i.e., eggs), aquatic invertebrates, and waterfowl (e.g., Harlequin Duck).
Wildlife and Vegetation	• Wildlife sensory disturbance causing displacement/habitat avoidance; • Wildlife habituation/attraction to artificial food sources; • Impeded/altered wildlife movement; • Potential safety hazard for wildlife; • Habitat destruction or alteration; • Injury or mortality from project activities; • Introduction of invasive species, or expansion of existing populations; • Damage to and removal of vegetation, disturbance of adjacent natural areas, root exposure and physiological distress; • Disturbance, damage, or destruction of habitat components considered necessary for species at risk and their critical habitat (e.g., migratory birds, bats, American marten, lichens).
Visitor Experience and Safety	• Reduced quality of visitor experience due to noise and presence of construction equipment; • Reduced accessibility to portions of the site where work is taking place; • Hazard to visitors and staff due to construction activities; • Disruption of services.
Cultural Resources	• Adverse effects to the heritage value or character-defining elements of a cultural resource or a heritage place;

	• Impacts to archaeological resources (known or potential) from displacement or destruction, resulting in loss of heritage value; • Impacts to cultural landscapes, buildings, engineering works, or objects.

Mitigation Measures

Pre-Project Planning:

1) Schedule work to avoid wet, windy and rainy periods or very dry periods that may increase erosion and sedimentation. Work schedule shall preference winter seasonal conditions (i.e., snow and frost), to minimize ground disturbance and freshwater habitats.
2) Work activities will be scheduled to avoid sensitive environmental features and habitats as presented in the Environmental Timing Window (Table 1).
3) Treated wood is prohibited in certain situations and must be handled, installed, and disposed of according to current guidance prepared by Parks Canada (see [Guidelines for the Use, Handling and Disposal of Treated Wood]).

Table 1: Environmental Timing Windows Table

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Fish[2] (Estuaries and Main Stems)	Reduced risk for work in estuaries and main stems.				Avoid in-water work (e.g., stream fording): Estuaries and Main Stem May 1 to September 30					Reduced risk for work in estuaries and main stems		
Fish (Tributaries and Headwaters)	Avoid in-water work (e.g., stream fording): Tributaries and headwaters. October 1 to May 31					Reduced risk window for work in tributaries and headwaters.				Avoid in-water work (e.g., stream fording): Tributaries and headwaters. October 1 to May 31		
Birds[3]	Reduced risk for harm to birds.					Avoid Vegetation clearing during the bird nesting period: May 15 to August 15			Reduced risk for harm to birds			
Bats (SAR: Little Brown Myotis and Northern Myotis)	Bats in Hibernacula.			Avoid work that could disturb bat roosts or maternal colonies (e.g., felling of snags): April 15 to August 31.					Reduced risk for harm to bats.			
American marten, Newfoundland population[4]	Reduced risk for harm to marten.			Avoid disturbing potential den sites during marten natal and maternal denning period: April 1 to June 30.			Reduced risk for harm to marten.					

[2] This timing window includes the breeding period for Harlequin Duck (listed as Special Concern un SARA).
[3] This timing window includes the breeding period for Olive-sided Flycatcher and Red Crossbill, for which SARA protections apply, as well as Rusty Blackbird, Evening Grosbeak, and Short-eared owl (listed as Special Concern under SARA).
[4] Marten den sites are described as rock piles, squirrel middens, fallen logs, openings at bases of trees, cavities in snags and woodpecker holes.

Work Site Conditions/Staging/Laydown:

4) Prior to starting work all personnel working on site will be required to attend an environmental briefing led by Parks Canada's Environmental Protection Officer to review mitigation measures.
5) Key contacts and their respective roles and responsibilities must be identified prior to work starting and communicated to all on-site workers.

6) Clearly mark the work site and restricted areas with stakes, biodegradable flagging tape or other eco-friendly means to minimize the disturbance footprint and safeguard the general public; remove when the project is completed.
7) Staging areas, material/equipment drop sites, and parking areas must be identified and within an existing disturbed footprint (e.g., roadways, gravel surface, previously disturbed areas with high resiliency) or approved by designated Parks Canada staff.
8) Use existing roadways, access trails, disturbed areas or other areas as approved by designated Parks Canada staff for site access, travel within the site and work activities (Figures 1-6 in Appendix A).

Equipment Operations:

9) The use of all-terrain vehicles and/ or over-the-snow vehicles must be pre-approved by designated Parks Canada staff and requires a permit approved by the FUS.
10) Vehicle access to the power line corridor will be limited to the equipment (i.e., all-terrain vehicle, over the snow vehicle, excavator) required to complete the work.
11) Select equipment appropriate to the nature of work being conducted (e.g., avoid using large scale machinery when hand tools or smaller scale machinery could be used).
12) Heavy equipment operating on paved surfaces must be equipped with street pads; damage to paved surfaces must be restored to original conditions.
13) Equipment must be properly tuned, clean and free of contaminants, in good operating order, free of leaks (e.g., fuel, oil or grease), and fitted with standard air emission control devices and spark arrestors prior to arrival on site.
14) Machinery must be stored, maintained and refueled on a flat surface, outside the dripline of trees and 30 meters from the High Water Mark and in such a way as to prevent any deleterious substances from entering the water. Increase the buffer zone depending on the level of risk and site-specific conditions.
15) Refueling must take place on an impermeable fuel mat with a berm or within a container. Leaks and spills during refueling must be cleaned up, reported and contaminated materials must be disposed of appropriately. Fuel must never be dispelled or deposited into the environment or any water body.
16) Any required cleaning of tools and equipment must be done off-site. If it must be on-site, it must be in an appropriate area at least 30m from a waterbody.
17) Gas generators must be secured to prevent movement during the operation and set up on an impermeable fuel mat with a berm or within a container that can contain 110% of the volume of fuel in the generator.

Site Clean-up and Waste Management:

18) All wildlife attractants must be secured (e.g., petroleum products, human food, recyclable drink containers and garbage) in wildlife-proof containers, a secure building or vehicle. When possible, keep food waste separate from construction waste and remove daily.
19) All salvageable, non-combustible and non-hazardous waste materials will be removed, reused and recycled to the greatest extent possible. Any unsalvageable waste and demolition debris is to be disposed of at an approved disposal facility outside the boundaries of Parks Canada and National Historic Sites.

20) Secure all materials (e.g., construction waste and materials, vegetation) above the high water mark of nearby waterbodies and ensure wastes do not enter waterbodies (e.g., use tarps to capture debris). Any waste that does fall into a waterbody will be immediately retrieved, provided worker safety is not compromised, and if removal can be done without excessive disturbance of bottom sediment.
21) Contain wastes and transport to an approved waste landfill site outside the Parks Canada site unless otherwise directed; cover waste loads during transportation.
22) Any hazardous material (e.g. electrical equipment), treated wood poles (e.g., creosote) and pollutants such as fuels and solvents found on-site will be separated and contaminated materials will be disposed of at provincially certified disposal sites.
23) All construction materials must be removed from the site on project completion. Burning or burying is not permitted unless approved by Parks Canada.
24) If present, portable sanitary facilities must be serviced on a regular basis and accumulated waste disposed of at a sanitary waste disposal facility. The portable facilities must have sufficient capacity and be managed to ensure waste is not discharged to the receiving environment. Portable sanitary facilities shall be situated and anchored to prevent being upended.

Spill Response Plans and Hazardous Material Management:

25) Ensure that all on-site workers are aware of the location and use of spill kits and containment devices.
26) Other than fuel containers of up to 25 liters of fuel (i.e., jerry cans), no other fuel shall be stored in the national park or national historic site.
27) Fuel shall be stored within a spill pan or in some form of an impermeable secondary containment capable of capturing 110% of the largest possible spill.
28) All equipment on site shall be accompanied by a spill kit of the appropriate size. A spill contingency response kit including sorbent material and berms to contain 110% of the largest possible spill related to the work must be available on site at each location of potential spills (sites where equipment is working and at refueling, lubrication, and repair locations).
29) All spills of toxic materials (e.g., fuels, chemicals) must be contained and cleaned-up as soon as it is possible to safely do so and must be reported immediately to designated Parks Canada staff or through Parks Canada's Emergency Response (Jasper Dispatch: 1-877-852-3100). Any spill that may harm the environment or pose a risk to public health and/ or safety must be reported within 24 hours to the Fisheries and Oceans Coast Guard (Regional Office: 709-772-2083, or toll free: 1-800-563-9089). In the event of a major spill, all other work must stop until the spill has been adequately contained and cleaned up. It is the operator's responsibility to call the first contact authority.
30) Identify and handle all toxic/ hazardous materials as required under the Canadian Environmental Protection Act, Transportation of Dangerous Goods Act and Workplace Hazardous Materials Information System. The site will be inspected by Parks Canada staff to ensure completion to expected standards.

Soil/ Land Resources:

31) Where work and vehicle access is required on limestone barrens habitat or Fernald's Braya critical habitat at Port au Choix National Historic Site, it shall occur during the winter when snow cover is at least 30 cm deep and only flat-tracked vehicles are permitted. If these seasonal conditions

cannot be met and/ or other vehicles are required for the work additional mitigations, such as surface padding, may be required to protect the structure of limestone barrens gravels and soils (e.g. use of timber matts).

32) Do not travel or operate equipment outside of designated areas (i.e., RoW, access routes, existing roads and highways).
33) Use low pressure or rubber tracked equipment or surface padding (e.g., timber mats) where feasible to minimize soil compaction and ground disturbance, and/or complete work that requires tracked equipment in the winter when good snow pack and ground frost occur. Vegetation, such as branches and logs, cut during maintenance work may also be used for surface padding. Avoid travel on saturated soils.
34) Erosion control measures shall be implemented if required to prevent sediment transport into any waterway, water body or wetland. Measures include the dispersal of vegetation cut for the purpose of RoW maintenance (e.g., branches, tree trunks, or wood chips), or erosion control fabric that is certified to reduce potential wildlife entanglement and 100% biodegradable. If erosion control fabric is applied it shall be installed based on the specifications presented in Appendix D, Figure 9.
35) Use of hay or straw for erosion and sediment control is not permitted.
36) Sediment controls shall be implemented where erosion controls have not been completely effective and/ or where soils have been mobilized by erosion. A sediment fence can be applied, and shall be installed based on the specifications presented in Appendix D, Figure 10 and 11.
37) Maintain effective erosion and sediment control measures until any required re-vegetation of disturbed areas is achieved, then remove temporary erosion and sediment control products, especially non-biodegradable materials, when they are no longer required.

Water Quality and Fish Habitat:

38) Follow the requirements of Fisheries and Oceans Canada (DFO) Fisheries Protection Program, and have all the necessary, up-to-date permits, Letters of Advice, etc., that are required by DFO for any work that may enter below the high water mark.
39) Current DFO guidelines for fording of streams allow a one-time crossing (over and back) in flowing waters, or a seasonally dry streambed ford, or a crossing in the winter with solid ice and snow pack.
40) Fording locations are limited to existing crossing sites, as presented in Figures 1-6.
41) Stream fording shall be restricted to time periods of reduced risk for fish (Table 1). If fording is required during winter, snow pack and ice shall be of the appropriate thickness as to not disturb the stream bed. When these conditions cannot be met, staff must use other environmentally and safety appropriate means such as vegetation/ logs that have been cut for the purpose of power line maintenance as cribbing/ crossing structures.
42) The channel width at the crossing shall be no greater than 5 meters from ordinary high water mark to ordinary high water mark.
43) A vegetable based or biodegradable version of chainsaw oil or lubricant shall be used within 30 meters of any water body.

Wildlife and Vegetation:

44) Conduct any clearing of vegetation outside critical wildlife timing windows such as the bird nesting period, bat maternity and marten maternal denning season (Table 1).

45) Plant surveys for rare plants may be required for specific sites based on input from Park specialists. Depending on survey results, additional mitigations may apply.
46) On-site workers must be made aware of potential wildlife that they may observe.
47) On-site workers must be made aware of and subsequently report any incidental sightings of wildlife and species at risk immediately to designated Parks Canada staff.
48) If active nests, dens or roosts are suspected or discovered, stop work and contact designated Parks Canada staff immediately for direction.
49) When possible, conduct activities during daylight hours, avoiding critical foraging times (dusk and dawn). Consult with Parks Canada staff for site-specific advice.
50) Minimize the time between removal and replacement of transmission pole, and cover or fence when left unattended to reduce the potential for wildlife and human injury.
51) Never approach or harass wildlife (e.g., feeding, baiting, luring). If wildlife is observed at or near the work site, allow the animal(s) the opportunity to leave the work area.
52) Designated Parks Canada staff must be alerted immediately to any potential wildlife conflict (e.g., aggressive behaviour, persistent intrusion), distress or mortality.
53) Clear minimum area necessary; trees should be removed only if necessary for project completion or visitor/staff safety. Trimming of branches and tree tops must be considered first, prior to complete removal of entire tree, and vegetation should not be trimmed more than necessary to mitigate the hazard.
54) When felling trees, precautions must be taken to minimize damage to surrounding vegetation.
55) The felling of trees with obvious wildlife use (e.g., snags with cavity nests, large trees with stick nests) must be avoided wherever possible; if unavoidable, Parks Canada staff consultation and approval is required.
56) All cut wood is the property of Parks Canada; consult with designated Parks Canada staff to determine appropriate cutting methods, use and disposal of cut wood and other plant material.
57) Employ pruning techniques to minimize risk of tearing the bark and harming the tree; ensure that only branch tissue is removed and stem or trunk tissue is left undamaged (refer to Appendix B).
58) Protect roots of trees to drip line to prevent disturbance or damage. Avoid traffic, dumping and storage of materials over root zone.
59) Retain a 15-meter vegetated buffer from the high water mark of waterbodies where existing infrastructure and safety are not considered at risk due to further vegetation growth. In steeply sloped areas buffers should increase as the slope increases, where possible.
60) Where riparian vegetation must be removed clearing should be kept to a minimum. Ensure the vegetation mat, root structure and soil stability are maintained.
61) A fire extinguisher shall be on site.
62) All construction equipment from outside the Parks Canada protected heritage place must be washed outside the site prior to arrival to minimize risk of introducing invasive weed species. Proof that this mitigation was applied may be requested before equipment is permitted into the protected heritage place.
63) Work in areas less likely to be infested with invasive plants (e.g., power lines further from roadways and human activities) before moving to sites more likely to be infested (e.g., areas adjacent to community enclaves, campgrounds, highway pull-offs, etc.,).
64) Stabilize and re-vegetate disturbed areas as soon as possible. If there is insufficient time remaining in the growing season, stabilize the site to prevent erosion (e.g., erosion control fabric, application of mulch, dispersion of branches and vegetation around the work area), and only vegetate (e.g.,

hydroseed with a mixture of 60% annual rye and 40% red fescue) the following spring if deemed necessary by the designated Parks Canada official.

65) Monitor disturbed and re-vegetated areas until native vegetation is growing successfully and invasive alien species spread is prevented. Parks Canada shall be notified if an invasive species is identified, (i.e., giant hogweed).

Visitor Experience and Safety:

66) If possible, schedule noisy activities outside peak visitor season or adjust hours of noisy work to minimize disturbance to visitors using the area.
67) Close and mark the work site and safety hazards with appropriate signage while active construction, repair or maintenance is underway; consider temporary detours or reroutes as appropriate. Additional messaging and signs shall be posted during the moose hunting season. A 1 kilometer buffer for no hunting will be created around the work site.
68) If closing the area is not possible, maintain a safe working distance between work activities and visitors. If traffic control is required, a flag person should manage traffic through the construction/hazard area.
69) Visitor access trails and roads outside the construction area must be free of construction materials, waste, machinery and equipment.

Cultural Resources:

70) Avoid known potential cultural resources and/or archaeological sites.
71) If cultural resources (i.e., structural remains and/ or artifact concentrations) are encountered, work must cease immediately, the site secured and the designated Parks Canada staff contacted for further direction.
72) Stockpiled material must not be permitted to damage or bury known cultural resources.
73) On-site workers shall receive cultural resource awareness training, appropriate to the complexity of the task and potential level of sensitivity of the proposed work area.

Supplementary Mitigations

74) A few supplementary mitigation(s) may be required to ensure all potential impacts are mitigated.

Development and Review Team

Developed by:	Date:
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Reviewed by:	
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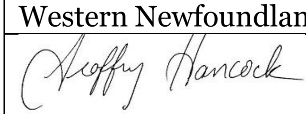
Geoffrey Hancock Western Newfoundland and Labrador Field Unit Superintendent	**Date:**
	**Mar. 8, 2021**

References:

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Parks Canada, 2009. *Guidelines for the Use, Handling and Disposal of Treated Wood*. Accessed March 2021.

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Parks Canada. 2017. *National Best Management Practices for Common Activities*.

Van Osch Innovations Ltd. 2020. Environmental Monitoring for Construction Projects Practitioner. Participant's Manual. VOI Training Group.

Appendix A. Maps presenting existing power lines, access routes, and fording locations in Gros Morne National Park.

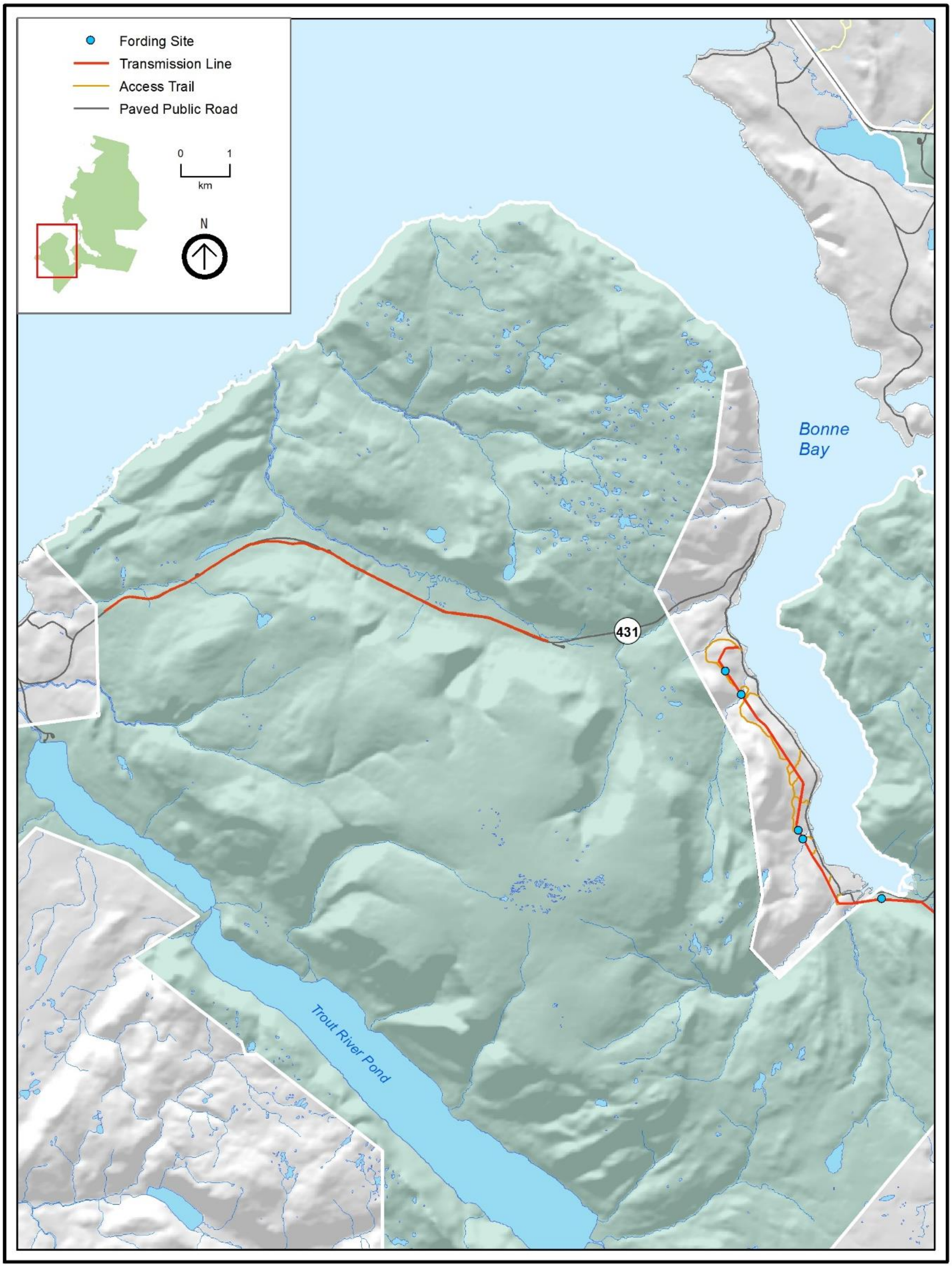


Figure 1. Fording sites, access points and trails along NL Hydro's power distribution line (TL 229 and Tablelands Distribution) from Trout River to Glenburnie in Gros Morne National Park.

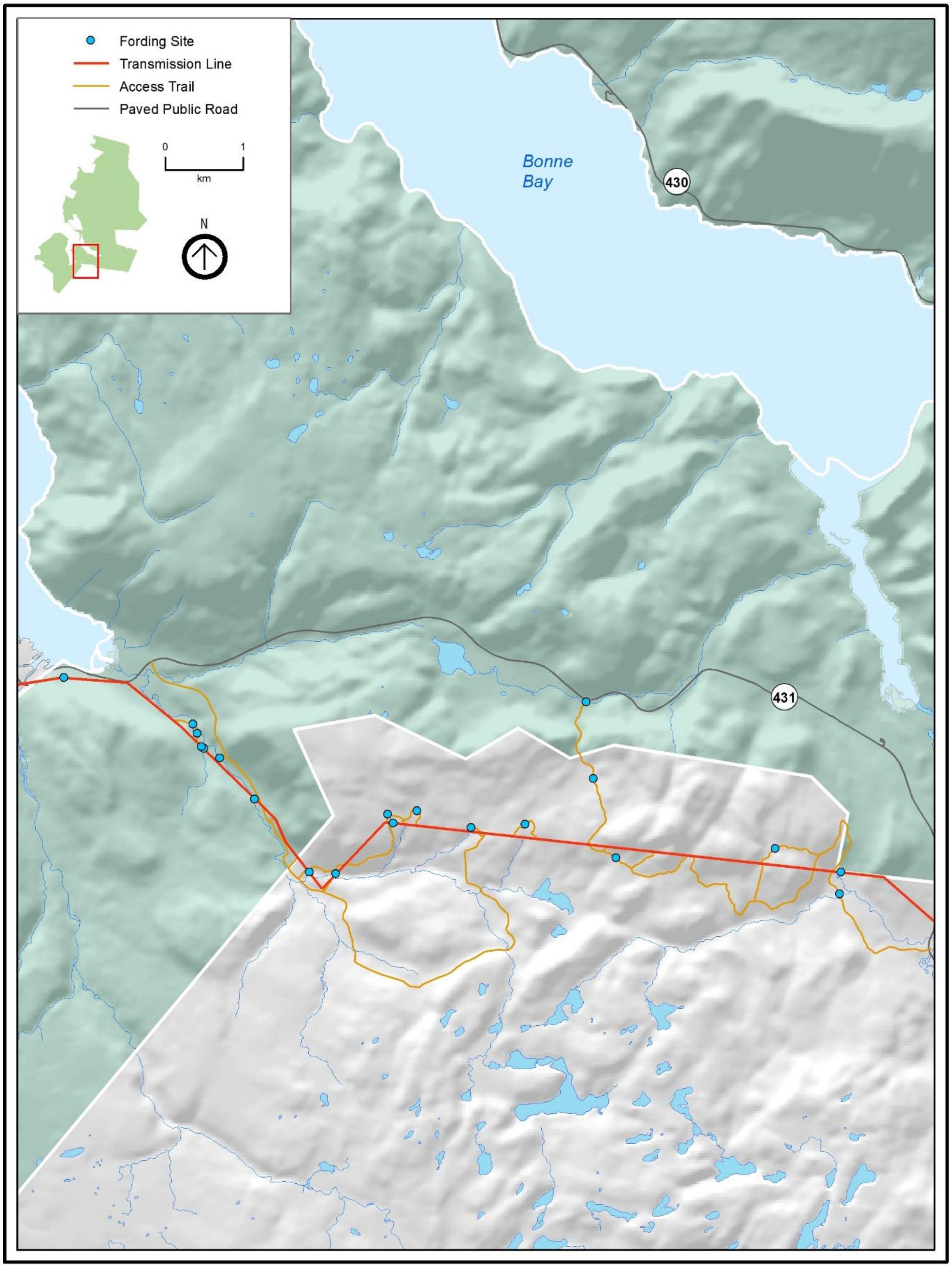


Figure 2. Fording sites, access points and trails along NL Hydro's power line (TL229) from Glenburnie to Lomond in Gros Morne National Park.

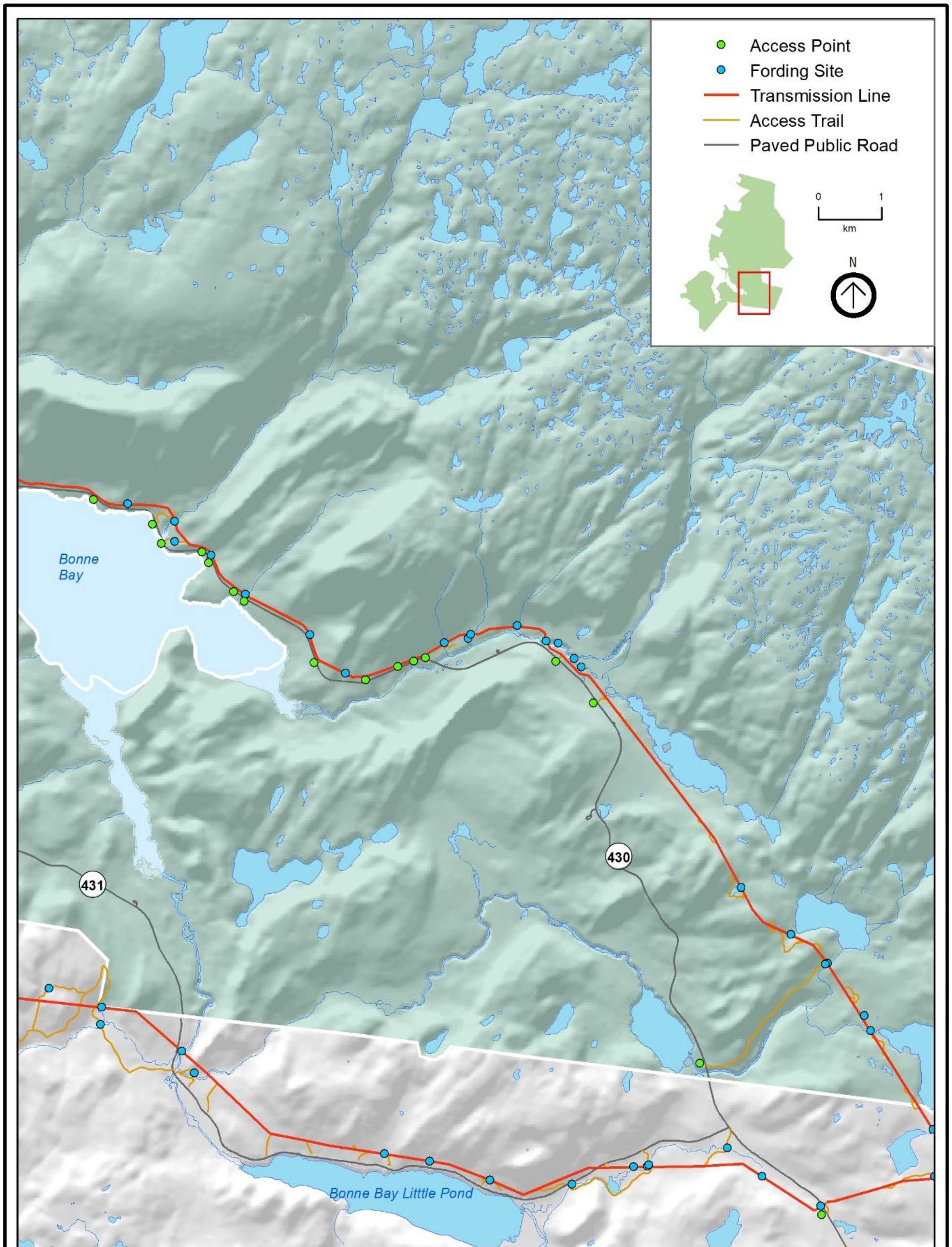


Figure 3. Fording sites, access points and trails along NL Hydro's power lines (TL 226, 239 and 229) from Lomond to Rocky Barachois in Gros Morne National Park.

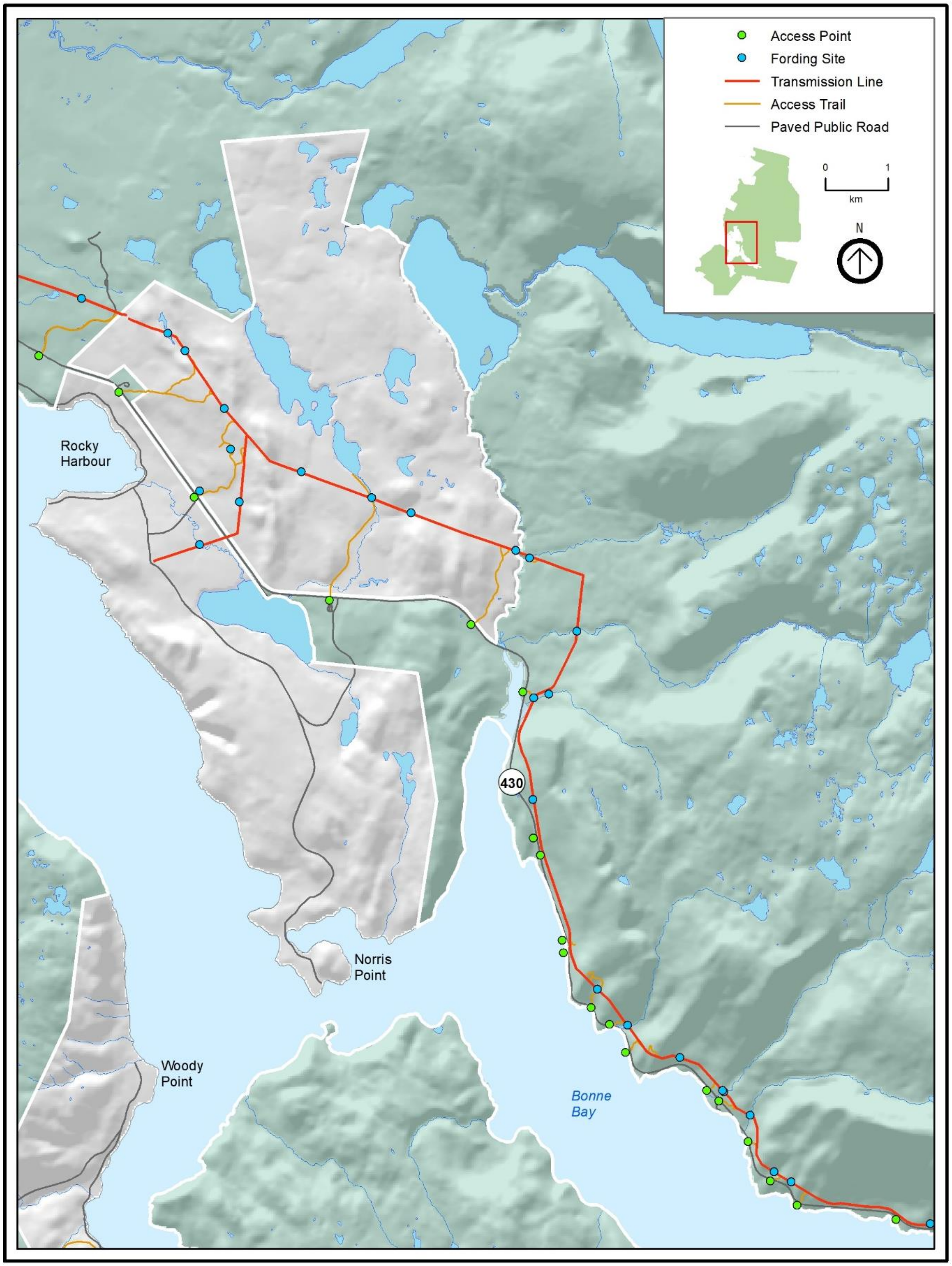


Figure 4. Fording sites, access points and trails along NL Hydro's power lines (TL 226 and TL239) from Rocky Barachois to Rocky Harbour in Gros Morne National Park.

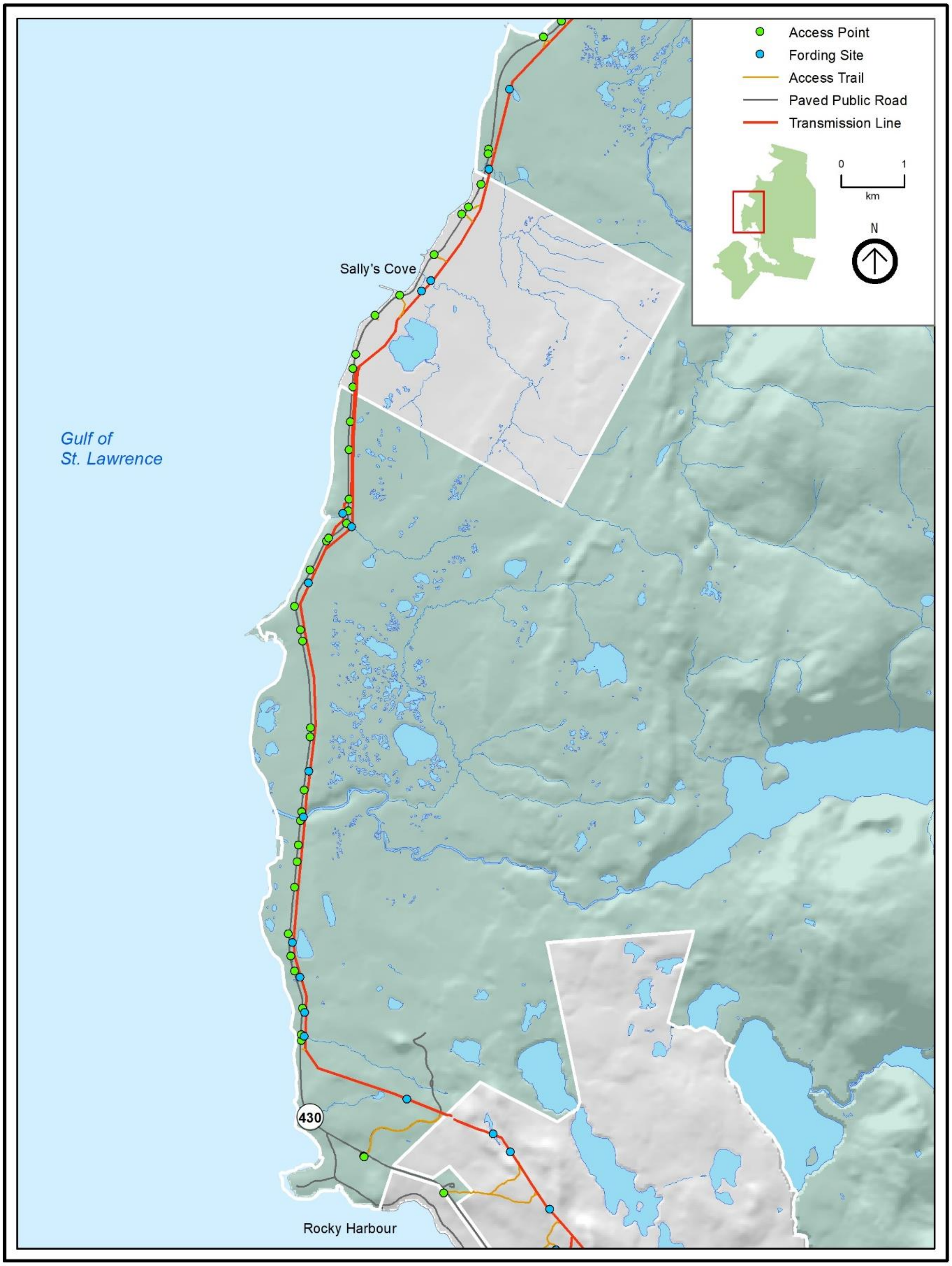


Figure 5. Fording sites, access points and trails along NL Hydro's power lines (TL 227 and 259) from Rocky Harbour to Sally's Cove in Gros Morne National Park.

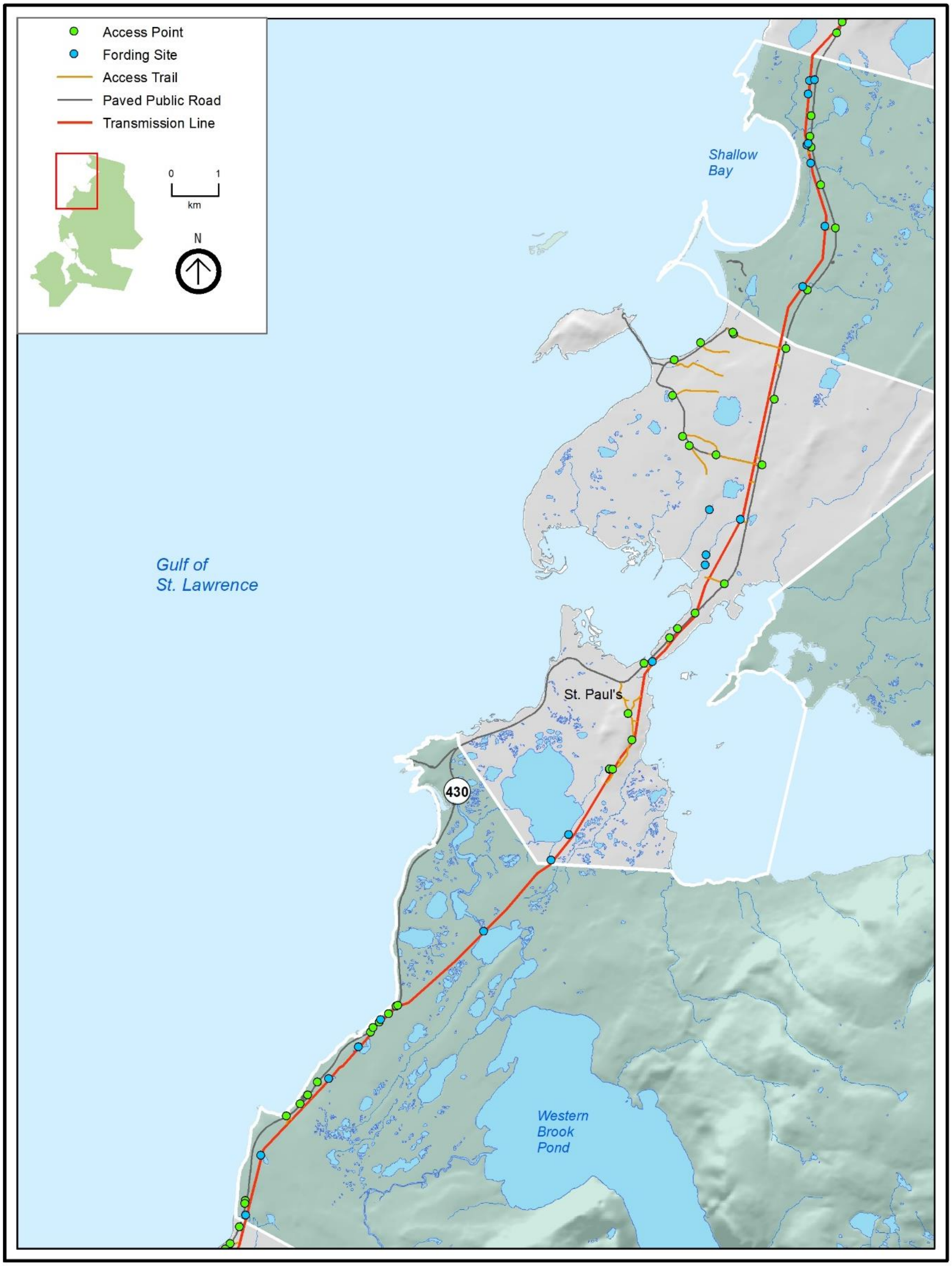
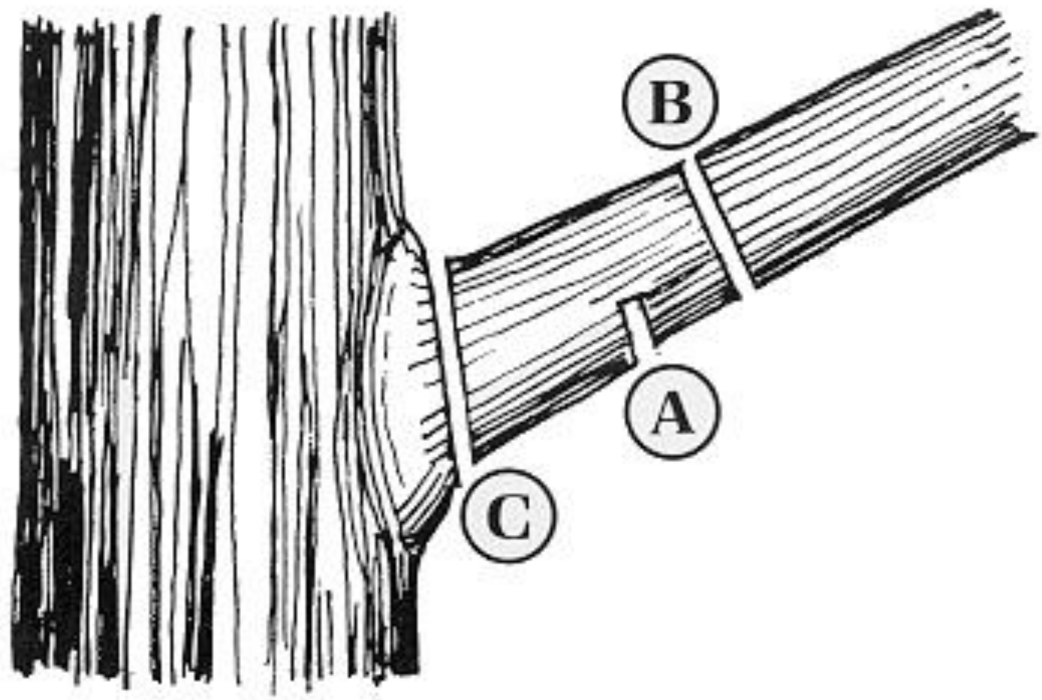


Figure 6. Fording sites, access points and trails along NL Hydro's power lines (TL 227 and 259) from Sally's Cove to Shallow Bay in Gros Morne National Park.

Appendix B. Proper Pruning Method



To find the proper place to cut a branch, look for the branch collar, an often visible swelling that forms at the base of a branch where it is attached to its parent branch or to the tree's trunk. On the upper surface, there is usually a branch bark ridge that runs (more or less) parallel to the branch angle, along the stem of the tree. A proper pruning cut does not damage either the branch bark ridge or the branch collar.

A – The first cut is a shallow undercut to prevent bark tearing.

B – The second cut completely removes the limb.

C- The third cut removes the stub and is cut flush with the branch collar

Appendix C. Species at Risk critical habitat that occurs adjacent to or intersects with power lines.

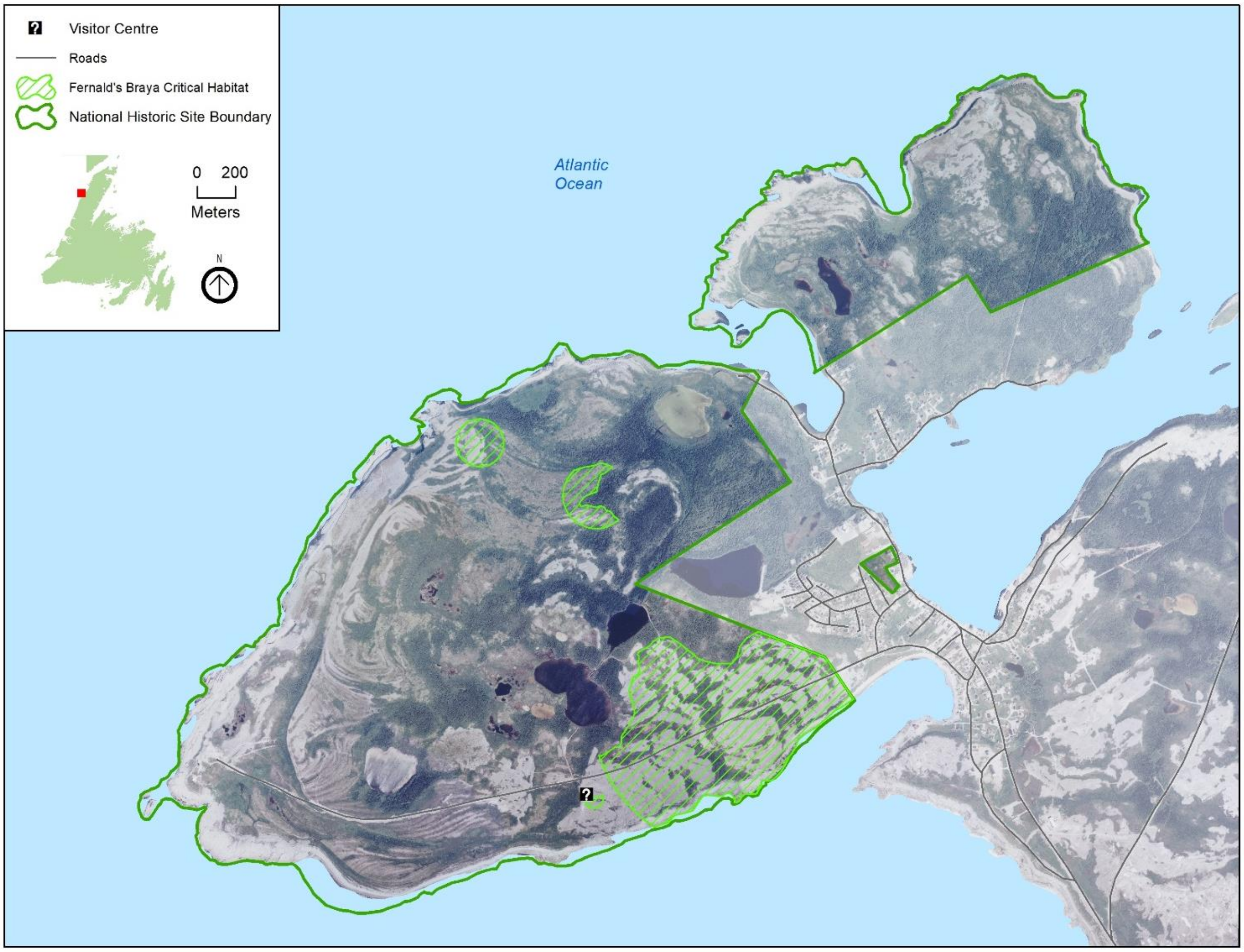


Figure 7. Fernald's braya critical habitat in Port au Choix. The power line within this National Historic Site follows approximately 20 meters north, parallel to the road and intersects the largest area of Fernald's braya critical habitat within the site.

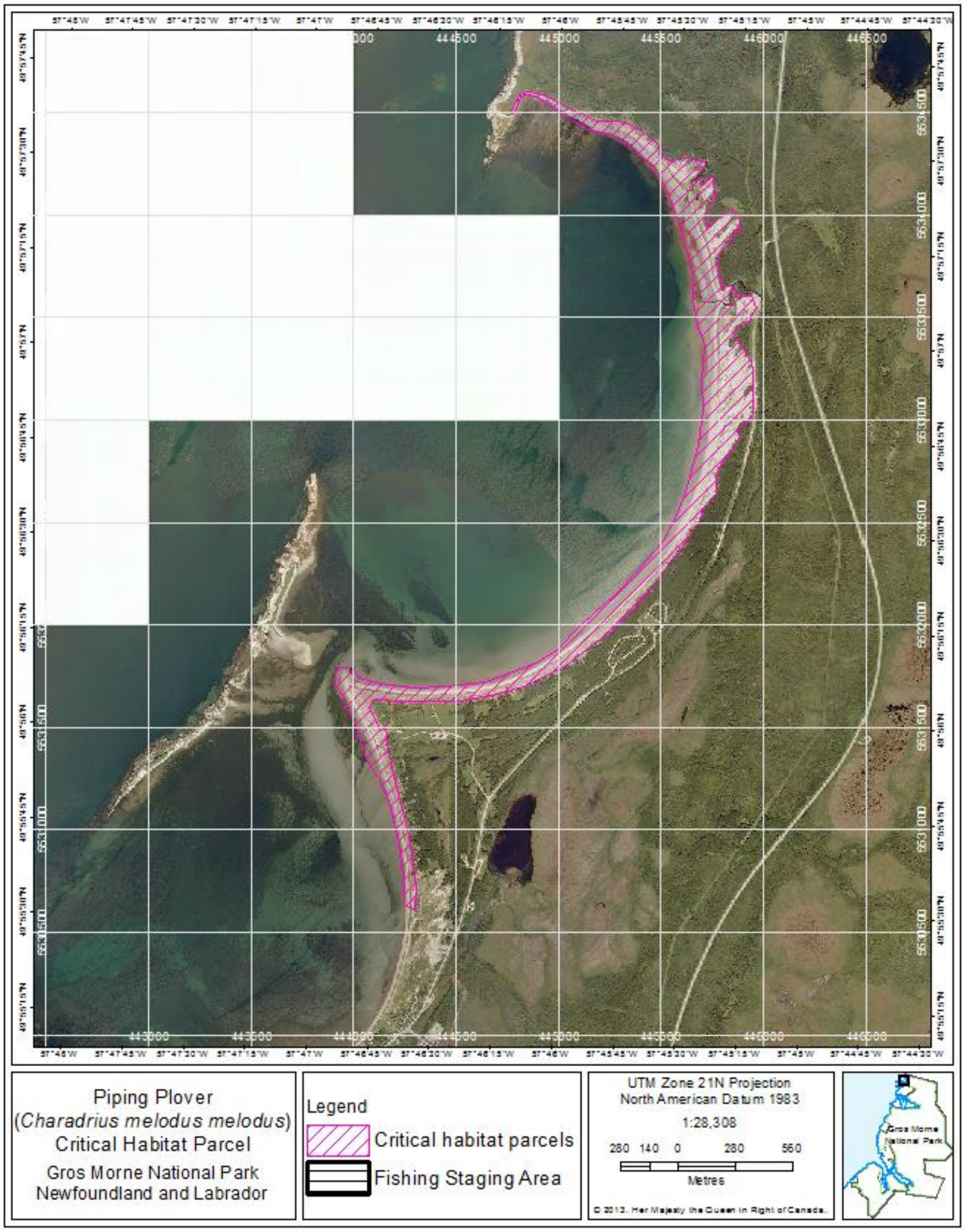


Figure 8. Piping plover critical habitat at Shallow Bay in Gros Morne National Park. Transmission line 227 and 259 travels parallel along the western shoulder of highway Route 430 and a distribution line to the Shallow Bay Day Use Area and Campground follows the access road to these sites along the west shoulder. The power line does not intersect the critical habitat.

Appendix D. Specifications for installation of erosion and sediment controls.

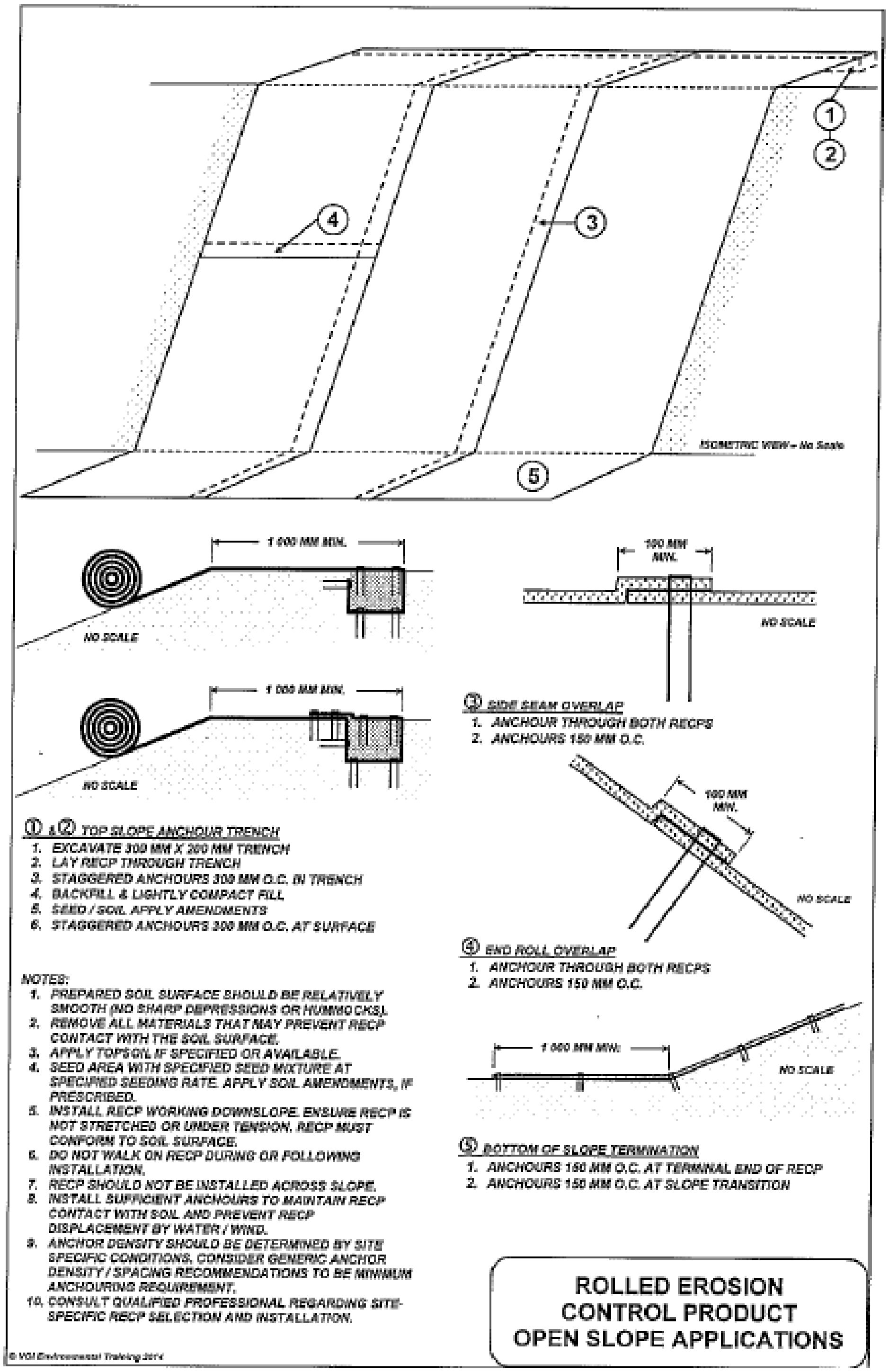


Figure 9. Specifications for the installation of erosion control fabric. (Van Osch Innovations Ltd., 2020)

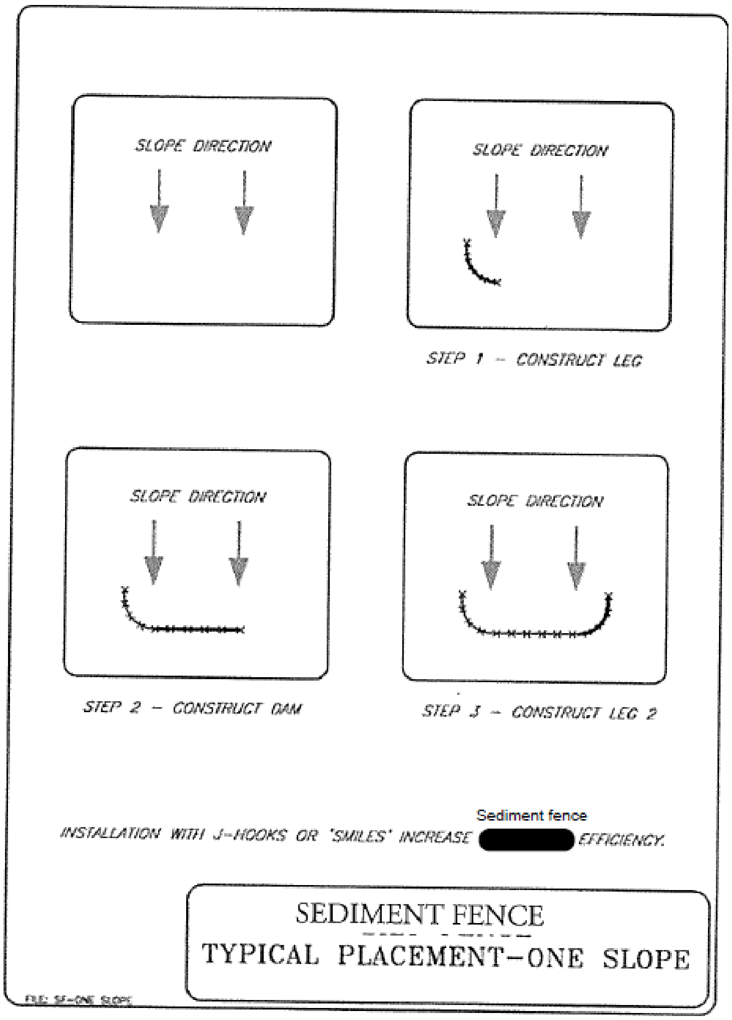


Figure 10. Specified placement of sediment fence perpendicular to the slope. (Van Osch Innovations Ltd., 2020)

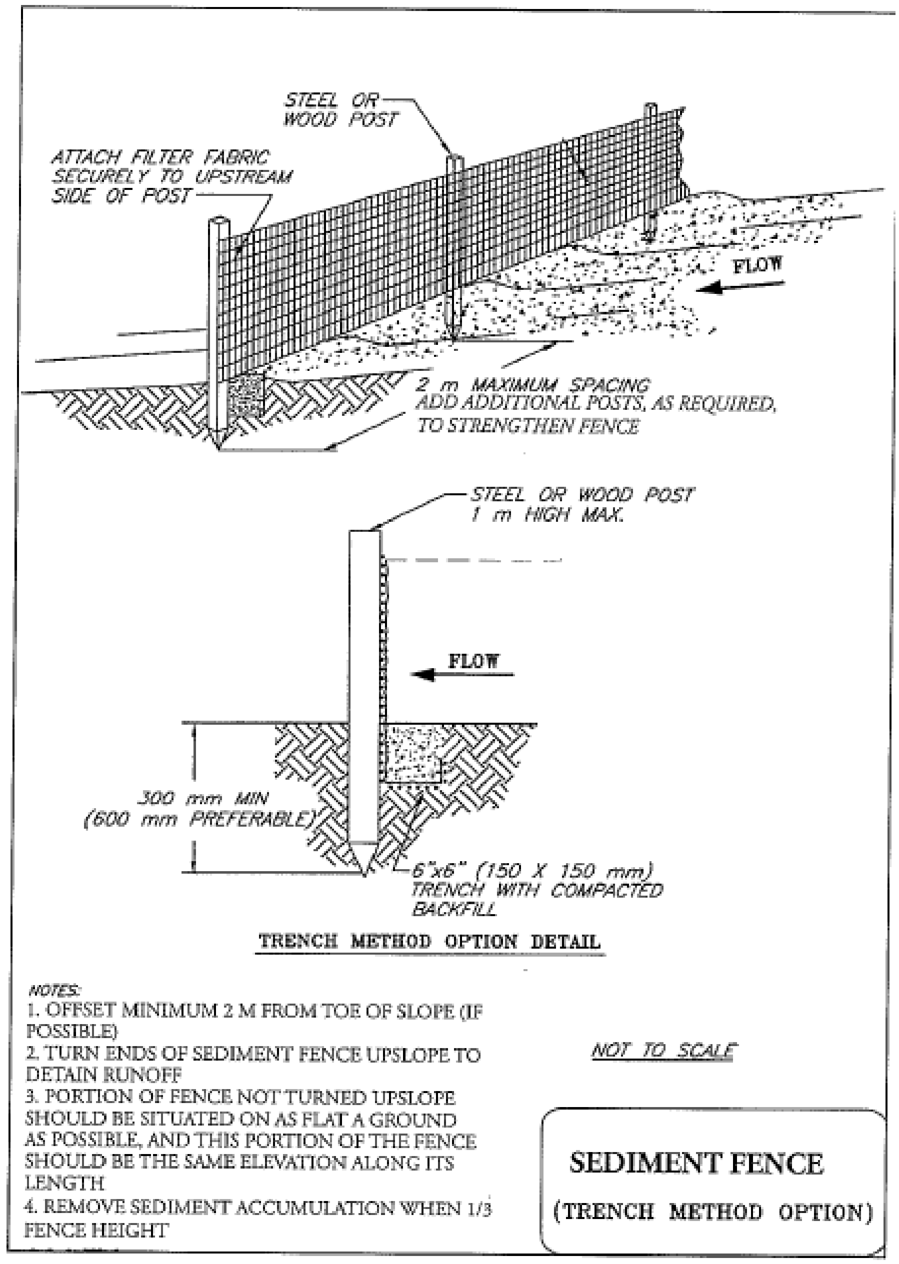


Figure 11. Specifications for the installation of a sediment fence using the trench method. (Van Osch Innovations Ltd., 2020)

APPENDIX C

Compilation of Monitoring and Follow-up Requirements

Monitoring and Follow-Up Requirements

Hydro personnel will direct and monitor Project activities full-time. Hydro will continue to work collaboratively with Parks Canada throughout the Project execution phase and incorporate lessons learned and opportunities for improvement. Joint annual Project reviews are recommended in addition to routine collaboration throughout the life of the Project.

Hydro recognizes the importance of existing, narrow visual buffers between roadways and the transmission ROW corridors. Hydro is interested in exploring the opportunity with Parks Canada to support the planting of trees in critical locations along, or within, these existing buffers to enhance their effectiveness in the long term.

APPENDIX D

Detailed Widening Plan

Right-of-Way Widening - Consolidated Master Plan [1]

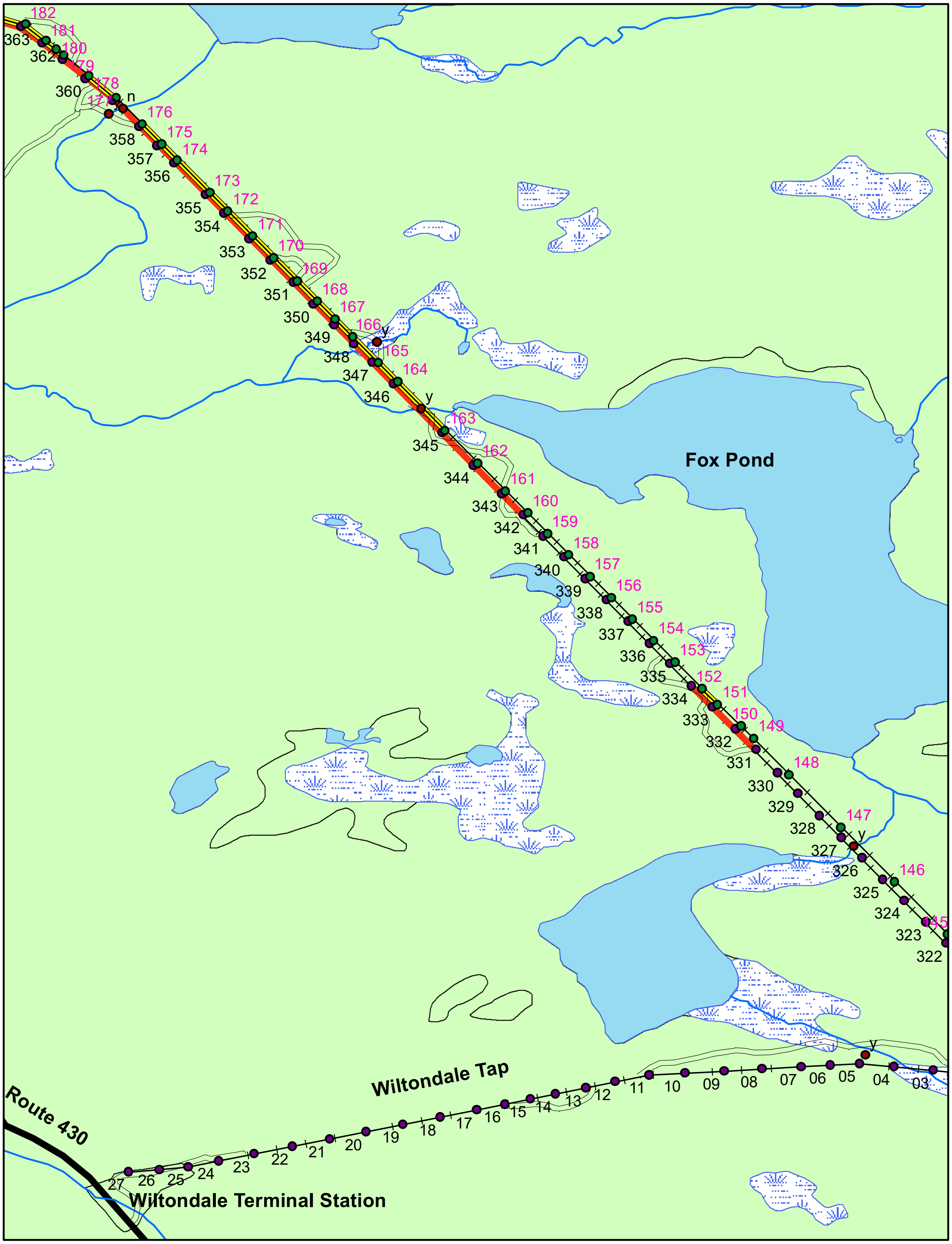
Line and Structures	Widening Requirements	Plant Species of Concern Location			Visually Sensitive Area(s)[3]	Widening Year
		Vreeland Striped Coralroot[2]	Yellow Birch	Black Ash		
TL 239						
149-153	1 side					2024
163-202	1 side					2024
228-233	1 side					2024
266-273	1 side; 266-267 both sides				233-295	2024
294-304	1 side					2024
309-329	1 side					2024
336-339	1 side			337-338		2024
343-348	1 side	344-345				2024
353-358	1 side			355-357	333-376	2024
362-365	1 side					2024
370-400	1 side	370-371	382-383			2024
443-446	1 side					2024
458-462	1 side					2024
475-478	1 side		475-476		478-489	2024
TL 226						
330-335	1 side					2025
341-413	1 side				412-413	2025
426-451	1 side; 432-448 both sides				431-432	2025
460-511	1 side	492-493, 505-506, 507-508				2025
521-527	1 side	521-522				2025
535-540	2 sides			540-541	481-667	2025
540-585	1 side, 540-548 both sides	546-547, 561-563	561-562, 563-564,	540-541		2026
590-666-2	1 side, 608-630 & 652-666-2 both sides	613-614, 636-637,640-641	642-643, 645-650, 651-660, 661-666			2026
671-687	1 side				677-681	2026
697-700	1 side					2026
TL 229						
109-114	1 side					2027
175-217	2 sides		183-184, 185-215	182-183, 195-196		2027
TL 227						
1-30	2 sides				1 to 39	2027
73-80	2 sides					2027
80-104	2 sides					2028
119-121	2 sides					2028
232-235	2 sides					2028
257-267	2 sides					2028
459-464	2 sides					2028
469-470	2 sides					2028
TL 259						
2-3	2 sides				1 to 22	2024
16-22	2 sides				26-32	2024
31-78	2 sides					2024
128-141	2 sides				137-139	2024
147-155	2 sides					2024
161-177	2 sides					2024

Rev 0. April 1, 2024

[1] Where this consolidated plan conflicts with attached mapping, this plan takes precedent.
[2] To be confirmed. There are 18 potential occurrences identified that will be verified when the plants are in flower.
[3] Sensitivity level, and planned mitigation approach, varies.

TL 226 and TL 239
Gros Morne Widening Program

newfoundland labrador hydro



Legend

- Fording Sites
- TL 226 Access Trails
- TL 226 Center Line
- TL 239 Center Line
- TL 226 Widening Area
- TL 239 Widening Area

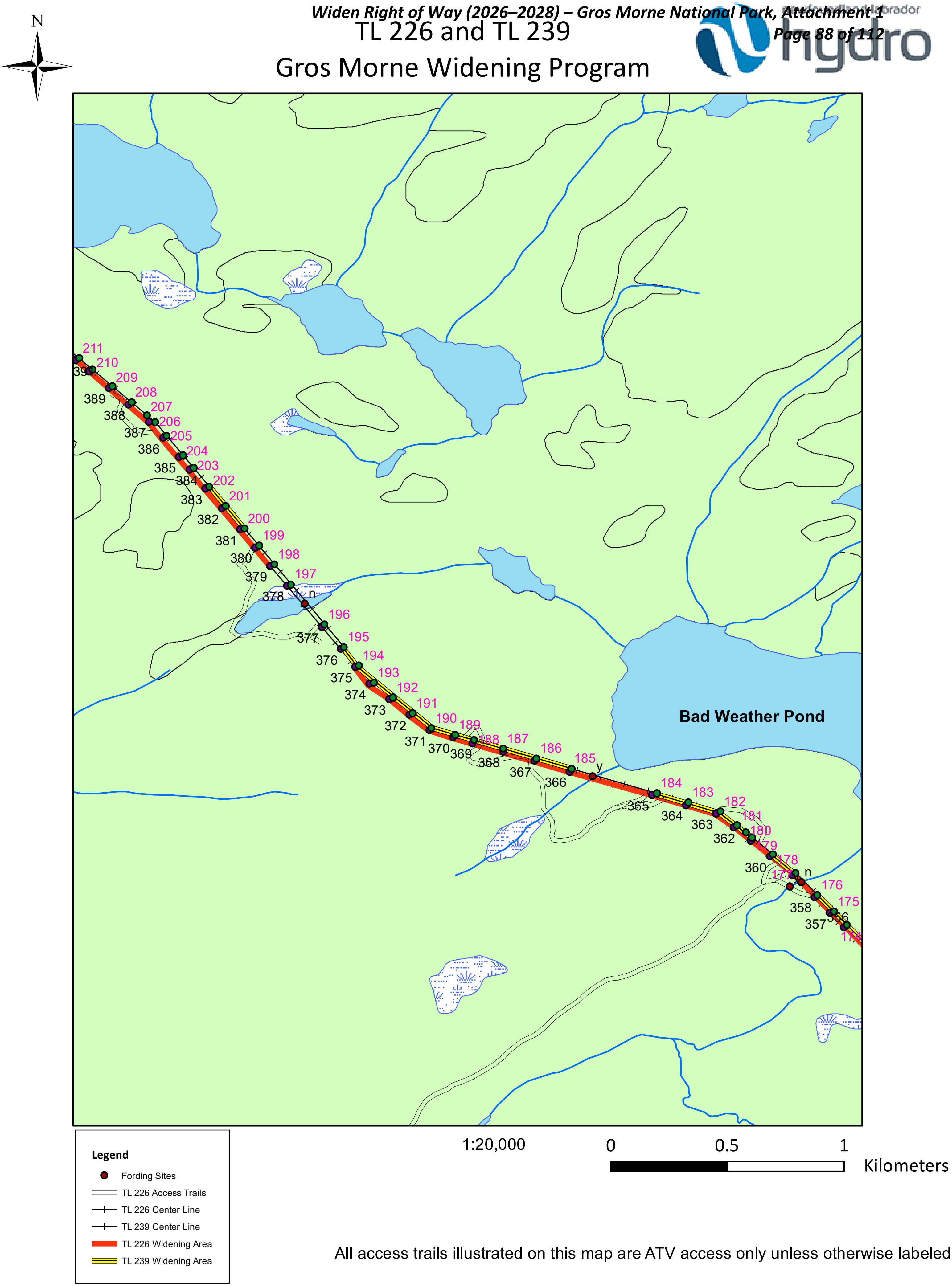
1:20,000

0 0.5 1 Kilometers

All access trails illustrated on this map are ATV access only unless otherwise labeled.

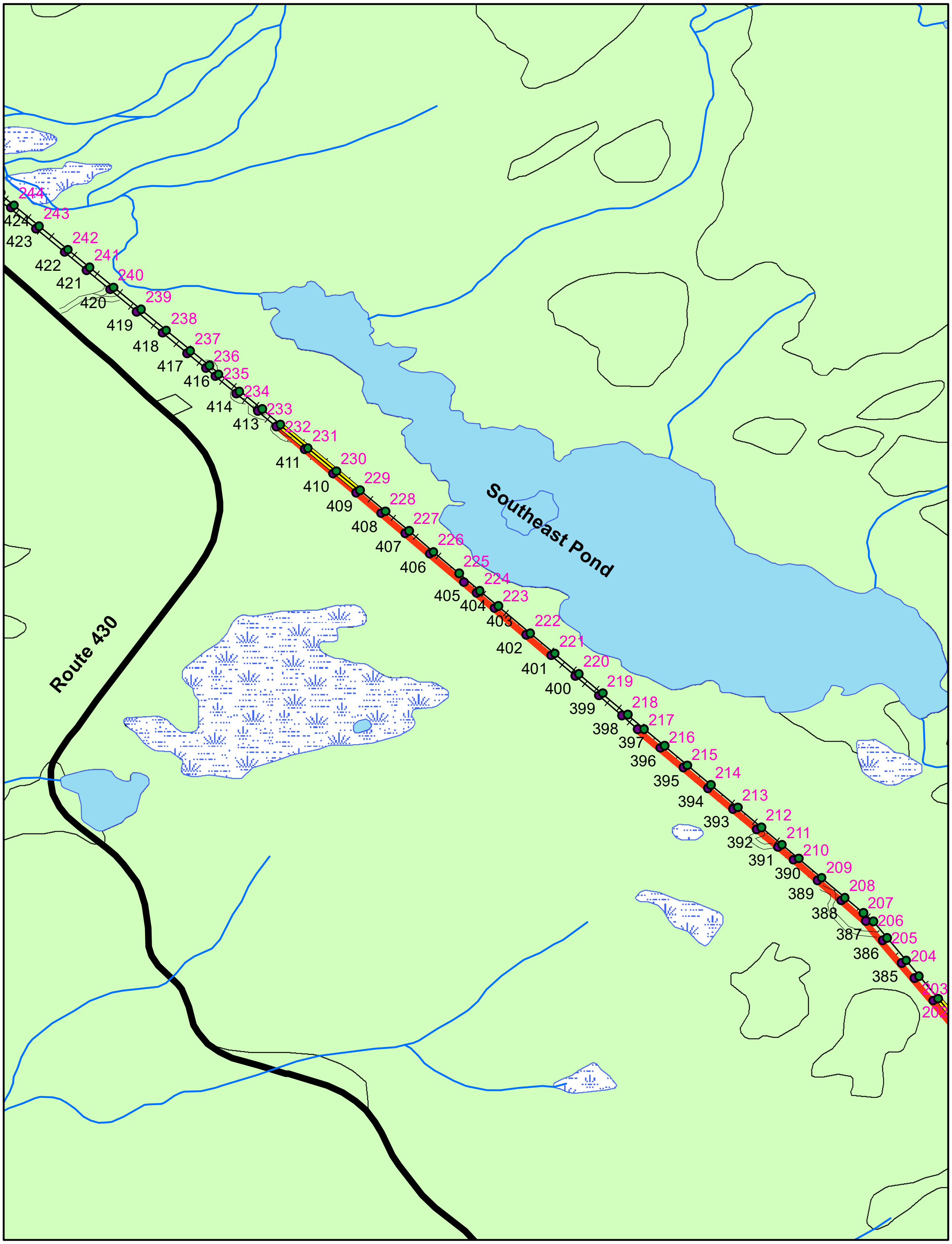
TL 226 and TL 239

Gros Morne Widening Program



All access trails illustrated on this map are ATV access only unless otherwise labeled.

TL 226 and TL 239
Gros Morne Widening Program



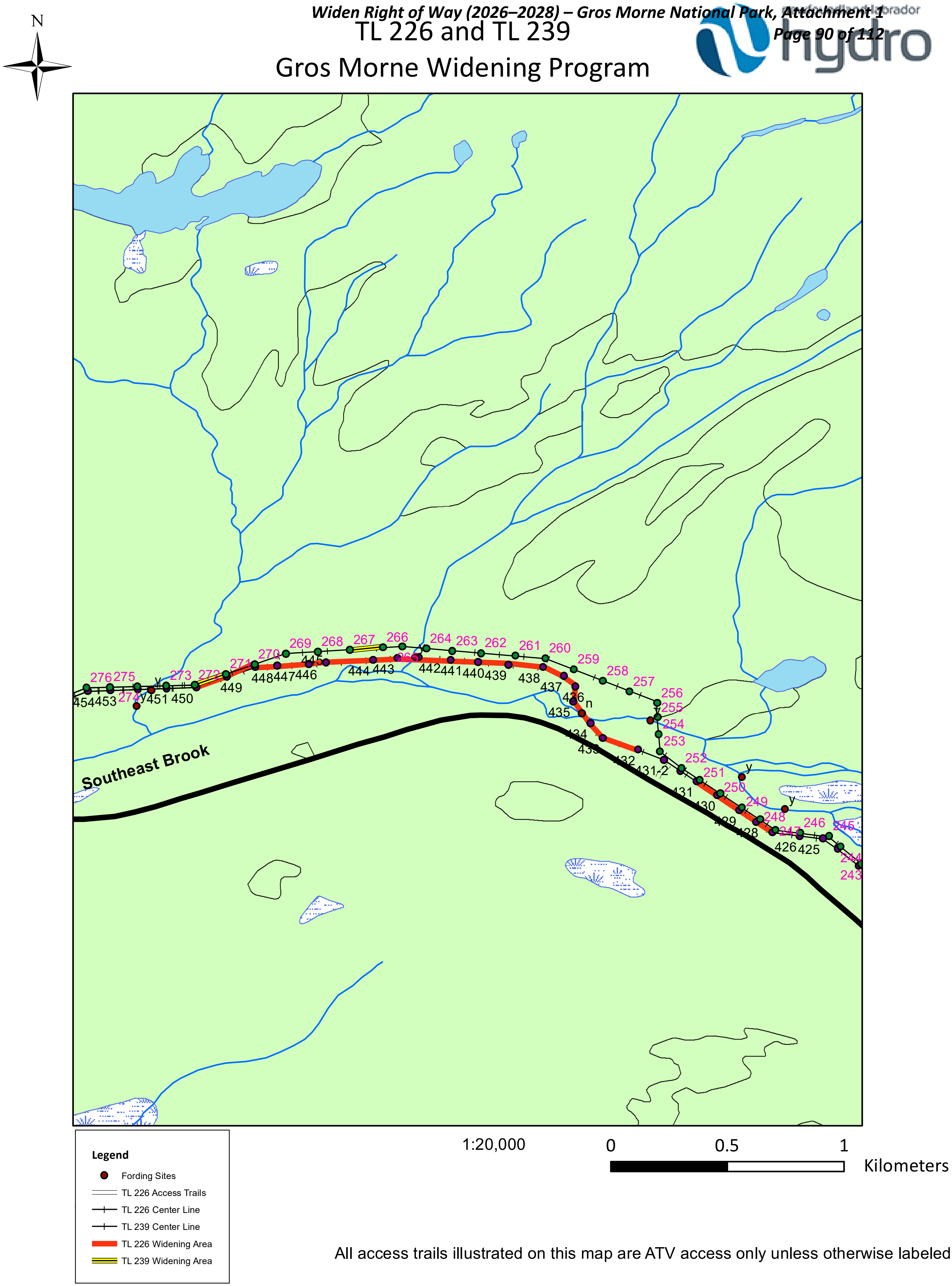
Legend
- Fording Sites
- TL 226 Access Trails
- TL 226 Center Line
- TL 239 Center Line
- TL 226 Widening Area
- TL 239 Widening Area

1:20,000

0 0.5 1 Kilometers

All access trails illustrated on this map are ATV access only unless otherwise labeled.

TL 226 and TL 239
Gros Morne Widening Program



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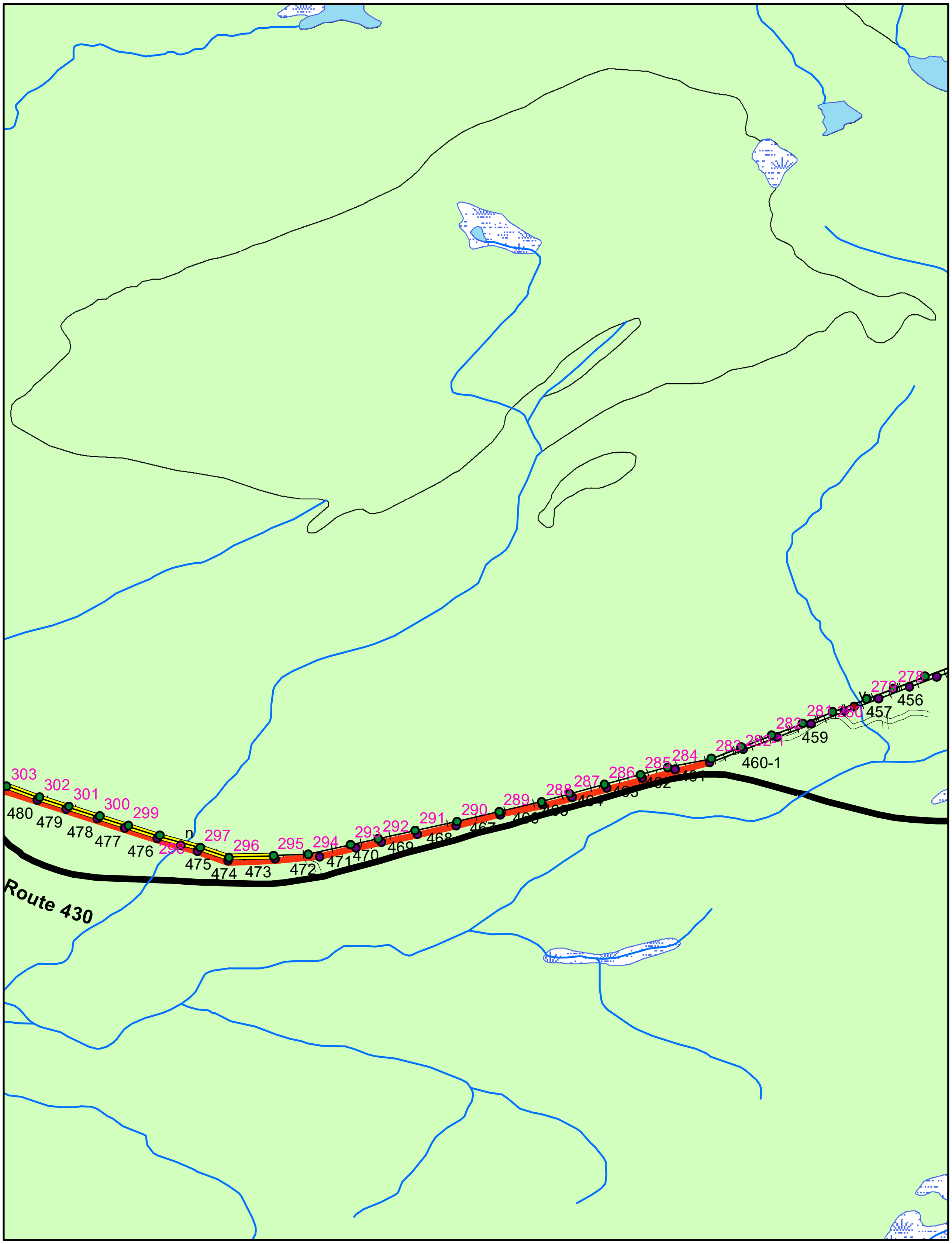
TL 226 and TL 239
Gros Morne Widening Program



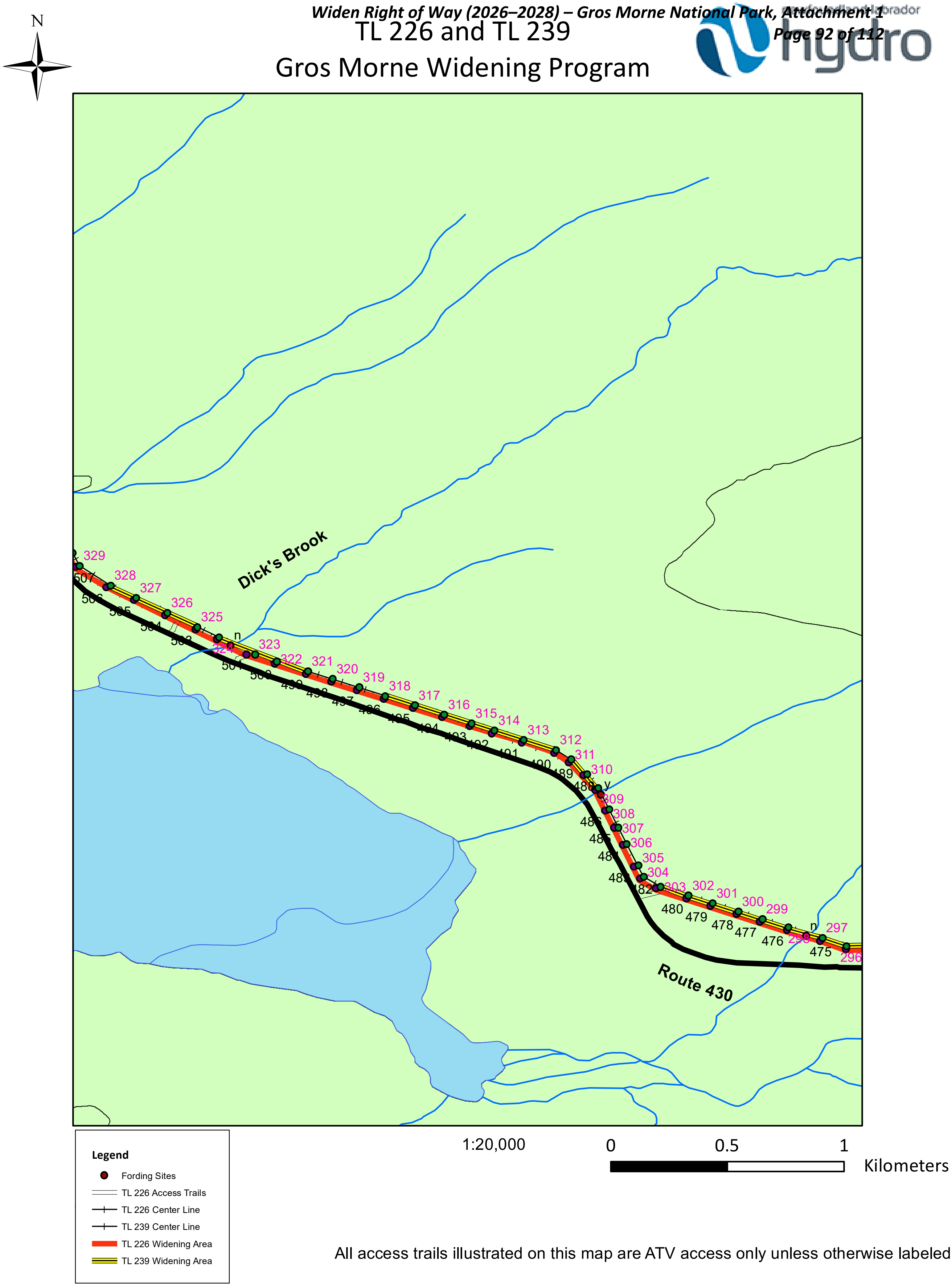
Legend
- Fording Sites
- TL 226 Access Trails
- TL 226 Center Line
- TL 239 Center Line
- TL 226 Widening Area
- TL 239 Widening Area

1:20,000

0 0.5 1 Kilometers

All access trails illustrated on this map are ATV access only unless otherwise labeled.

TL 226 and TL 239
Gros Morne Widening Program



All access trails illustrated on this map are ATV access only unless otherwise labeled.

TL 226 and TL 239

Gros Morne Widening Program

Legend

- Fording Sites
- TL 226 Access Trails
- TL 226 Center Line
- TL 239 Center Line
- TL 226 Widening Area
- TL 239 Widening Area

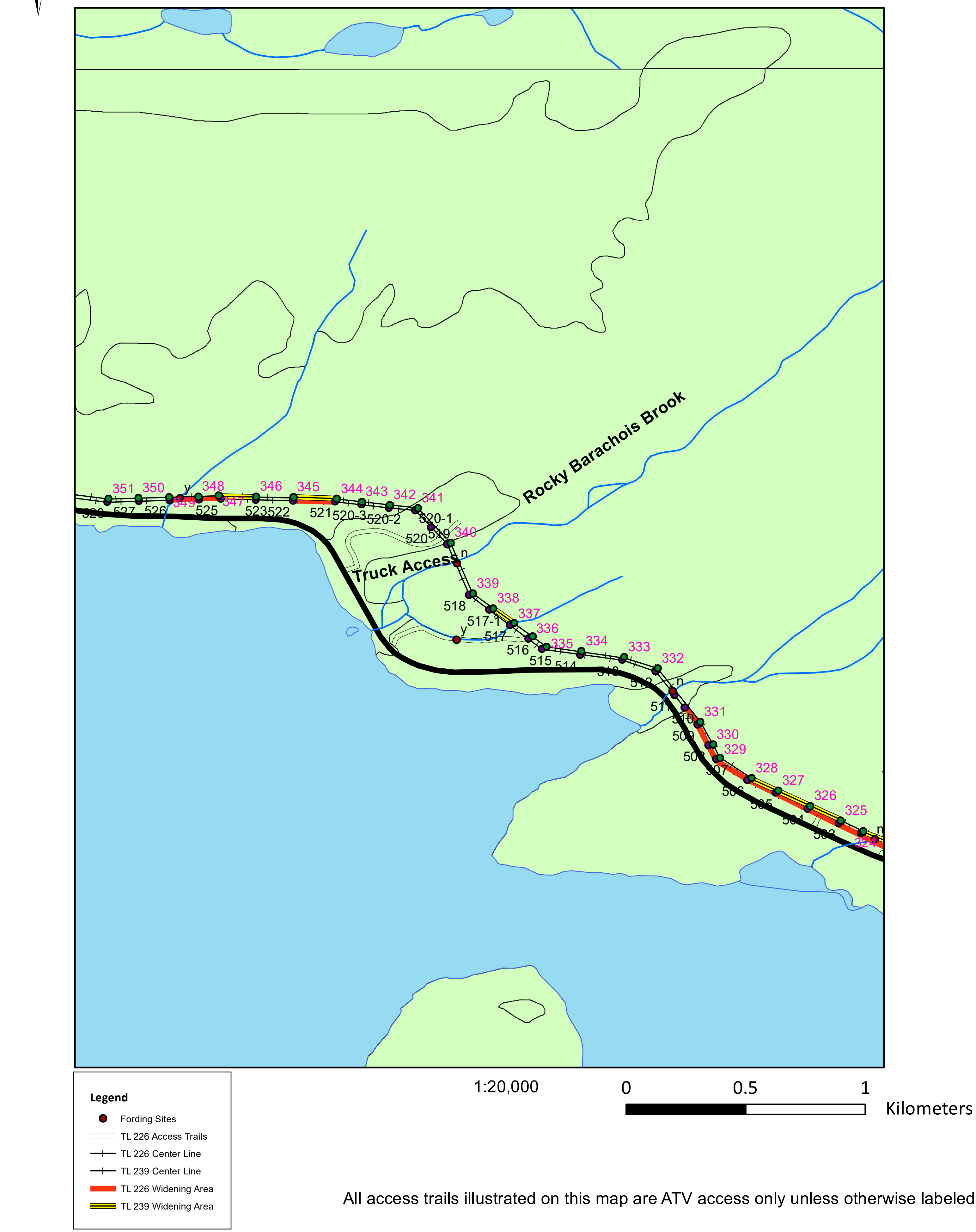
1:20,000

0 0.5 1 Kilometers

All access trails illustrated on this map are ATV access only unless otherwise labeled.

TL 226 and TL 239

Gros Morne Widening Program

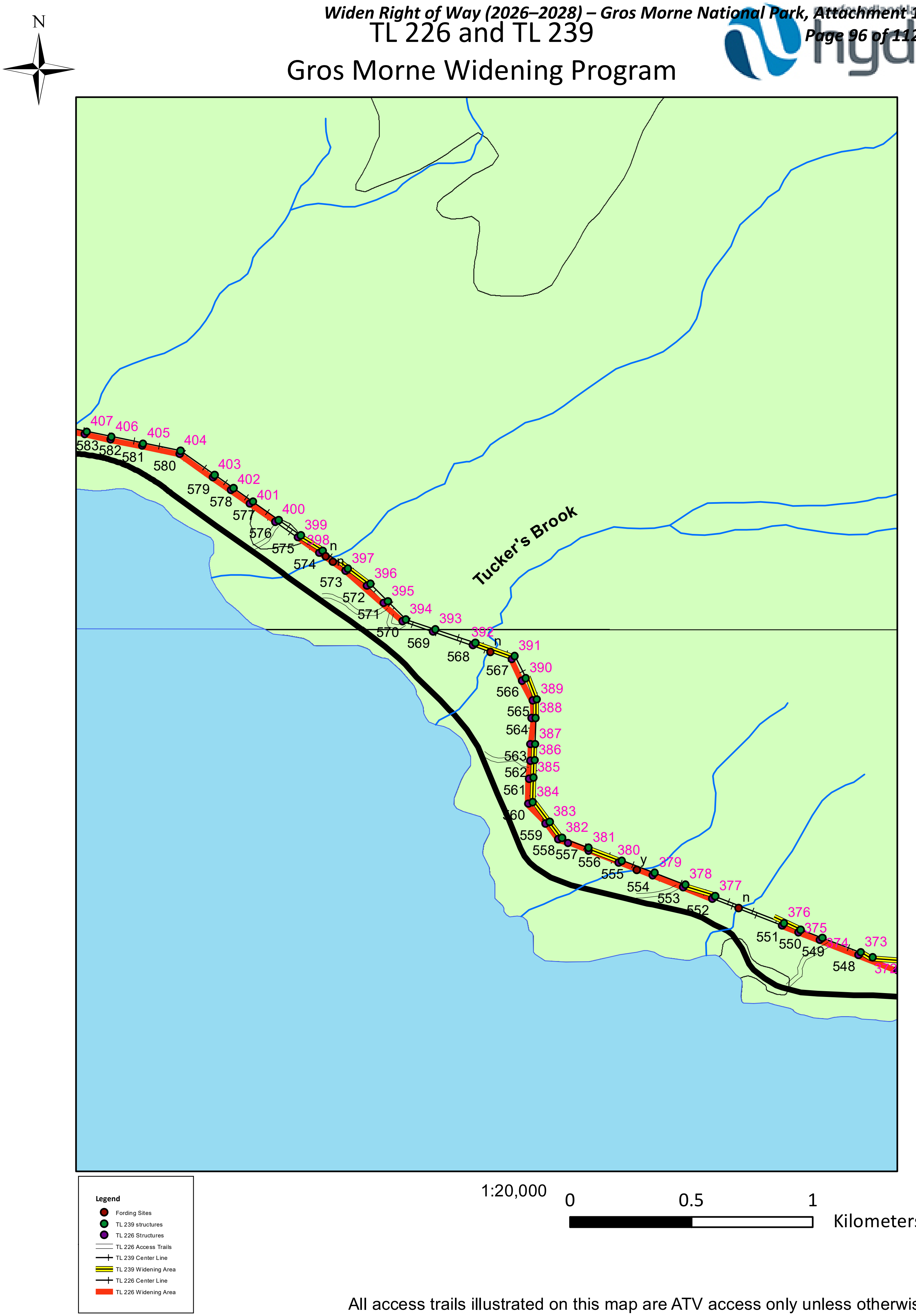


All access trails illustrated on this map are ATV access only unless otherwise labeled.

TL 226 and TL 239
Gros Morne Widening Program

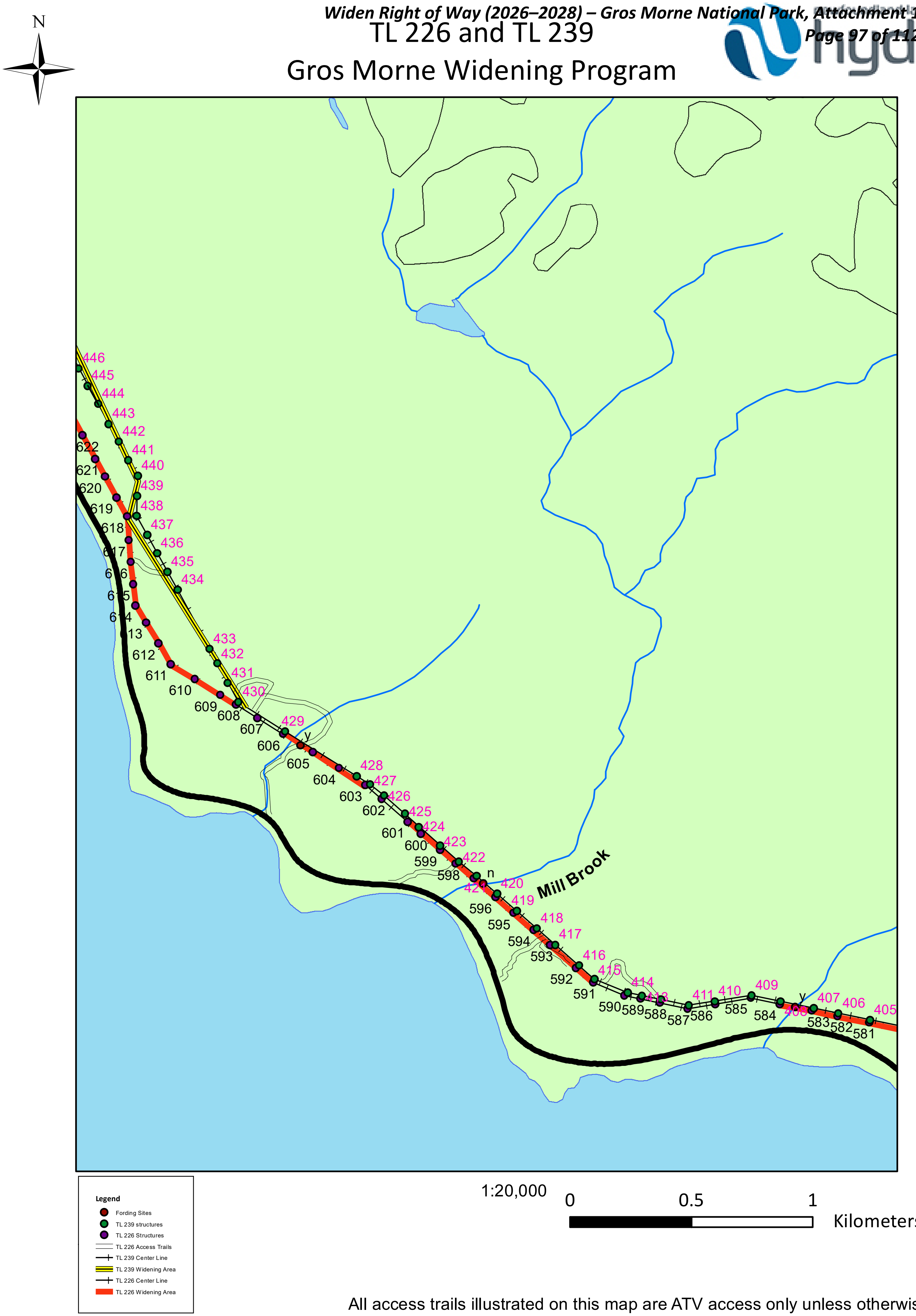
All access trails illustrated on this map are ATV access only unless otherwise labeled.

TL 226 and TL 239
Gros Morne Widening Program



All access trails illustrated on this map are ATV access only unless otherwise labeled.

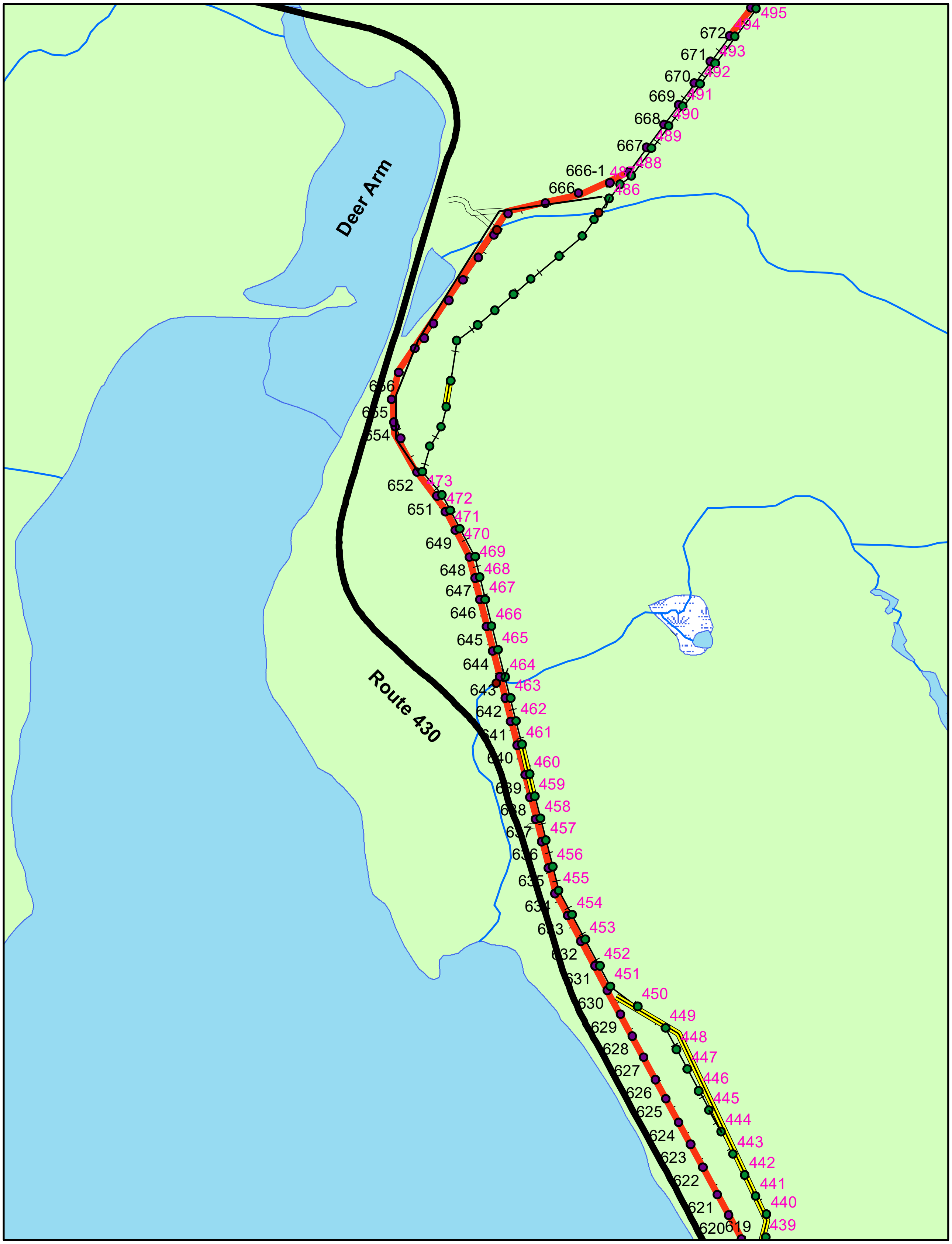
TL 226 and TL 239
Gros Morne Widening Program



All access trails illustrated on this map are ATV access only unless otherwise labeled.

N

TL 226 and TL 239
Gros Morne Widening Program



Legend
- Fording Sites
- TL 239 structures
- TL 226 Structures
- TL 226 Access Trails
- TL 239 Center Line
- TL 239 Widening Area
- TL 226 Center Line
- TL 226 Widening Area

1:20,000

0 0.5 1 Kilometers

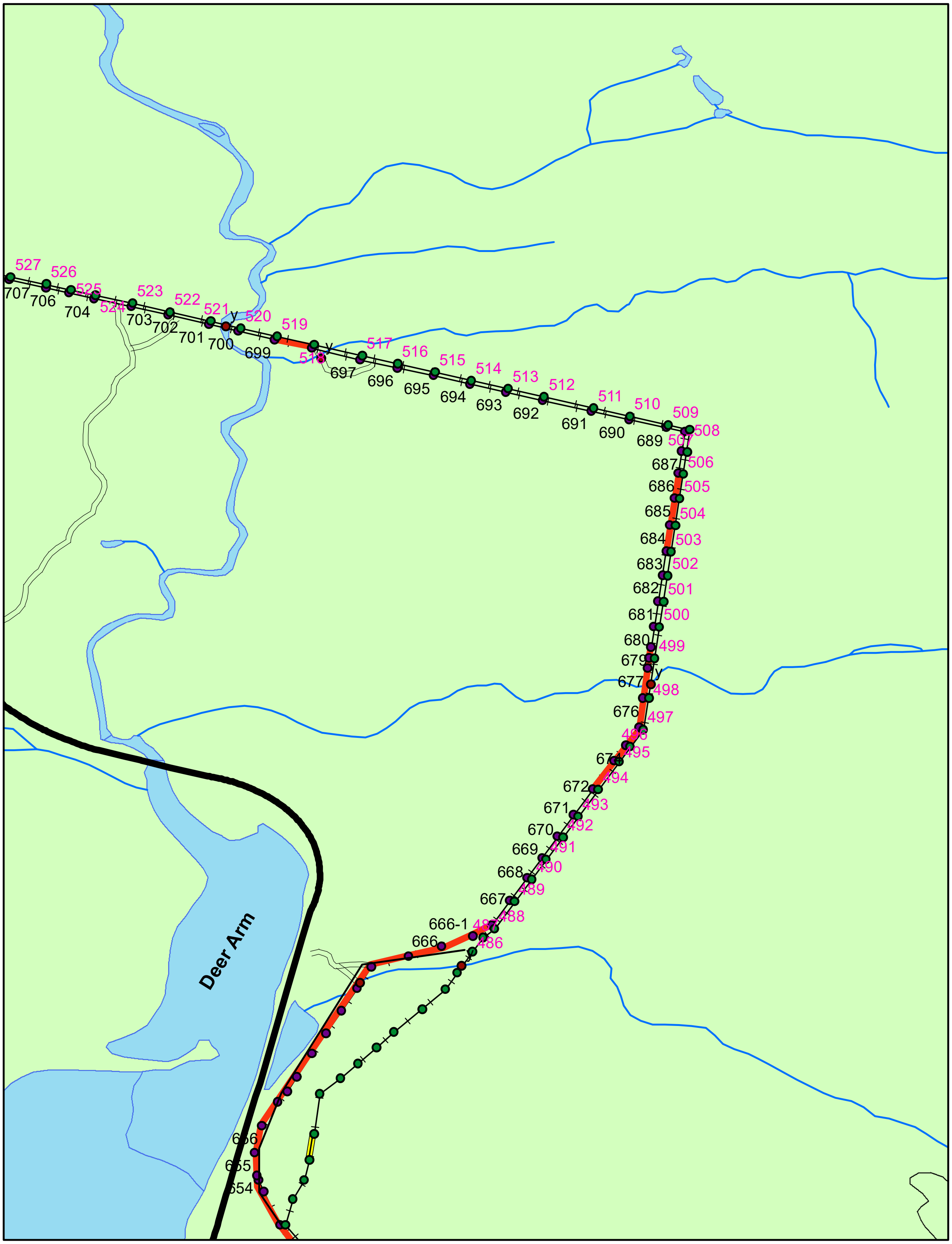
All access trails illustrated on this map are ATV access only unless otherwise labeled.

N

TL 226 and TL 239

Gros Morne Widening Program

newfoundland labrador hydro



Legend
- Fording Sites
- TL 239 structures
- TL 226 Structures
- TL 226 Access Trails
- TL 239 Center Line
- TL 239 Widening Area
- TL 226 Center Line
- TL 226 Widening Area

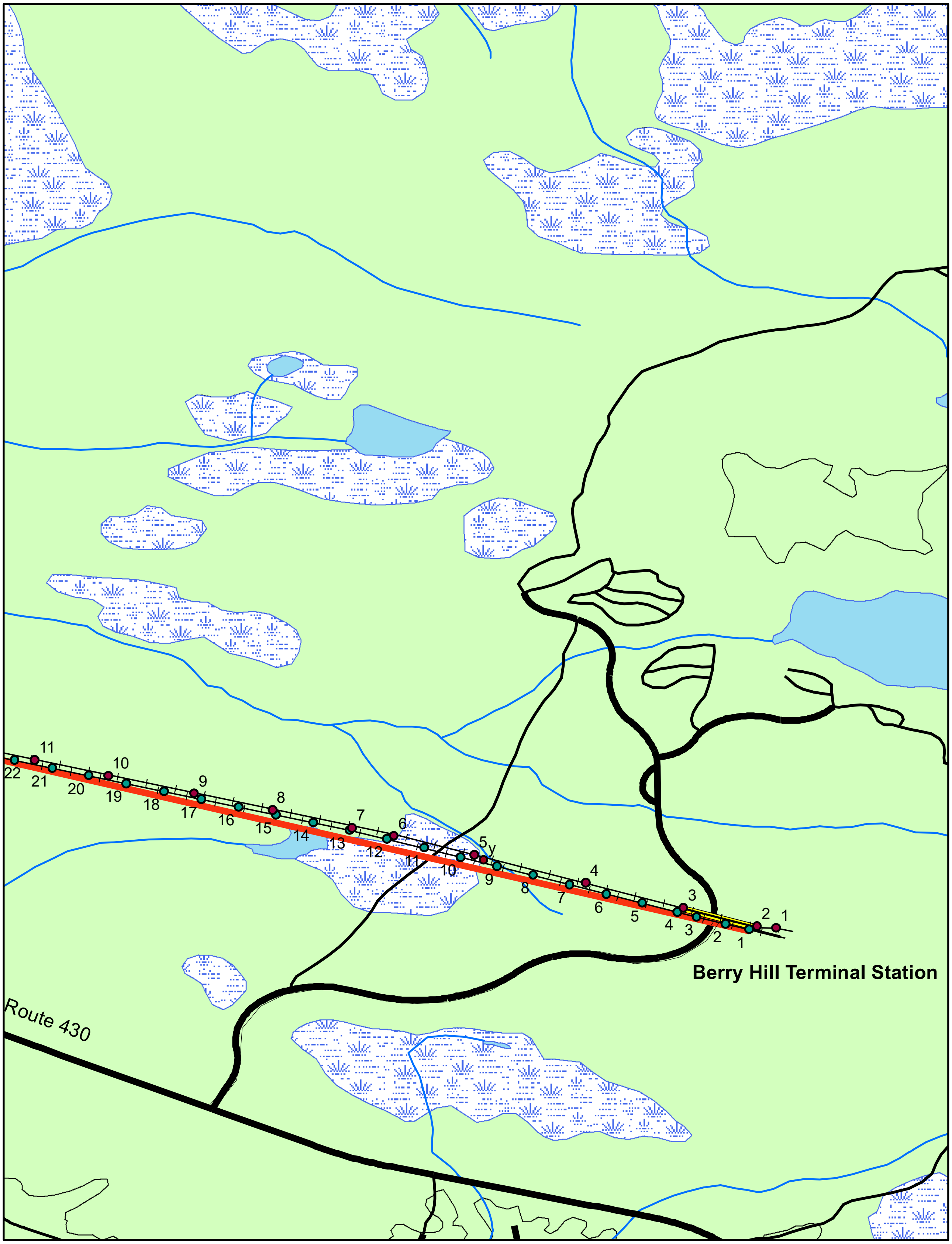
1:20,000

0 0.5 1 Kilometers

All access trails illustrated on this map are ATV access only unless otherwise labeled.

TL 227 and TL 259

Gros Morne Widening Program



1:20,000

0 0.5 1 Kilometers

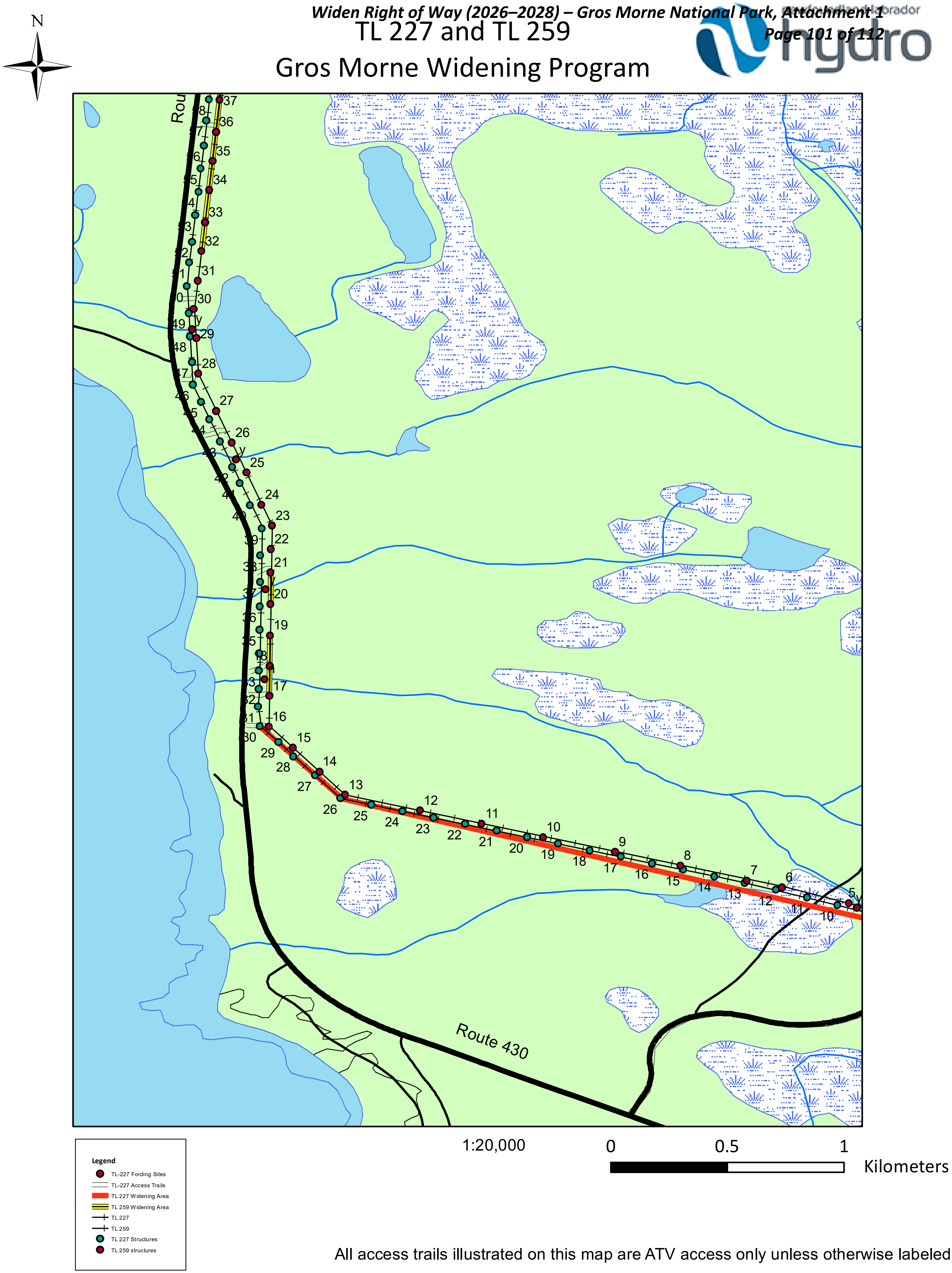
Legend

- TL-227 Fording Sites
- TL-227 Access Trails
- TL 227 Widening Area
- TL 259 Widening Area
- TL 227
- TL 259
- TL 227 Structures
- TL 259 structures

All access trails illustrated on this map are ATV access only unless otherwise labeled.

TL 227 and TL 259

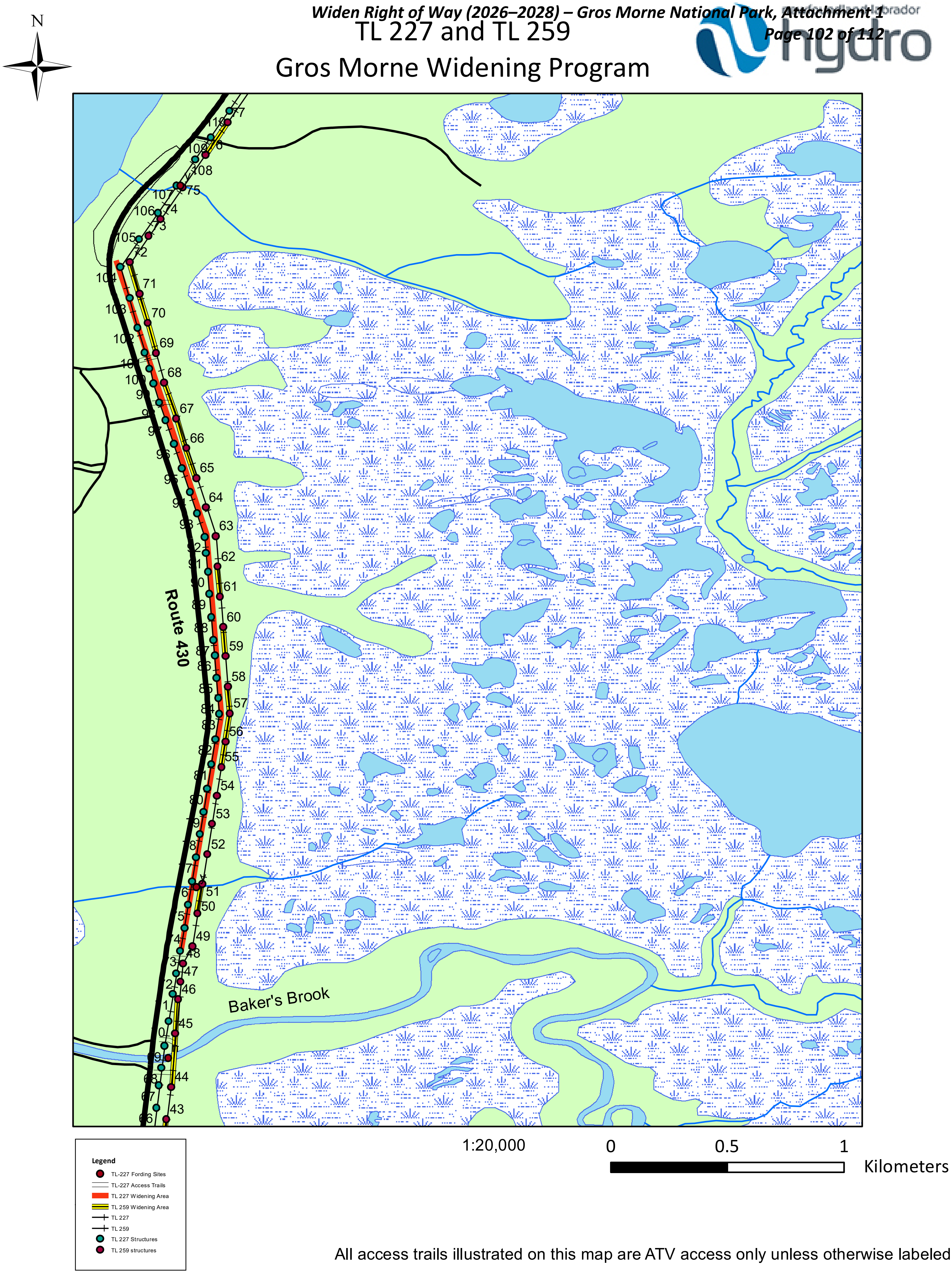
Gros Morne Widening Program



All access trails illustrated on this map are ATV access only unless otherwise labeled.

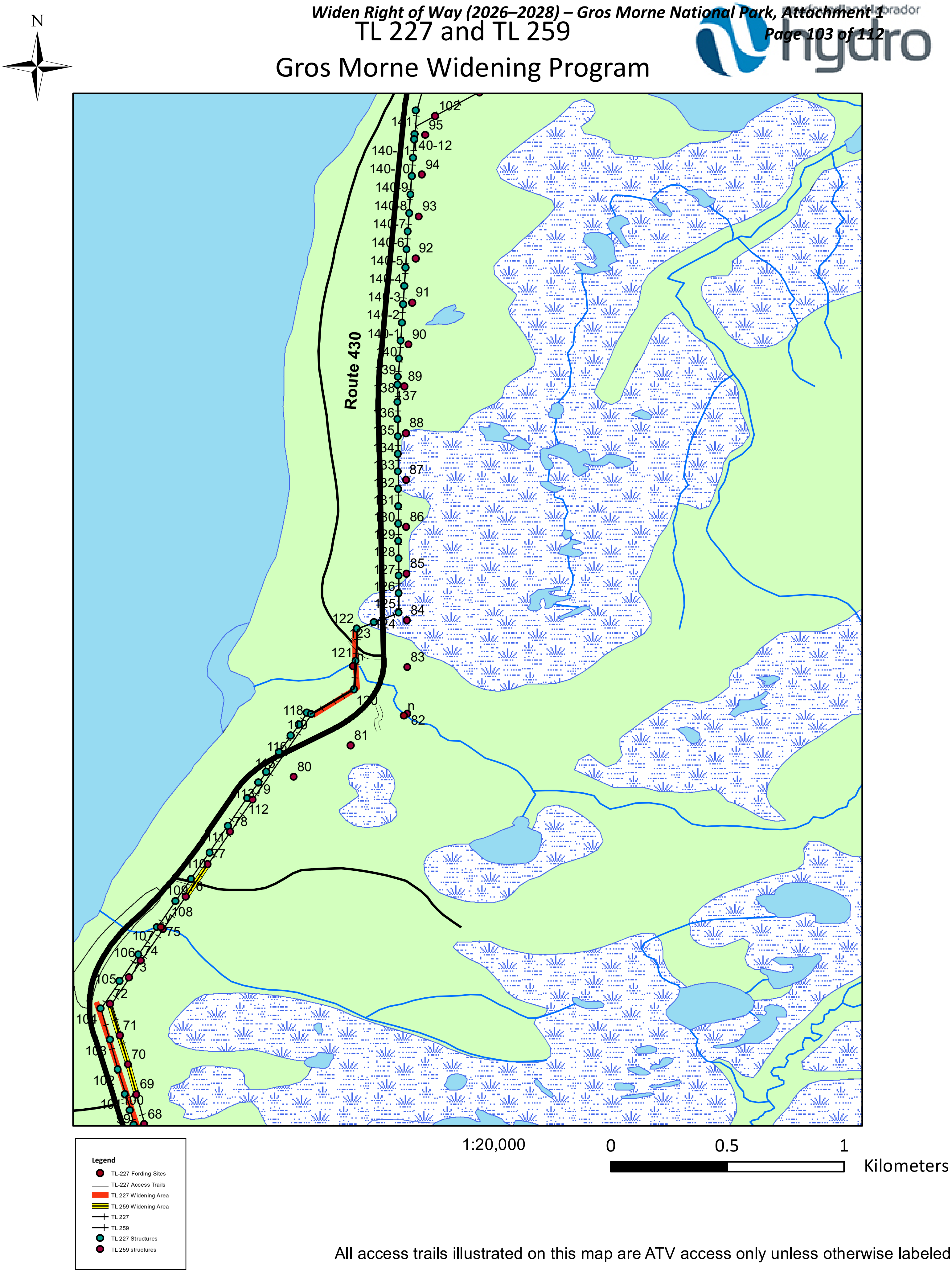
TL 227 and TL 259

Gros Morne Widening Program



All access trails illustrated on this map are ATV access only unless otherwise labeled.

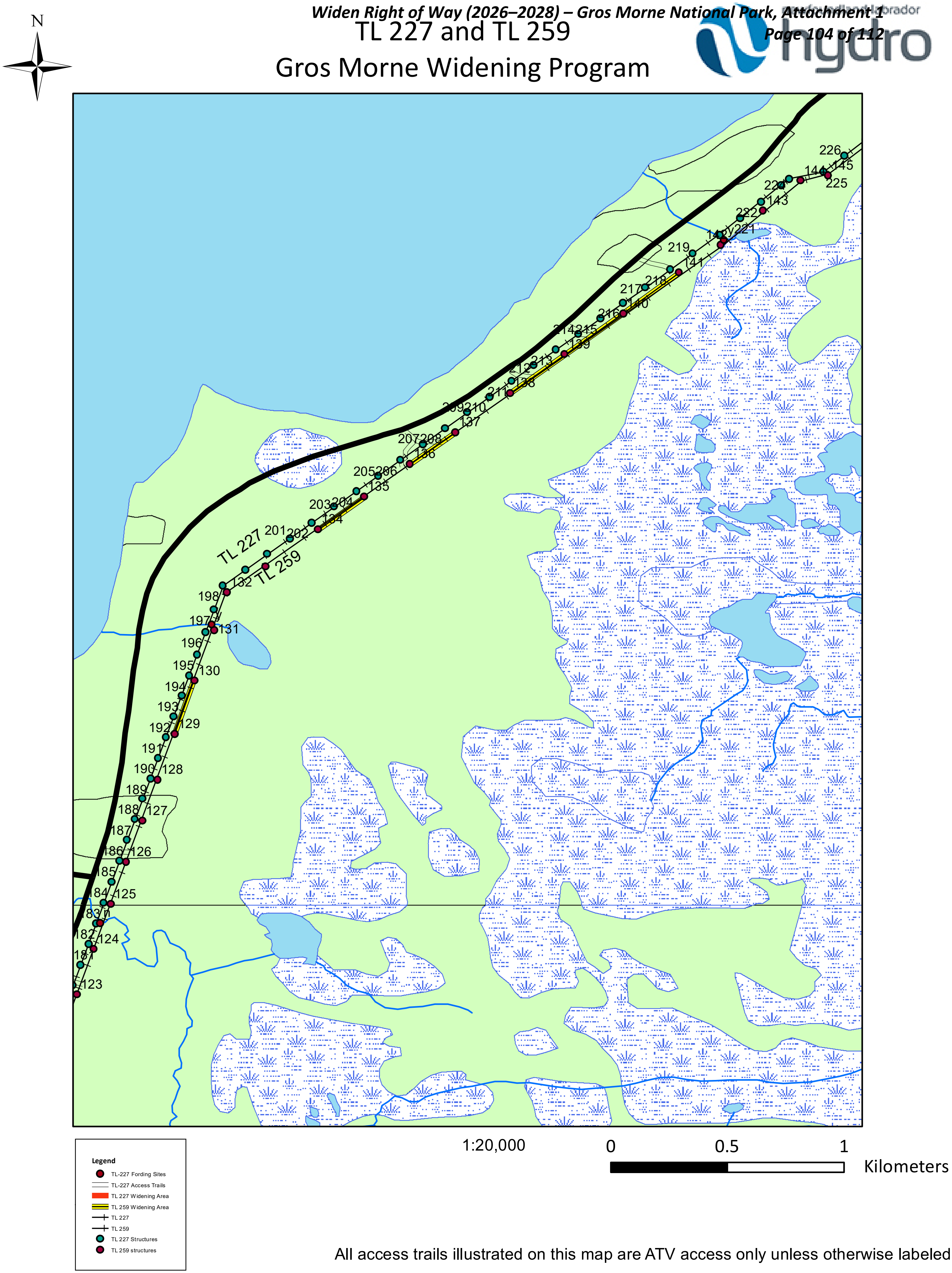
TL 227 and TL 259
Gros Morne Widening Program



All access trails illustrated on this map are ATV access only unless otherwise labeled.

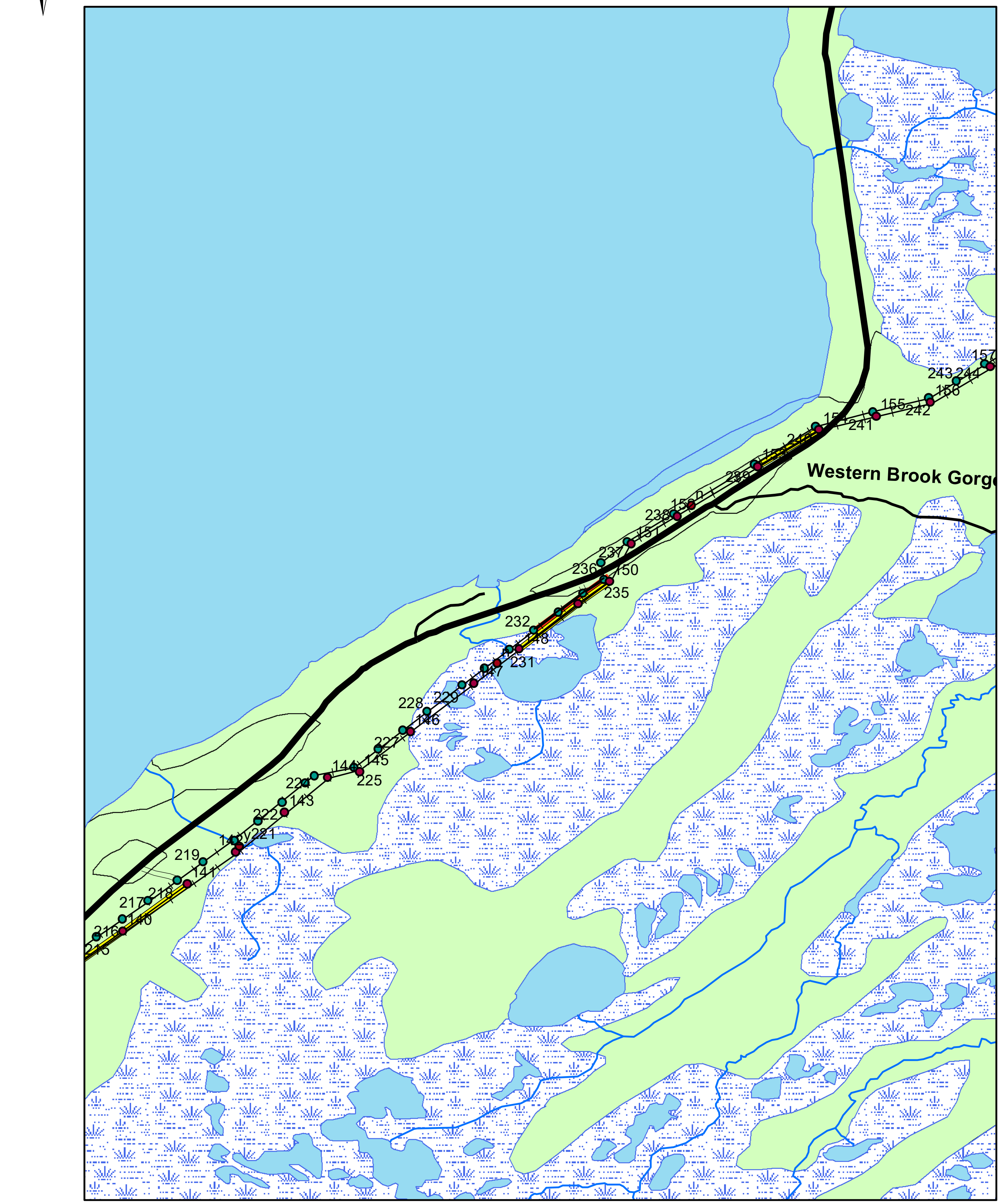
TL 227 and TL 259

Gros Morne Widening Program



All access trails illustrated on this map are ATV access only unless otherwise labeled.

TL 227 and TL 259
Gros Morne Widening Program

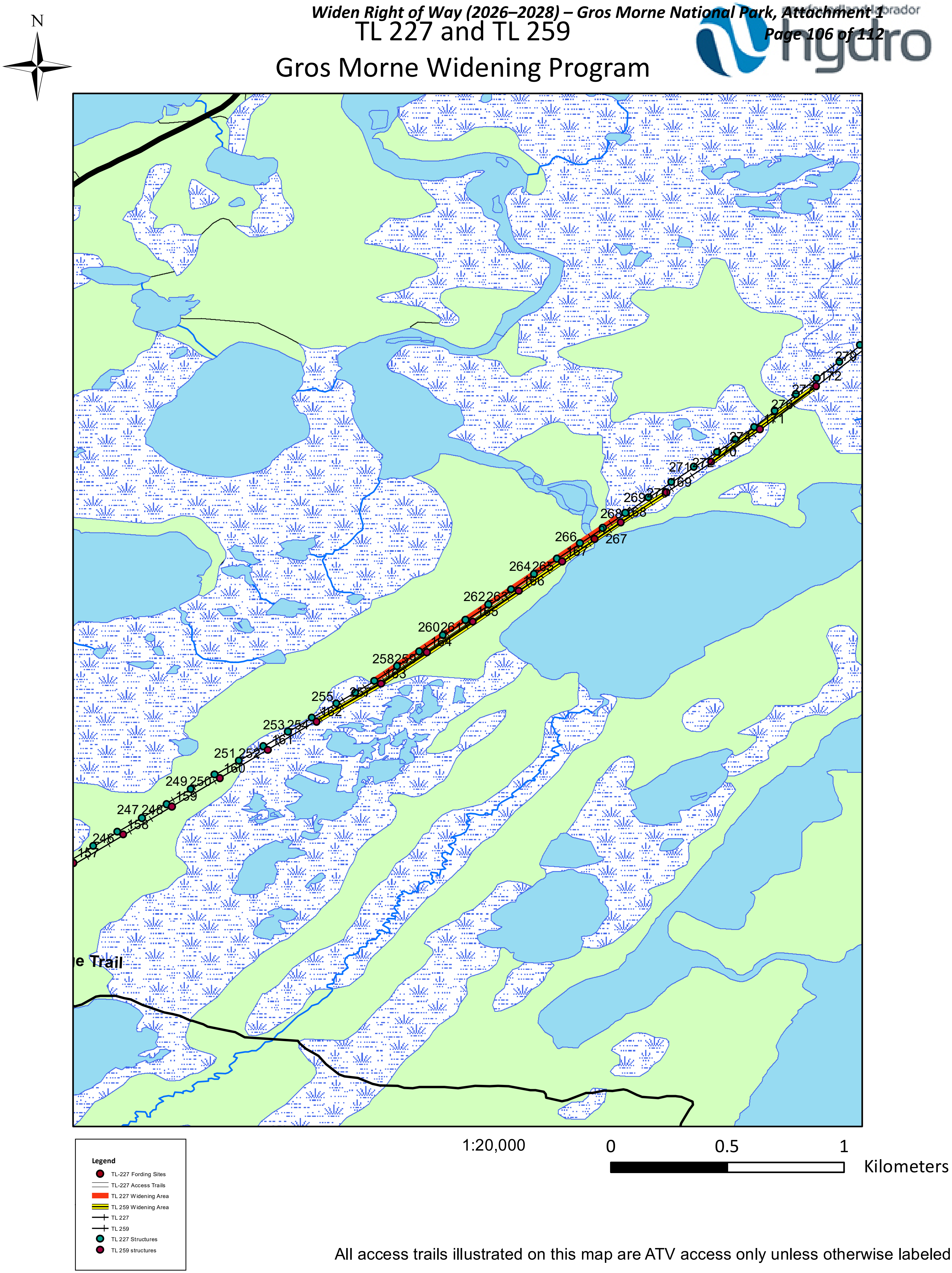


Legend
- TL-227 Fording Sites
- TL-227 Access Trails
- TL 227 Widening Area
- TL 259 Widening Area
- TL 227
- TL 259
- TL 227 Structures
- TL 259 structures

1:20,000 — 0 0.5 1 Kilometers

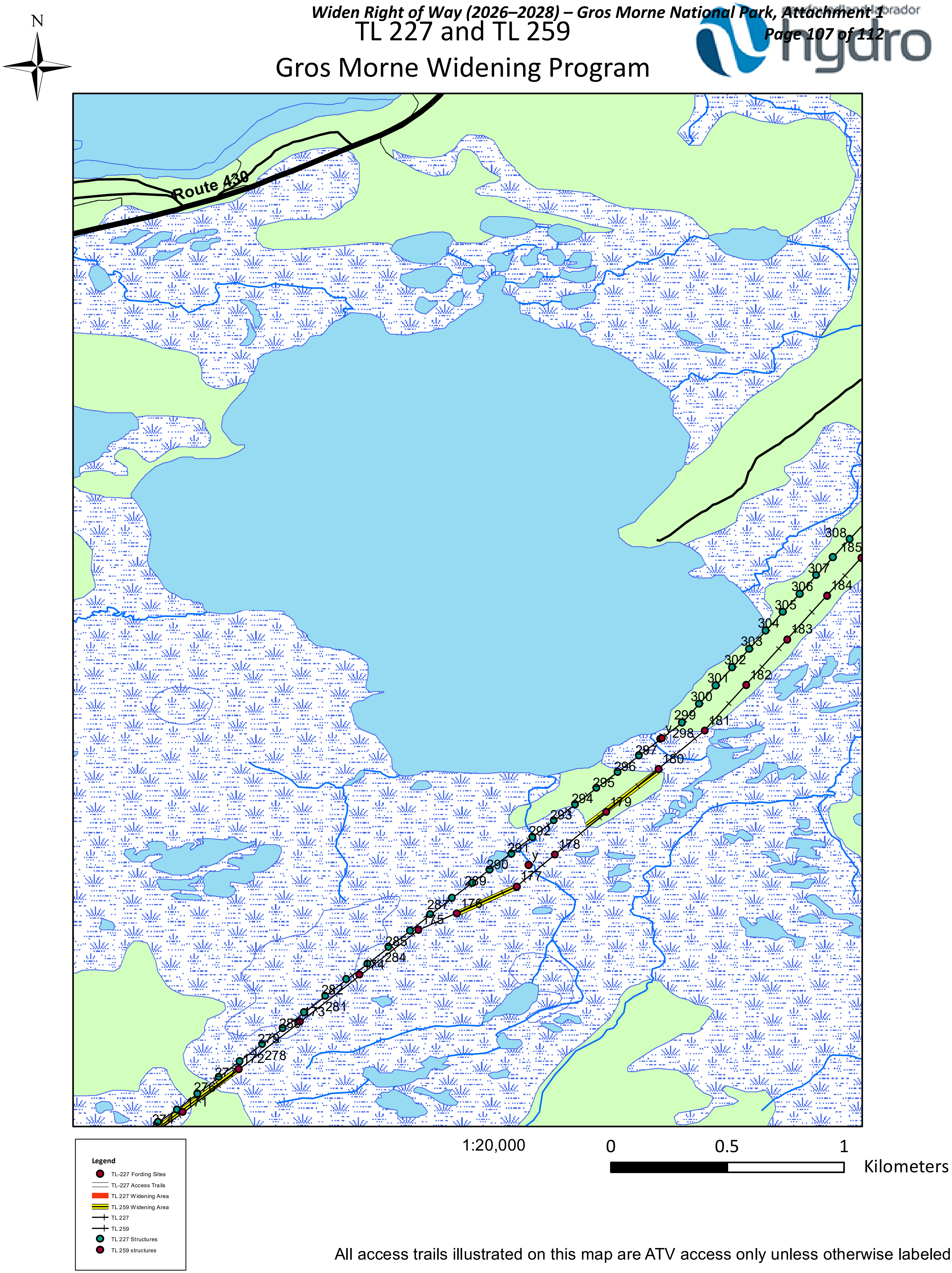
All access trails illustrated on this map are ATV access only unless otherwise labeled.

TL 227 and TL 259
Gros Morne Widening Program



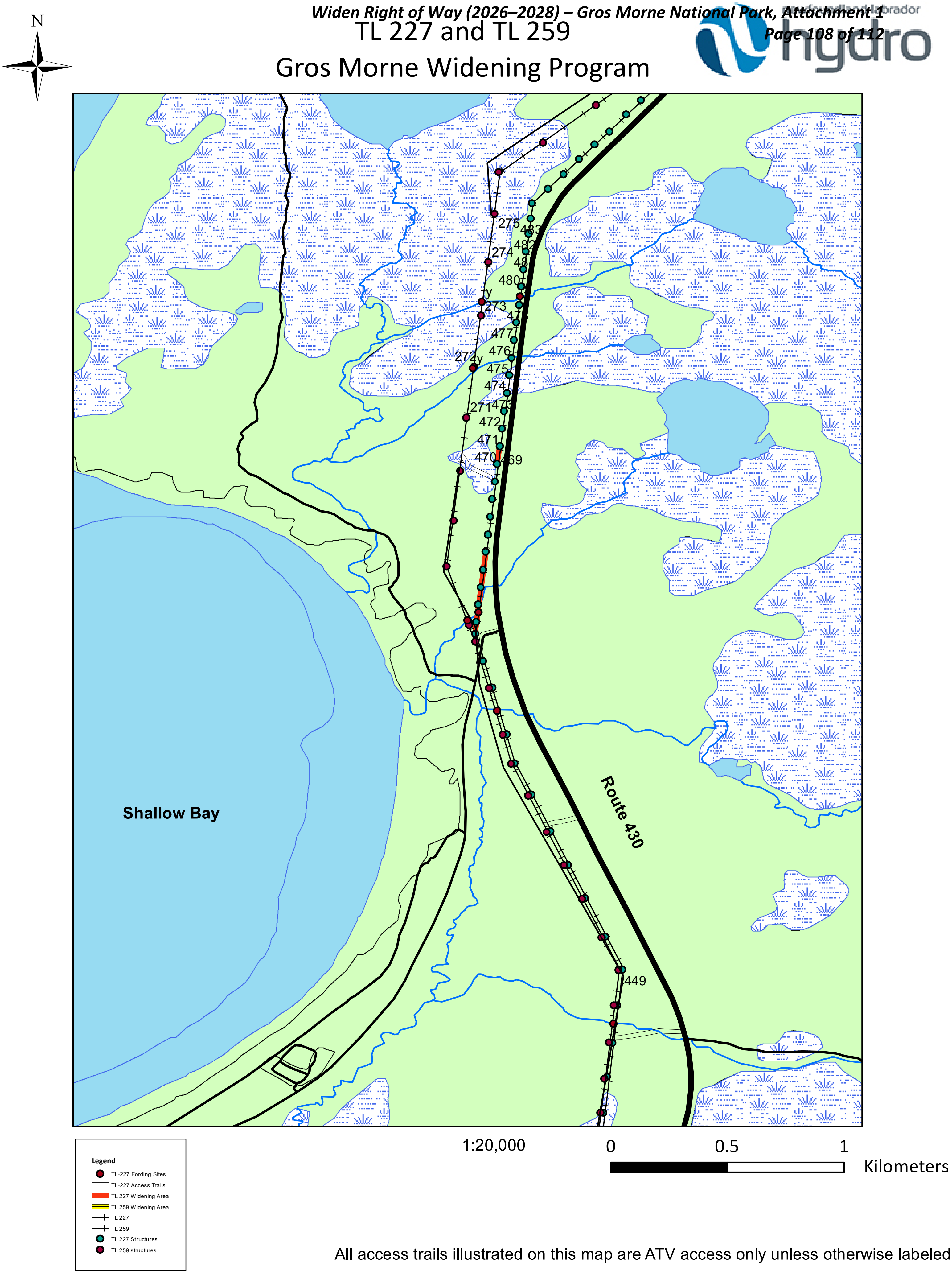
All access trails illustrated on this map are ATV access only unless otherwise labeled.

TL 227 and TL 259
Gros Morne Widening Program



All access trails illustrated on this map are ATV access only unless otherwise labeled.

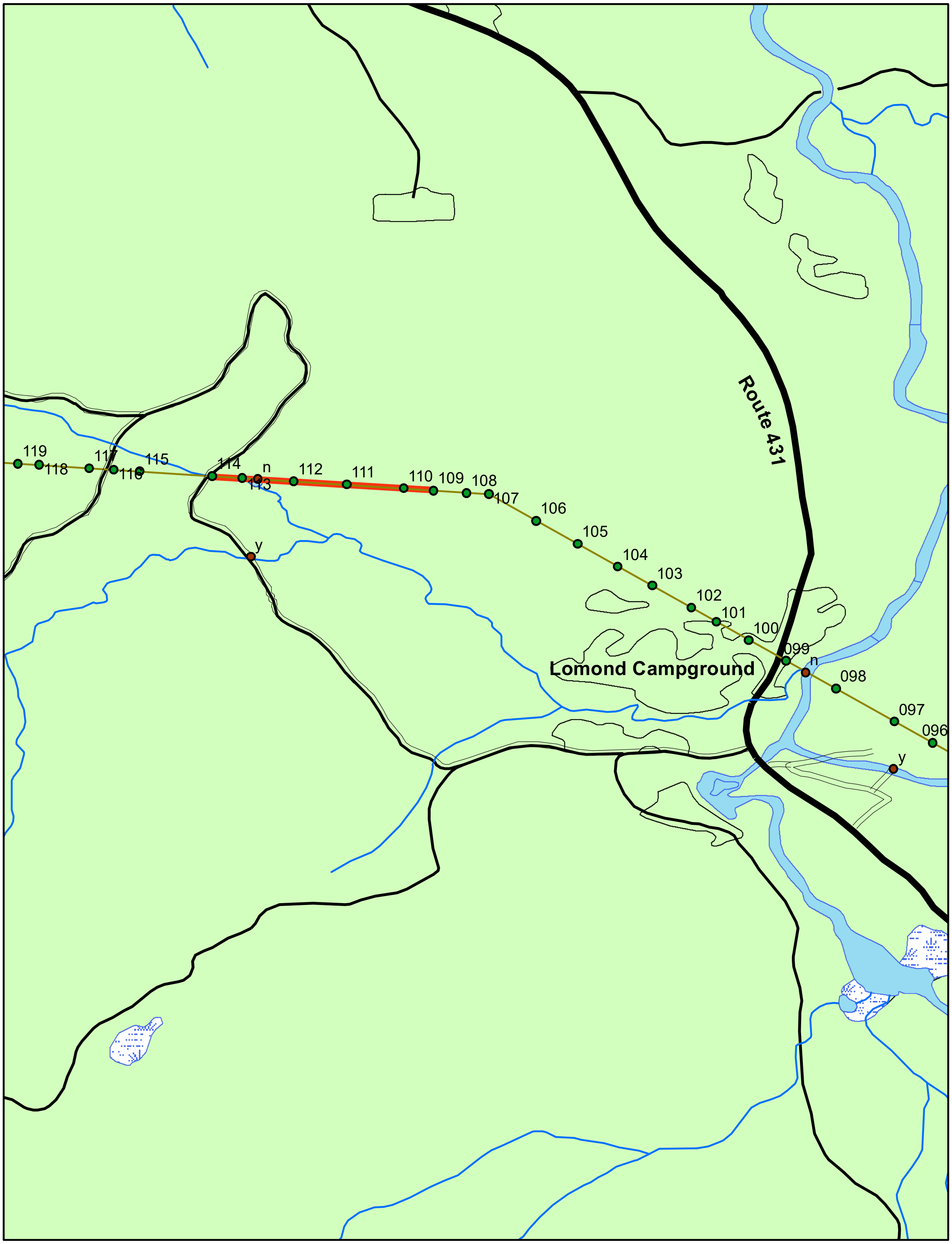
TL 227 and TL 259
Gros Morne Widening Program



All access trails illustrated on this map are ATV access only unless otherwise labeled.

TL 229

Gros Morne Widening Program



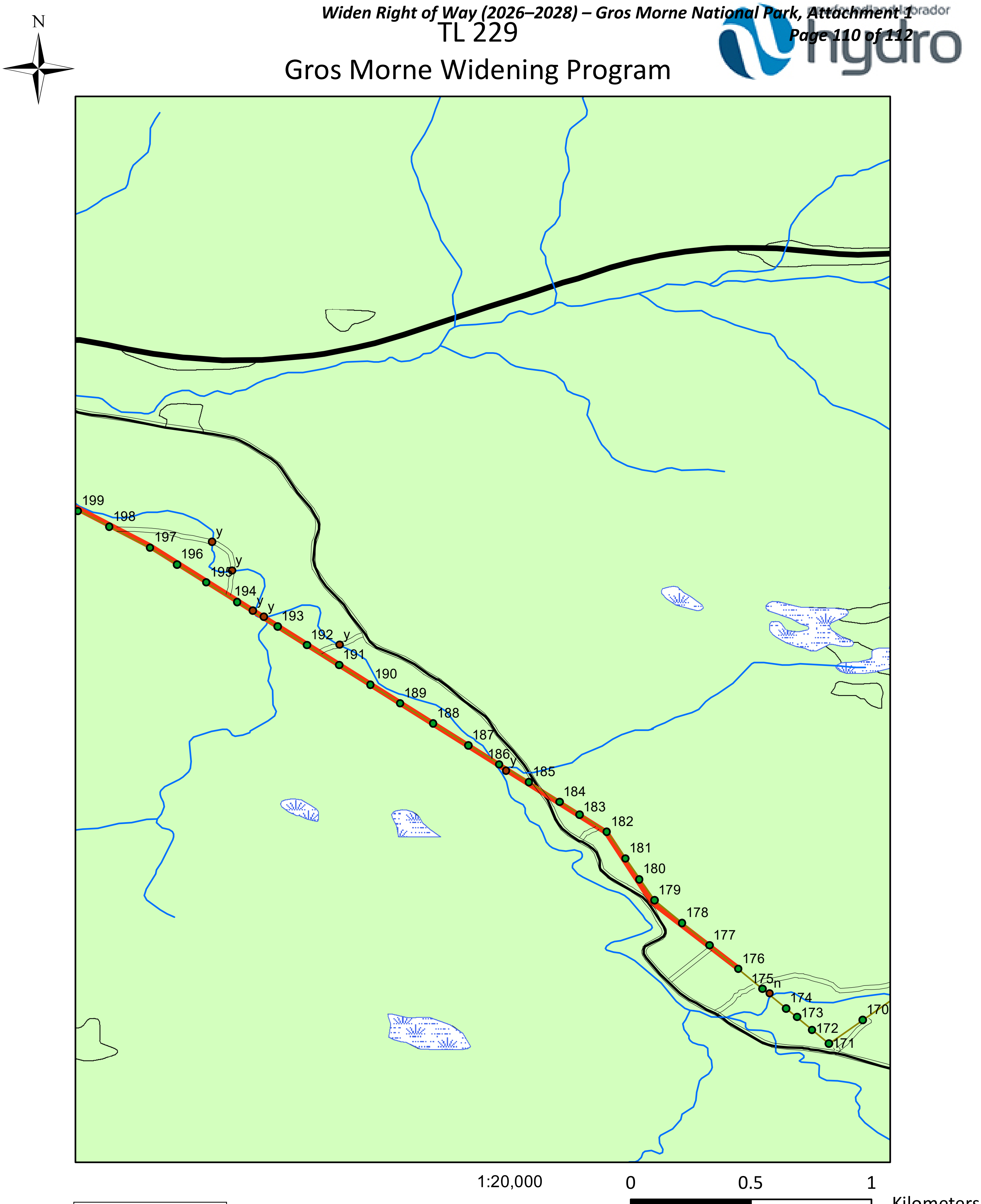
1:20,000 0 0.5 1 Kilometers

Legend

- Fording Sites TL 229
- TL 229 Structures
- TL 229 Access Trails
- TL 229 Center Line

All access trails illustrated on this map are ATV access only unless otherwise labeled.

TL 229
Gros Morne Widening Program



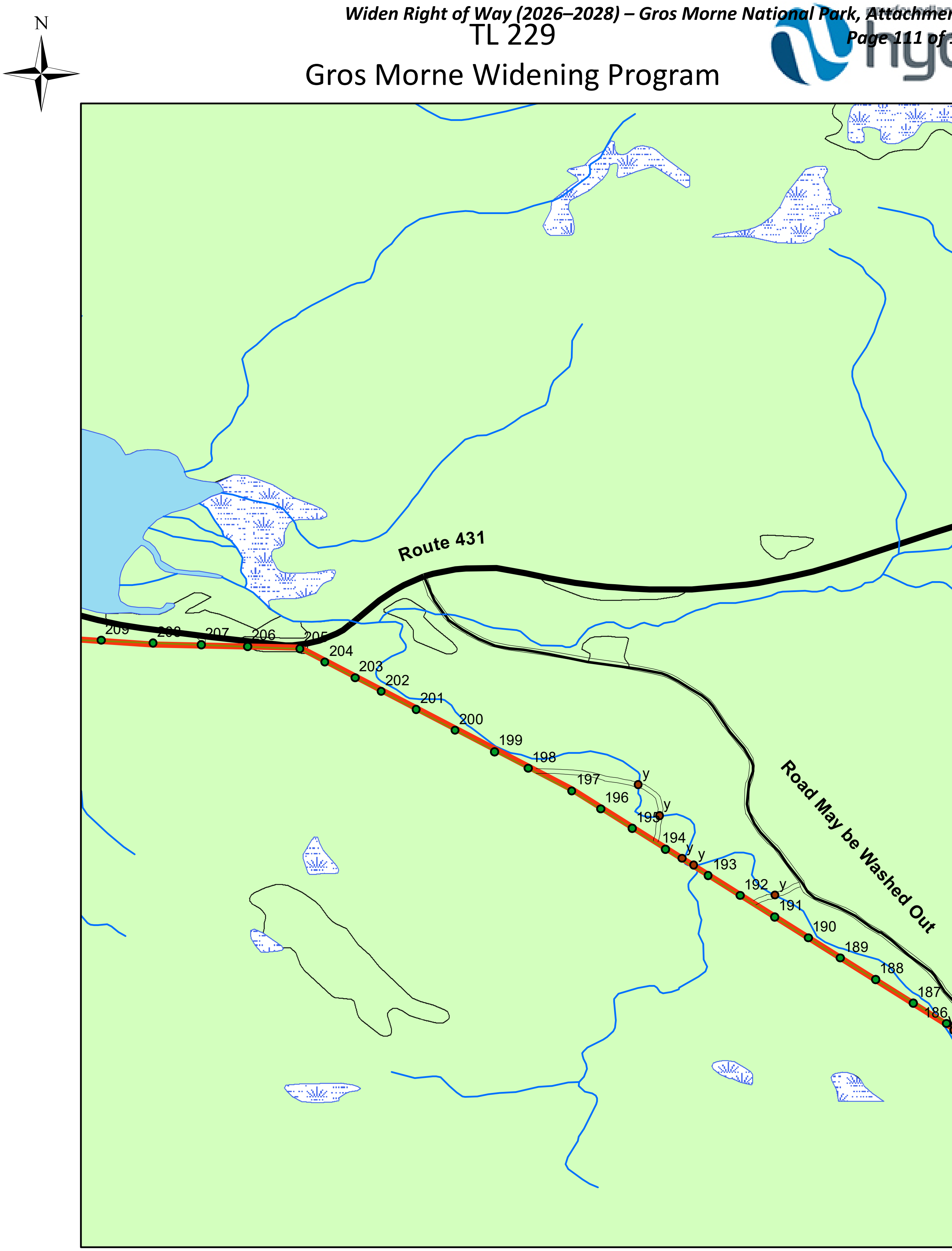
Legend

- Fording Sites TL 229
- TL 229 Structures
- TL 229 Access Trails
- TL 229 Center Line

All access trails illustrated on this map are ATV access only unless otherwise labeled.

TL 229

Gros Morne Widening Program



1:20,000 — 0 — 0.5 — 1 Kilometers

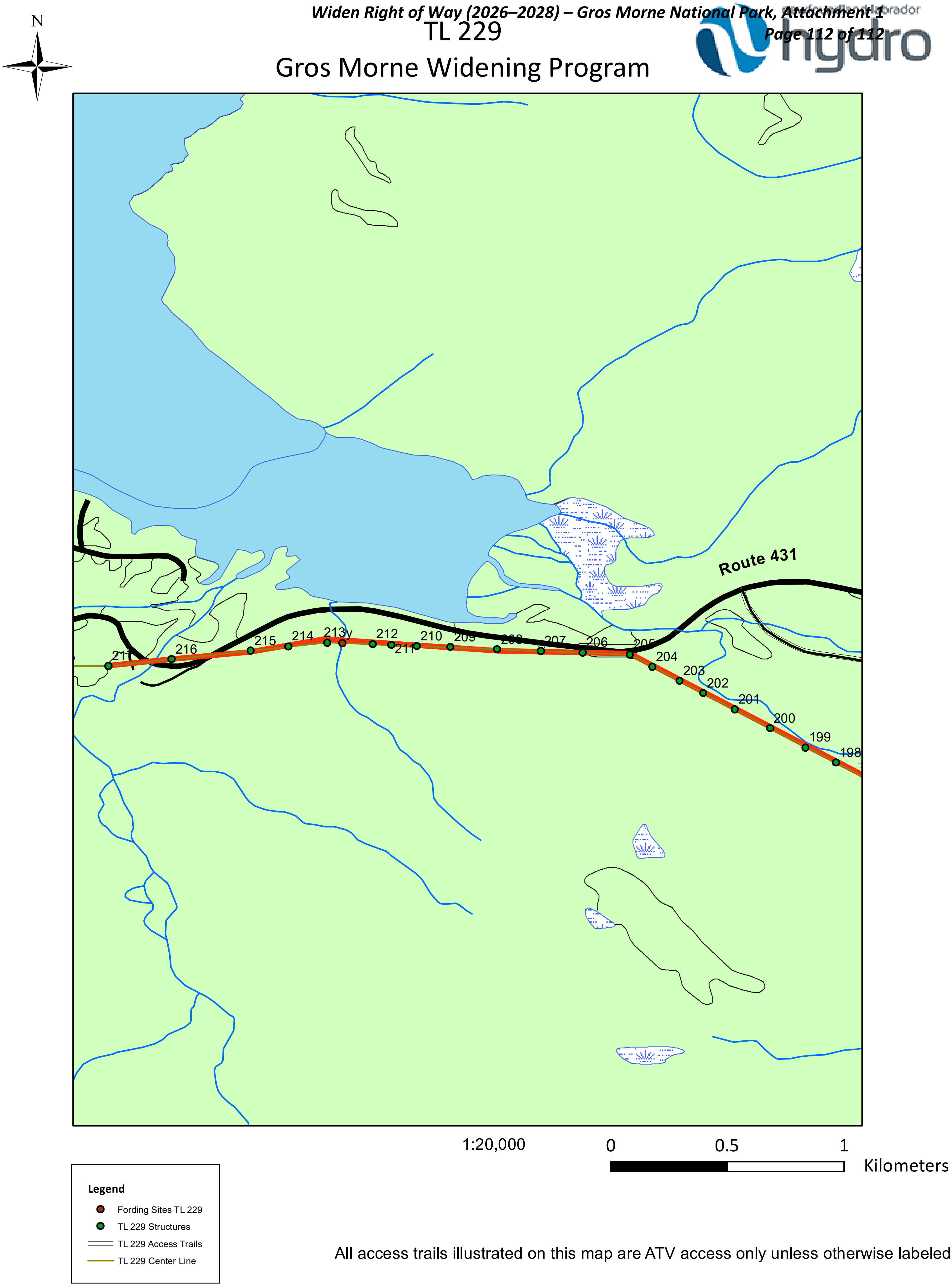
Legend

- Fording Sites TL 229
- TL 229 Structures
- TL 229 Access Trails
- TL 229 Center Line

All access trails illustrated on this map are ATV access only unless otherwise labeled.

TL 229

Gros Morne Widening Program



All access trails illustrated on this map are ATV access only unless otherwise labeled.

Attachment 2

Memorandum of Understanding

Parks Canada Agency

MEMORANDUM OF UNDERSTANDING REGARDING THE NEWFOUNDLAND AND LABRADOR HYDROTRANSMISSION LINES MODIFICATION PROJECT (the "MOU")

ENTERED INTO ON THIS 31st **DAY OF JULY 2024**

BETWEEN: **NEWFOUNDLAND AND LABRADOR HYDRO,** a corporation and agent of the Crown constituted by statute, renamed and continued by the Hydro Corporation Act, 2007 Chapter H-17 of the 2007 Statutes of Newfoundland and Labrador and having its head office at St. John's, in the Province of Newfoundland and Labrador ("**Hydro**")

AND: **PARKS CANADA AGENCY,** a Crown agency constituted and existing pursuant to the Parks Canada Agency Act, S.C. 1998, c. 31. **(the "Agency")**

WHEREAS Hydro operates and maintains five (5) transmission lines ((the "**Transmission Lines**") that pass through Gros Morne National Park ("**Park**"), as outlined in Schedule "A" attached..

AND WHEREAS The Transmission Lines are critical infrastructure, delivering electricity to more than 10,000 customers, including Park facilities, enclave communities, and all Northern Peninsula communities located north of the Park.

AND WHEREAS the Transmission Lines are situated within existing rights-of way, which were granted by the Agency to Hydro for the purpose of erecting, inspecting, maintaining and repairing the Transmission Lines, (the "**ROW's**").

AND WHEREAS Hydro manages vegetation in and around the Transmission Line along the ROW's to reduce the likelihood of unplanned service disruptions, associated with tree contact with the lines, and to allow a safe ROW for Hydro personnel to access the lines to perform inspections, maintenance, and repairs.

AND WHEREAS the ROW's are generally 50-60% as wide as those situated outside the Park and, as a result, higher service disruption rates are experienced with respect the Transmission Lines within the ROW's.

AND WHEREAS To improve service reliability, worker safety, Hydro proposes to selectively widen the ROWs, in prioritized high-risk areas, over a 5-year period, commencing in the fall of 2024 (the "**Project**").

AND WHEREAS in or about [-], Hydro conducted a Detailed Impact Assessment to develop, in co-operation with the Agency, an approved scope of the Project (the "**DIA**").

AND WHEREAS the Agency has agreed to allow Hydro to proceed with the Project in accordance with the DIA.

NOW THEREFORE THIS MOU WITNESSES that in consideration of the mutual covenants expressed, the Parties agree as follows:

1. **Commitments of Hydro and the Agency**:

    a. That Hydro shall be permitted, at its own cost and expense, to proceed with the Project in accordance with the DIA, including but not limited to selectively widen the ROW's as deemed necessary by Hydro to ensure the objectives of the DIA and the Project .

    b. That Hydro shall have a right of way, on the same terms and conditions of the ROW's over any land cleared as a part of the Project, (the "**Cleared Lands**").

    c. That any future renewals of the ROW's by the Agency shall be amended to specifically include the Cleared Lands.

2. **Governing Law:**

    a. This MOU shall be governed by the laws of the Province of Newfoundland and Labrador and federal laws of Canada applicable therein. With respect to any suit, action or proceedings relating to this MOU, each of the parties hereby irrevocably submits to the jurisdiction of the courts of Newfoundland and Labrador.

3. **Execution:**

    a. This MOU may be executed in any number of counterparts, each of which will be considered an original of this MOU, and which together will constitute one and the same instrument. No Party will be bound to this MOU unless and until all Parties have executed a counterpart. A facsimile signature or an otherwise electronically reproduced signature of either Party shall be deemed to be an original.

[signing page to follow]

July 31, 2024

Michael Ladha, K.C.
VP, Chief Legal Officer & Corporate Secretary
Newfoundland and Labrador Hydro

DATE

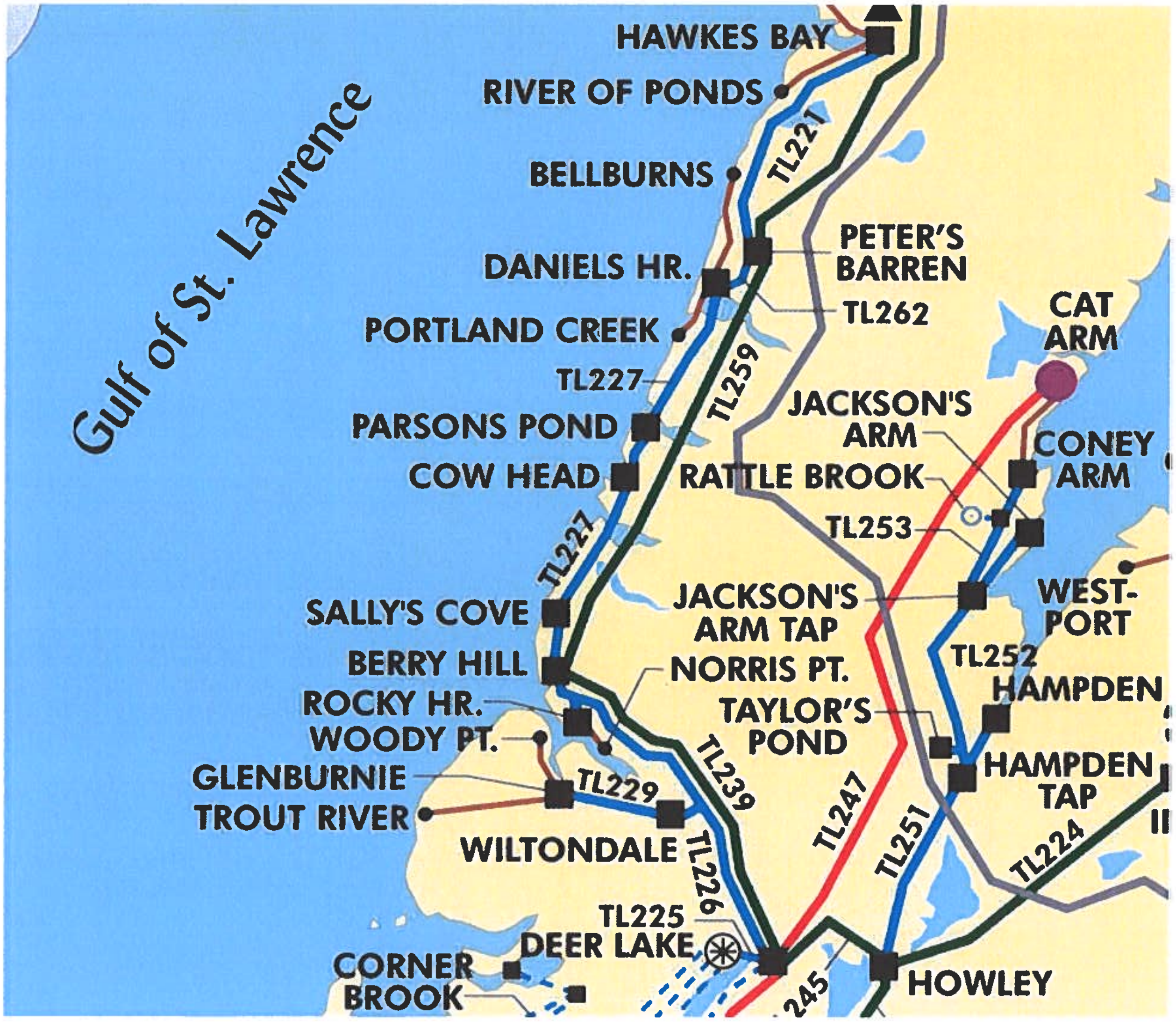
July 31, 2024

[NAME], [POSITION TITLE]
Parks Canada Agency
Geoffrey Hancock
Field Unit Superintendent
Gros Morne National Park

DATE

Schedule "A"

TL 226
TL 227
TL 229
TL 239
TL 259


Gulf of St. Lawrence
HAWKES BAY
RIVER OF PONDS
TL221
BELLBURNS
PETER'S BARREN
DANIELS HR.
TL262
PORTLAND CREEK
CAT ARM
TL227
TL259
PARSONS POND
JACKSON'S ARM
CONEY ARM
COW HEAD
RATTLE BROOK
TL253
TL227
WEST-PORT
JACKSON'S ARM TAP
SALLY'S COVE
TL252
BERRY HILL
NORRIS PT.
HAMPDEN
ROCKY HR.
TAYLOR'S POND
WOODY PT.
GLENBURNIE
HAMPDEN TAP
TL229
TL239
TROUT RIVER
TL247
TL251
WILTONDALE
TL226
TL224
TL225
DEER LAKE
CORNER BROOK
HOWLEY

Attachment 3

Notice of Determination

Notice of Determination

This notice of determination is being issued by Parks Canada under the *Impact Assessment Act* for the Newfoundland and Labrador Hydro (NL Hydro) Transmission Lines Modification Project Detailed Impact Assessment (DIA). Parks Canada has determined that the proposed project is not likely to cause significant adverse effects. Mitigation measures will be implemented for the following medium- and high-risk valued components: vegetation communities and species, viewscapes, and UNESCO World Heritage Site - Outstanding Universal Value (OUV) for scenic beauty. Additional mitigation measures will be implemented for low-risk natural resources, and visitor experience and safety valued components.

Proposed Project

NL Hydro is proposing to widen the Right of Way (ROW) corridors for five transmission lines that run through Gros Morne National Park. These lines are critical infrastructure, delivering electricity to national park facilities, enclave communities, and destinations north of the national park (i.e., over 9,000 customers). The transmission lines currently have higher service disruption rates than lines outside the park. The service disruptions are the result of ROWs within the park being 40-50% narrower compared to outside the park, which increases the likelihood of trees contacting the lines. Narrower ROWs also make repairs more difficult and dangerous and increase the risk of wildfires.

The proposed five-year (2024-2028) project will increase the five ROW widths from 9-15m to 19-29m within the park, depending on the terrain. A two-zone approach is proposed where the “wire zones” continue to be cleared of all trees and shrubs while selective removal of trees tall enough to reach the wire security area will occur in the “border zones”. All vegetation removal will be performed using manual methods (i.e., chainsaws, brush saws, pruning saws rather than heavy equipment). Crews will access sites by ATV and/or on foot via existing access trails. Utilizable wood will be cut, piled, and stacked for use by participants in Parks Canada’s domestic timber harvest program (once work in the area is complete). The total area of trees to be cleared during this project is estimated to be 33 hectares, distributed along the approximately 80km of transmission lines. The total transmission line area within Gros Morne National Park will increase from approximately 157 to 190 hectares.

Indigenous Consultation and Engagement

Parks Canada initiated discussions about the project with the Miawpukek and Qalipu First Nations in November 2023. In April 2024, both First Nations were provided the opportunity to review and provide feedback on the proposed project. In May 2024, the draft DIA report was also provided for their review and comment.

Public Engagement

Parks Canada and NL Hydro engaged with community members, approximately 100 identified stakeholders, and local governments, regarding the proposed project. Parks Canada and NL Hydro also met with municipal councils of enclave communities in February 2024, including the Town of Woody Point, Town of Trout River, Town of Glenburnie-Birchy Head-Shoal Brook, Town of Norris Point, Town of Rocky Harbour, Town of St. Paul’s, and Town of Cow Head.

Summary of Analysis

The DIA examined the risks and benefits of the Newfoundland and Labrador Hydro Transmission Lines Modification Project. The DIA considered “No Action” and “Status Quo” alternatives to the project, but ultimately it was determined that there is no viable alternative to the proposed ROW widening which will effectively mitigate the current service reliability issues and safety risks.

High or Medium-Risk Valued Components

Vegetation Communities and Species

Widening and future maintenance of the ROWs may negatively impact the vegetation communities (forests and wetlands) that the hydro lines pass through, as well as Endangered Vreeland’s Striped Coralroot, Threatened Black Ash, and locally significant Yellow Birch, White Pine, and Red Maple.

No vegetation clearing will occur in wetlands within the project area. Impacts to significant plant species will be mitigated through crew education/awareness, retaining trees wherever possible, and the use of manual and careful tree cutting practices. Management zones will also be established around individual Vreeland’s Striped Coralroot and Black Ash, where all vegetation is retained, and project activities are limited. Clean equipment protocols will be implemented, and ground disturbances will be minimized to limit the potential introduction or spread of invasive plant species to the project area.

Although the ROW widening will result in the permanent removal of approximately 33 hectares of forest, the impacts have been minimized to the greatest extent possible, using the two-zone approach. Impacts are also localized to the edges of the existing ROW and the scale of impacts constitutes a very small percentage of the overall park area. The desired outcome, to conserve healthy vegetation communities that maintain a native and biodiverse species composition, will be achieved.

Viewscapes

Vegetation removal may affect viewscapes within the park, which could negatively impact visitor experience. Parks Canada determined that 10 key viewscapes and areas within the park could be affected by the widening of the ROW for the project (2023).

The DIA provides mitigation measures for minimizing impacts to viewscapes. In addition to the implementation of the two-zone approach, which will retain shrubs and understory vegetation where possible, mitigations will include crew education/awareness and exploring tree planting as an option to enhance viewscape buffers. NL Hydro and Parks Canada will also collaborate closely to develop site-specific prescriptions for the 10 viewscapes and areas identified in the DIA.

Impacts to the viewscapes will be semi-permanent, extending for the duration of the hydro corridor maintenance program. Impacts will be localized and, with the implementation of mitigation measures, including the two-zone approach and the development of site-specific plans and detailed prescriptions, they have been minimized to the greatest extent possible. The desired outcome, to minimize the creation of new, and expansion of existing, undesirable visual impacts while supporting the safety and reliability of power delivery infrastructure, will be achieved.

UNESCO Outstanding Universal Value

The widening of the ROW corridors for five transmission lines may change viewscapes within the park and has the potential to affect the Park's UNESCO OUV for exceptional natural beauty (Criterion vii).

Given that the project will be widening existing ROW corridors within the park, the implementation of the two-zone approach, as well as the mitigations, site-specific plans and detailed prescriptions for viewscapes, the potential impacts from the project are expected to be localized and minimized to the greatest extent possible.

The Desired Outcome, for the maintenance of the OUV of the Park in relation to its scenic beauty (Criterion vii) and for the park to continue to be a "wilderness environment including landlocked, freshwater fjord and glacier-scoured headlands in an ocean setting and evidence of human intervention does not distract from the natural beauty" is expected to be achieved.

Low Risk Valued Components

Parks Canada identified the following low-risk natural resource and visitor experience VCs that the Project may interact with habitat connectivity, aquatic habitats/water quality, migratory birds, Threatened Red Crossbill, Threatened American Marten, Special Concern Woodland Caribou, Species at Risk bats, Moose, Soils, and Visitor Experience – Access and Safety. Impacts to these VC's are expected to be negligible to low given the scope and scale of the proposed project and following the implementation of the two-zone approach and other standard mitigation measures (e.g. timing windows). Significant adverse effects for low-risk VCs are not expected.

Monitoring

NL Hydro personnel will direct and monitor Project activities full-time. NL Hydro will continue to work collaboratively with Parks Canada throughout the Project execution phase and incorporate lessons learned and opportunities for improvement. Joint annual project reviews are recommended in addition to routine collaboration throughout the life of the Project.

The widened areas, or "border zones", where shrubs and small trees will be retained, will be monitored and scheduled for selective cutting or trimming once trees approach a height where they become an encroachment concern.

Conclusion

Taking into account the results of the DIA analysis and implementation of mitigation measures outlined in the assessment, Parks Canada has determined that the proposed NL Hydro Transmission Lines Modification Project is not likely to cause significant adverse effects.

To request a copy of the final Detailed Impact Assessment report, contact:

Gros Morne National Park
PO Box 130
Rocky Harbour, Newfoundland and Labrador A0K 4N0
Telephone: 709-458-2417
Email: grosmorne@pc.gc.ca

Overhaul Major Pumps

(2026)

Holyrood

Contents

Overhaul Major Pumps (2026)

Location: Holyrood

Investment Classification: Renewal

Asset Category: Thermal Plant

Estimated Cost: $2,388,600

1.0 Introduction

The Holyrood Thermal Generating Station ("Holyrood TGS") is a critical part of the Island Interconnected System and is required to provide safe and reliable electricity. It has three generating units: Units 1, 2, and 3, with a total generation capacity of 490 MW.

There are 24 major pumps within the three generating units at the Holyrood TGS, as follows:

- Two boiler feed ("BF") pumps (east and west) per generating unit;
- Two cooling water ("CW") pumps (east and west) per generating unit;
- Two vacuum pumps (north and south) per generating unit; and
- Two condensate extraction ("CE") pumps (north and south) per generating unit.

All of these pumps are currently overhauled on an average interval of 12 years, except for the BF pumps, which are typically overhauled on a six-year cycle, depending on the condition of the pump's internal components. The overhaul interval is based on original equipment manufacturer ("OEM") recommendations, industry standards, and Newfoundland and Labrador Hydro's ("Hydro") operational experience. This overhaul schedule is also consistent with the Life Extension Condition Assessment ("LECA") as conducted by Hatch Ltd. ("Hatch") as part of the *Reliability and Resource Adequacy Review* proceeding ("*RRA Study Review*").[1]

Despite continued maintenance and refurbishment of major pumps at the Holyrood TGS, reliability and operational issues have persisted due to their age and deterioration. When the LECA was refreshed in

[1] "*Reliability and Resource Adequacy Study Review* – Assessment to Determine the Potential Long-Term Viability of the Holyrood Thermal Generating Station," Newfoundland and Labrador Hydro, March 31, 2022, att. 2.

March 2025,[2] a review of the failure history of CW, vacuum, and CE pumps indicated that failures are occurring within the 12-year overhaul cycle. As such, it was recommended to reduce the overhaul interval for these major pumps to be less than 12 years, and to include the pump motor in the overhaul plan. The recommendation to include the pump motor in the overhaul plan is also reflected in Hydro's five-year capital plan forecast expenditures for similar projects, and has been incorporated into the scope of this proposal.

This project encompasses the overhaul of four pumps, including pump motors: Unit 1 West BF Pump, Unit 1 East CW Pump, Unit 1 South CE Pump, and Unit 2 South CE Pump.

As identified through the *RRA Study Review*[3] the Holyrood TGS shall remain available for a "Bridging Period"[4] until 2030, or until such time that sufficient alternative generation is commissioned, adequate performance of the Labrador-Island Link is proven, and generation reserves are met. At this time, capital investment related to the generation function of the Holyrood TGS, such as the overhaul of major pumps, is necessary to support system reliability and maintain Hydro's ability to meet customer demand during peak periods.

2.0 Project Description and Justification

This project involves the completion of inspections and associated refurbishments and replacements for the overhaul of four major pumps, including pump motors, at the Holyrood TGS. These pumps are the Unit 1 West BF Pump, Unit 1 East CW Pump, Unit 1 South CE Pump, and Unit 2 South CE Pump, which are due for overhaul.

The Unit 1 West BF Pump was last overhauled in 2020 and is due for overhaul in 2026. The Unit 1 East CW Pump and Units 1 and 2 South CE Pumps were last overhauled in 2014 and are due for overhaul in 2026. Despite continued maintenance and refurbishment of major pumps at Holyrood TGS, reliability and operational issues have occurred due to their age and deterioration. Completing these overhauls

[2] "*Reliability and Resource Adequacy Study Review* – Holyrood Thermal Generating Station Capital Plan Refresh," Newfoundland and Labrador Hydro, March 7, 2025, att. 1.

[3] "2024 Resource Adequacy Plan – An Update to the Reliability and Resource Adequacy Study," Newfoundland and Labrador Hydro, rev. August 26, 2024 (originally filed July 9, 2024).

[4] Hydro considers the Bridging Period to be from the present to 2030. During the Bridging Period, the system would rely primarily on existing sources of generation capacity to maintain reliability while new generation capacity is being built. The primary, readily available supply options in this period are extending the retirements of the Holyrood TGS, Stephenville Gas Turbine and the Hardwoods Gas Turbine until their capacities can be adequately replaced.

will decrease the likelihood of in-service failures of the pumps during the 2026–2027 winter operating season, therefore contributing to continued safe and reliable operation at the Holyrood TGS through a reduction in forced outages and unit deratings.

Following the receipt of the 2025 Capital Budget Application ("CBA") Board of Commissioners of Public Utilities ("Board") Order No. P.U. 28(2024), Hydro conducted a review of the classification of its programs within the 2025 CBA and determined that due to the nature of the assets being replaced (i.e., individual asset values higher than the lowest materiality threshold), the scope of work contained in overhaul proposals for major pumps was more appropriately defined as a project. As a result, Hydro has provided the information within this proposal as required by the provisional CBA Guidelines[5] relating to projects.

3.0 Asset Overview

3.1 Asset Background

3.1.1 Boiler Feed Pumps

Each generating unit has two identical BF pumps (east and west). The two BF pumps receive water from the deaerator tank and deliver it to high-pressure heaters and then to the boiler. Each pump can individually provide 50% of the high-pressure feedwater required for steam production in the Unit 1 boiler to support 50% of the generation capability of Unit 1. When operating together, they can support the total generation capability of Unit 1 (170 MW). A spare volute impeller cartridge is maintained in inventory for Units 1 and 2 BF Pumps, which is rotated through all four pumps in Units 1 and 2 during their planned overhauls. The Unit 1 West BF Pump is shown in Figure 1 and was installed in 1969.

BF pumps are subjected to high temperatures, high pressure, and high flow velocity; all of which contribute to significant degradation of the equipment. If an overhaul is not completed, the pump could fail during operation. Such a failure would lead to a reduction of 50% MW of the generating capacity from Unit 1 for several weeks. An overhaul is necessary to maintain Hydro's safety and reliability standards, including Hydro's ability to meet customer demand during peak periods.

[5] "Capital Budget Application Guidelines (Provisional)," Board of Commissioners of Public Utilities, January 2022.

Figure 1: BF Pump

3.1.2 Cooling Water Pumps

The Unit 1 East CW Pump is one of two identical vertical pumps (Figure 2) inside Pumphouse 1. The two CW pumps share the required capacity to supply seawater to the condenser to cool steam after it exits the turbine, and also cooling water for other closed-loop systems. Both CW pumps are needed for Unit 1 to produce its full generating capacity of 170 MW. With one pump in service, the unit can produce about 50% of its generating capacity.

The Unit 1 East CW Pump is a single-stage pump that draws ocean water through a set of travelling screens to filter debris. The pump supplies CW to the condenser inside the powerhouse through 60-inch discharge piping that is extended underground from Pumphouse 1 to the powerhouse. It is necessary that the CW systems operate efficiently to maintain optimal plant thermal efficiency by minimizing steam turbine condenser backpressures.

Figure 2: CW Pump

3.1.3 Condensate Extraction Pumps

Each of the Unit 1 and Unit 2 South CE pumps (Figure 3) is a vertical canister pump that circulates condensate water through the gland steam condensers, the low-pressure heaters, and then into the deaerator. The CE pumps support the condensate system by removing condensate from the condenser.

Inefficient condensate removal affects power generation, potentially causing fluctuations in output and requiring more frequent maintenance. Moreover, inadequate condensate extraction poses risks of equipment damage and safety hazards, including turbine overheating and potential failures. A degraded CE pump can lead to reduced efficiency, decreased performance, and increased operating costs. The most likely issues leading to pump degradation are failure of the seals, bearings, and impeller. In addition, failure of a CE pump or its motor would cause a loss of 60% of the unit's generation.

Figure 3: CE Pump

3.2 Historical Reliability

Hydro tracks performance data for its thermal generation units using the Derated Adjusted Forced Outage Rate ("DAFOR");[6] this data is filed quarterly with the Board.[7] This overhaul allows Hydro to continue minimizing the DAFOR of its thermal generation units to ensure the provision of reliable service to customers.

[6] DAFOR is a metric that measures the percentage of time that a unit or group of units is unable to generate at its maximum continuous rating due to forced outages or unit deratings.
[7] Most recent "Quarterly Report on Asset Performance in Support of Resource Adequacy for the Twelve Months Ended March 31, 2025," Newfoundland and Labrador Hydro, April 30, 2025.

3.3 Asset Condition

The pumps for Units 1 and 2 included in the overhaul scope under this project are 55 years old. These pumps are subjected to different degradation mechanisms such as fatigue cracking, corrosion, and erosion under operating conditions such as high temperature, pressure, and flow velocity.

Overall, the Holyrood TGS has experienced minimal issues with reliability on the Unit 1 and 2 major pumps. This is due to the continued overhaul of the major pumps as per the OEM recommended cycles and alignment with industry best practices. However, Hydro has noted increased issues in recent years related to the age of the pumps, based on which an increase in overhaul frequency is warranted. Overhaul of the pumps on the established intervals is required to ensure pumps continue to operate reliably and to reduce the risk of in-service failures, which lead to forced derating or outage of generating units.

4.0 Analysis

4.1 Evaluation of Alternatives

Hydro evaluated the following alternatives:

- Deferral;
- Condition-based refurbishment; and
- Overhaul.

4.1.1 Deferral

To determine the time interval between overhauls, Hydro considers several factors, including, but not limited to: asset condition, reliability and criticality, frequency of operation, OEM recommendations, third-party assessments, industry standards, and Hydro's operational experience. Deferral of this project increases the failure risk of major pumps while in operation, which could result in a forced outage or derating of the generating unit for several weeks.

Parts are not readily available for these pumps due to their age. In the event of failure, reverse engineering and/or fabrication of required parts may be required, which would significantly extend the overhaul schedule time. In addition, the pumps are large, possibly requiring disassembly and shipping off-site for refurbishment. Completing the overhauls on a planned outage, with a scheduled timeslot in a pump service facility, is the prudent approach, as a major pump in-service failure has the potential for an extended forced derating of 50% of the unit's generating capacity, lasting up to several months. Further, an in-service failure of a major pump may cause additional damage to pump components, potentially resulting in additional repair costs and loss of production when compared to the cost of a planned overhaul.

4.1.2 Condition-Based Refurbishment

Hydro collects some condition-related data from installed instrumentation while the pumps are in service. Additional data is collected through measurements and testing performed during annual preventive maintenance. The data collected through each of these means has not proven to be adequately comprehensive to inform an accurate prediction as to whether the unit can operate reliably through to the next planned overhaul. Hydro has determined that, due to the limited information available, the condition of the major pumps cannot be adequately determined through external inspection or monitoring instrumentation to ensure the continued reliability of the major pumps. To assess the condition of internal components, disassembly of the major pumps is required. As such, condition-based refurbishment of major pumps is not a viable alternative.

4.1.3 Overhaul

This alternative consists of planned disassembly, detailed internal inspection, refurbishment or replacement as required, and reassembly of internal components of the major pumps and their motors. Components that have been identified as damaged in the inspections are refurbished or replaced.

This alternative aligns with Hydro's experience and OEM recommendations, including in the original and refreshed LECA, as conducted by Hatch as part of the *RRA Study Review*. The pumps identified as part of this project scope were selected in line with these recommendations, which allow Hydro to manage risk within an acceptable level.

4.1.4 Alternative Strategies

Hydro maintains spares in its inventory for major pump components. This reduces downtime in the event of an in-service failure of major pumps; however, time will still be required for the disassembly, installation, and reassembly of pumps should an in-service failure occur. This strategy also increases the availability of major pumps to contribute to the reliable operation of the generating units; however, it is not an alternative to the planned overhaul as per the established intervals.

4.2 Least-Cost Evaluation

Hydro has not identified any viable alternatives to facilitate a least-cost evaluation.

4.3 Recommended Alternative

Hydro recommends the overhaul of the major pumps included in this project in 2026. Overhauling the Unit 1 West BF Pump, Unit 1 East CW Pump, Unit 1 South CE Pump, Unit 2 South CE Pump and their motors in accordance with Hydro's practice and OEM recommendations will mitigate the risk of failure of a major pump and subsequent loss of generation capacity, contributing to the continued safe and reliable operation of the Holyrood TGS.

4.3.1 Risk of Asset Stranding

The risk of asset stranding is less imminent as a result of the decision to extend Holyrood TGS to remain available through the Bridging Period. As Hydro expects continued operation of all three units at the Holyrood TGS through the Bridging Period until its capacity can be adequately replaced to ensure reliable operation for customers, capital expenditures for this facility to operate as a generator continue to be required. Depreciation is required to be calculated on an accelerated basis (i.e., monthly depreciation = capital investment ÷ remaining months of service life).[8]

4.3.2 Risk Mitigation

Hydro assessed the pre- and post-implementation risk of the scope of work for this project in accordance with Hydro's Capital Risk Assessment process, as outlined in Section 7.0 of Schedule 1. The outcome of this assessment is provided in Table 1.

Table 1: Risk Scoring Pre- and Post-Implementation

	Impact	Likelihood	Score
Pre-Implementation	4	4	**16**
Post-Implementation	4	1	**4**
		Risk Mitigated	**12**
		Risk Mitigated per $1 Million	**5.0**

[8] Due to the extension of the Holyrood TGS through the Bridging Period, Hydro submitted an application to the Board to extend the Holyrood Accelerated Depreciation Deferral Account. The extension of the account and related amendments were approved in Board Order No. P.U. 1(2024). Hydro was also directed to file a report on the account in its next general rate application.

5.0 Scope of Work

The scope of work for this project involves disassembly, inspection, refurbishment, and replacement of parts (as required), reassembly, and commissioning of four major pumps and their motors. The pumps identified for overhaul are the Unit 1 West BF Pump, Unit 1 East CW Pump, Unit 1 South CE Pump and Unit 2 South CE Pump.

The pumps' disassembly and reassembly will be executed by internal resources. An experienced pump service contractor will be engaged to perform a condition assessment of the pumps, provide onsite technical support for the disassembly and reassembly, and complete the offsite condition assessment and refurbishment of each pump component.

For the BF pump, the volute impeller cartridge will be replaced with a refurbished cartridge from Hydro's spares inventory. The volute impeller cartridge, which is removed from the BF pump, will then be refurbished and returned to inventory as a critical spare to support the identical Units 1 and 2 BF Pumps prior to the next winter operating season. Figure 4 shows the volute impeller cartridge.

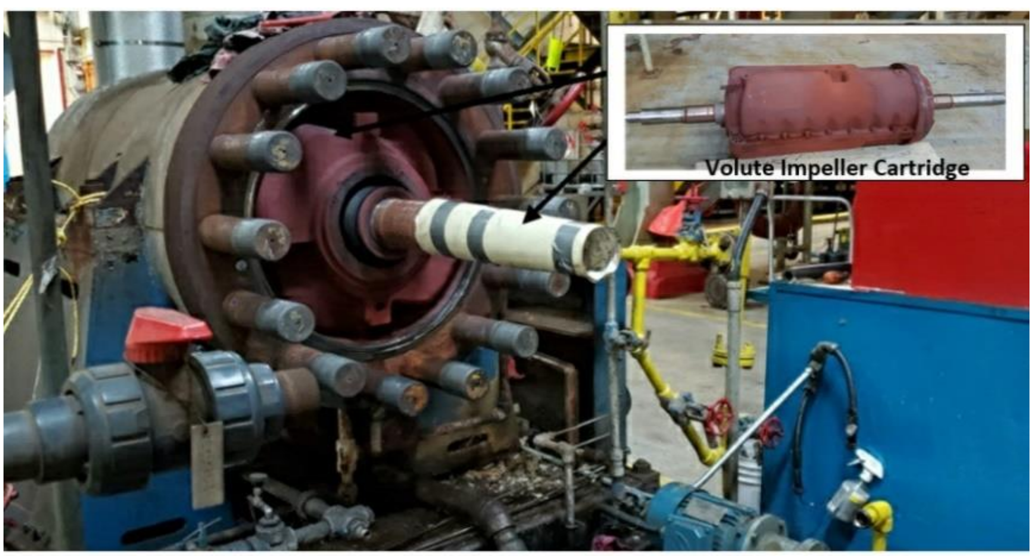


Figure 4: BF Pump Volute Impeller Cartridge During Disassembly

As the CW and CE pumps do not have a replaceable volute impeller cartridge, the internal components of these pumps will be sent to the OEM's service facility for inspection and refurbishment, then returned and installed before the pumps are placed back in service.

5.1 Project Budget

The estimate for this project is shown in Table 2.

Table 2: Project Estimate ($000)[9]

Project Cost	2026	2027	Beyond	Total
Material Supply	10.0	0.0	0.0	10.0
Labour	337.4	0.0	0.0	337.4
Consultant	0.0	0.0	0.0	0.0
Contract Work	1,538.0	0.0	0.0	1,538.0
Other Direct Costs	6.2	0.0	0.0	6.2
Interest and Escalation	118.5	0.0	0.0	118.5
Contingency	378.3	0.0	0.0	378.3
Total	**2,388.6**	**0.0**	**0.0**	**2,388.6**

5.2 Project Schedule

The overhaul and replacement work included in the project scope is scheduled to take place during the planned outages for Units 1 and 2. The schedule for this project is shown in Table 3.

Table 3: Project Schedule

Activity	Start Date	End Date
Planning:		
Preparation of planned documentation.	January 2026	February 2026
Design:		
Prepare technical specifications.	February 2026	March 2026
Procurement:		
Award overhaul contracts.	March 2026	May 2026
Construction:		
Disassemble the pumps.	May 2026	August 2026
Inspect, refurbish, and reassemble the BF pump using a spare volute impeller cartridge.	May 2026	August 2026
Inspect and refurbish the BF pump volute impeller cartridge and components of CW and CE pumps at the contractor's facility.	June 2026	October 2026
Reassemble and install the CW and CE pumps.	May 2026	October 2026
Closeout:		
Prepare closeout documentation.	October 2026	December 2026

[9] Numbers may not add due to rounding.

6.0 Conclusion

To support the continued safe and reliable operation of the Holyrood TGS, Hydro proposes to overhaul the Unit 1 West BF Pump, Unit 1 East CW Pump, Unit 1 South CE Pump, Unit 2 South CE Pump and their motors in 2026. The project is required to maintain the acceptable operating condition of the pumps, which contributes to the reliable operation and availability of Units 1 and 2 at full generation capacity.

Upgrade PLX Metering System

(2026–2028)

Labrador East

Contents

Upgrade PLX Metering System (2026–2028)

Location: Labrador East

Investment Classification: Mandatory

Asset Category: Metering

Estimated Cost: $2,168,900

1.0 Introduction

Metering is a core function of Newfoundland and Labrador Hydro's ("Hydro") service obligation. Accurate metering of electricity usage is necessary to provide quality service to customers and for Hydro to meet its legal obligations with Measurement Canada. Hydro is undergoing a transition in its meter reading technology and currently has multiple metering systems in place, including: manually-read meters; the TS1 and PLX systems, which utilize power line carrier ("PLC") technology to enable data retrieval;[1] and drive-by automatic meter reading ("AMR") system.

The replacement of the TS1 metering system and manually-read meters was within the scope of the Replace Metering System project in Hydro's 2022 Capital Budget Application ("CBA").[2] The Board of Commissioners of Public Utilities ("Board') approved Hydro's proposal to transition to the use of a drive-by AMR system, which uses a vehicle-mounted radio in data collection. However, since the PLX solution was still working reasonably well and was still supported by the manufacturer, Hydro planned to monitor its performance in determining when to discontinue its use and propose the replacement of PLX meters. PLX meters represent approximately 20% of all meters currently in service.

The PLX technology is now being phased out, and new meters and parts have become unavailable.[3] All meters must be replaced by 2028 to maintain compliance with Measurement Canada requirements. Additionally, Hydro is experiencing the failure of substation equipment and meters. Under the Government of Canada's *Electricity and Gas Inspection Act*[4] and *Electricity and Gas Inspection*

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[1] Meters which utilize PLC technology for data retrieval are no longer being developed by metering manufacturers as they are switching to other communication means that provide increased communication capacity with less expensive equipment requirements.

[2] As approved in Board Order No. P.U. 37(2021).

[3] As this technology was still viable at the time of Hydro's planning and submission of the 2022 CBA, meter replacement for this area was not included within the scope of the Replace Metering System project.

[4] *Electricity and Gas Inspection Act,* RSC 1985, c E-4.

Regulations,[5] Hydro is mandated by Measurement Canada to ensure that in-service meters are accurate and in good working condition. Furthermore, revenue meters must be certified and sealed before being placed in service and are to be removed from service before their meter expiry date.

To date, Hydro has replaced 5,300 TS1 meters in Labrador East with AMR technology. Of the meters on the Labrador Interconnected System, 30% have already been replaced with AMR meters. This project represents the replacement of the remaining 70% of meters.

Hydro proposes to proceed with the replacement of the remainder of its PLX meters under this project, using the same AMR technology that was used within its Replace Metering System project for TS1 and manually read meters. The scope of this project for 2026–2028 will include the purchase of automated meters that will integrate into Hydro's current mass meter deployment project and replace the existing obsolete and failing PLX meters in Happy Valley-Goose Bay, Sheshatshiu, and the North West River area.

The full transition to an AMR approach will contribute to a safer work environment for Hydro's meter readers. The drive-by AMR system has been proven to be reliable in this jurisdiction. Hydro's 2019 Conservation and Demand Management Potential Study[6] found that Automated Metering Infrastructure ("AMI") would serve to increase system peak on the Labrador Interconnected System and therefore drive-by AMR system costs continue to meet Hydro's obligation for least cost, environmentally responsible, and reliable service to customers.

2.0 Project Description and Justification

This project is for the purchase and replacement of meters for Hydro's residential, commercial and Industrial customers in the Happy Valley-Goose Bay, Sheshatshiu, and the North West River area that are currently equipped with obsolete PLX technology. This technology has become obsolete since Hydro's Replace Metering System project in Hydro's 2022 CBA and is proposed for replacement with AMR meters with Radio Frequency ("RF") technology.[7] In addition, upgrades to meter cabinets/enclosures are required to protect the integrity of Hydro's commercial and Industrial customer installations, and to ensure accurate billing to customers.

[5] SOR/86-131.

[6] "Newfoundland and Labrador Conservation Potential Study (2020–2034)," Dunsky, filed in "Application for Approvals Required to Execute Programming Identified in the Electrification, Conservation and Demand Management Plan 2021–2025," Newfoundland and Labrador Hydro, rev. July 8, 2021 (originally filed June 16, 2021), sch. 3, sch. C.

[7] Mobile collector 4-core radio system. The RF technology will be required to enable automated reading of the meters.

The existing PLX system has reached the end of its life and is no longer being supported by the manufacturer. As such, Hydro is unable to purchase replacement PLX meters to integrate into its residential and commercial PLX system. The data collector system is no longer supported. In the event of a collector failure, Hydro would be forced to revert to manual meter reading or usage estimation for over 6,000 meters across the region. This would result in significant operational inefficiencies, increased labour costs, and a heightened risk of billing inaccuracies. PLX meters or parts have been unavailable for purchase since June 2022.[8] Additionally, Hydro's existing meter stock has been depleted due to the number of meter failures; meters are no longer available for replacements should they be required. Failure to replace meters that are due to be replaced may result in inaccurate customer billings and/or monetary penalties, as per the requirements under the *Electricity and Gas Inspection Act and Electricity and Gas Inspection Regulations*.

In addition, the substation data collectors and meters in Happy Valley-Goose Bay, Sheshatshiu, and the North West River areas are failing, and there are no PLX meters available for replacements, new services, or for meters that have failed in service due to damage or component failures. The replacement of this system will provide reliable, accurate billing for these areas. Upgrades to existing metering cabinets are required to ensure: i) the integrity of the metering circuit; ii) revenue protection; and iii) they meet the requirements of, and maintain compliance with, the Canadian Electrical Code. All meters must be replaced by 2028 to maintain compliance with Measurements Canada requirements. Additionally, Hydro is experiencing the failure of substation equipment and meters.

Revenue meters enable Hydro to accurately record energy and power consumption by its customers. This project would allow Hydro to meet its operational requirements, including an inventory of residential, commercial and industrial customer meters, to satisfy government-mandated annual testing, new customer installations, and the replacement of damaged meters.

3.0 Asset Overview

3.1 Asset Background

The PLX technology has become obsolete, and since June 2022, no new meters or parts have been available for purchase. Hydro's existing meter stock has since been depleted, and no new PLX meters

[8] At the time of Hydro's 2022 CBA, there was sufficient inventory of PLX meters to support the existing system. That inventory has since been depleted.

are available for new customer service requests[9] to replace meters that failed in service due to damage or component failures, meters required for technology changes, or meters required to fulfill customer accuracy testing requests.

4.0 Analysis

Hydro evaluated the following alternatives:

- Deferral;
- Installation of AMR drive-by system with AMI-compatible meters; and
- Installation of AMR drive-by system.

4.1 Evaluation of Alternatives

4.1.1 Deferral

Deferring the replacement of the PLX metering system is not a viable option due to the critical business risks it presents. The existing PLX meters and associated mobile collector technology are obsolete, no longer supported by the manufacturer, replacement parts are no longer available, and are increasingly prone to failure. In the event of a collector failure, Hydro would be forced to revert to manual meter reading or usage estimation for over 6,000 meters across the region. This would result in significant operational inefficiencies, increased labour costs, and a heightened risk of billing inaccuracies. Failure to proactively replace the PLX system jeopardizes Hydro’s ability to meet its core obligation of providing accurate, timely billing and could lead to customer dissatisfaction, complaints, and financial penalties. Immediate action is required to mitigate these escalating risks and ensure continuity of service; deferral is not a viable alternative.

4.1.2 Installation of AMR Drive-By System with AMI Compatible Meters

Under this approach, Hydro would install new meters that are compatible with both drive-by AMR and full AMI metering technology. This approach would allow drive-by AMR to be used in the near term, consistent with other meters in the province, and reduce the cost of upgrading to AMI in the future.

[9] Hydro fulfills new service requests and replacements due to failure with AMR meters; however, these meters are read manually until broader implementation of AMR technology is complete under this proposed project.

However, the up-front costs of an AMI-compatible meter are materially higher than the current AMR metering solution being implemented by Hydro.[10]

AMI metering would enable the use of dynamic rates on the Labrador Interconnected System, such as Time of Use Rates or Critical Peak Pricing. Hydro's 2019 Conservation and Demand Management Potential Study found that, due to the relatively flat peak day load shape, dynamic rates on the Labrador Interconnected System would serve to increase the system peak. As a result, there are limited customer or operational benefits associated with the additional cost of AMI-ready meters in Labrador East.

Due to the higher capital cost of AMI-ready meters, combined with the lack of customer benefit for the Labrador Interconnected System, this alternative is not recommended.

4.1.3 Installation of AMR Drive-By System

Under this approach, Hydro would install meters with built-in radios to transmit meter readings remotely to replace PLX meters. Meter readers would be equipped with a tablet or handheld unit that is paired with a radio to read meters as they drive through their respective routes. Further, installation and management of a single metering system would reduce operational complexities associated with maintaining multiple metering technologies and increase efficiencies for Hydro.

This alternative is least-cost and would allow Hydro to meet all its legal and statutory obligations for accurate and timely billing to customers in Labrador East; therefore, it is the recommended alternative.

4.1.4 Least-Cost Evaluation

Drive-by AMR has been identified as the least-cost alternative, which still allows Hydro to meet its statutory and legal obligations.

4.1.5 Recommended Alternative

Hydro recommends proceeding with the replacement of the PLX metering system with an AMR drive-by system.

[10] Meter costs only represent a portion of the cost of deploying dynamic rates. Other capital costs would be required for the implementation of a mesh network and back-end systems to capture and store interval metering data. An AMI conversion on the Labrador Interconnected System would also require replacement of the approximately 30% meters that have already been transitioned to AMR.

Hydro is required under the Government of Canada's *Electricity and Gas Inspection Act and Electricity and Gas Inspection Regulations*, as well as mandated by Measurement Canada, to ensure that in-service meters are accurate, in good working condition, and are removed from service before the meter expiry date. This is the least-cost alternative.

5.0 Scope of Work

This project is for the purchase and installation of 6,175 AMR meters with RF technology that will integrate into Hydro's current mass meter deployment, and upgrades to 195 metering cabinets/enclosures to ensure accurate revenue collection. This project is distinct from the Purchase Meters and Metering Equipment program, which focuses on the replenishment of inventory for the replacement and/or supply of meters for industrial and wholesale customers and associated equipment, as well as meter cabinets for transformer-rated meters.

These installations and upgrades will be completed in a phased approach between 2026 and 2028, as resources, materials, and weather permit, prioritizing sites as necessary to ensure quality of service to customers. The project includes the procurement of meter reading equipment (a mobile collector) and field labour for the meter replacements, meter cabinet/enclosure upgrades, and decommissioning of the PLX substation equipment.

5.1 Project Budget

The estimate for this project is shown in Table 1.

Table 1: Project Estimate ($000)[11]

Project Cost	2026	2027	Beyond	Total
Material Supply	759.0	0.0	0.0	**759.0**
Labour	260.9	374.0	374.0	**1,008.9**
Consultant	12.5	12.5	12.5	**37.4**
Contract Work	0.0	0.0	0.0	**0.0**
Other Direct Costs	25.0	37.5	37.5	**100.0**
Interest and Escalation	25.7	19.5	28.0	**73.1**
Contingency	105.7	42.4	42.4	**190.5**
Total	**1,188.8**	**485.8**	**494.3**	**2,168.9**

[11] Numbers may not add due to rounding.

5.2 Project Schedule

The schedule for this project is shown in Table 2.

Table 2: Project Schedule

Activity	Start Date	End Date
Planning: Open project/review schedule.	January 2026	February 2026
Design: Review designs of new equipment.	February 2026	February 2026
Procurement: Tender for metering equipment.	February 2026	May 2026
Construction / Commissioning: Install new metering equipment.	June 2026	December 2028
Closeout: Project closeout.	December 2028	December 2028

6.0 Conclusion

The need for reliable metering is essential to Hydro's business and its customers. Hydro is required under legislation to provide reliable and accurate revenue metering to its customers and maintain compliance with the *Electricity and Gas Inspection Act* and *Electricity and Gas Inspection Regulations*.

This project is required to replace obsolete PLX meters in the Happy Valley-Goose Bay, Sheshatshiu, and the North West River areas. Installation of an AMR drive-by system is the least-cost alternative to address the PLX obsolescence as well as to improve the safety of meter readers, improve billing accuracy and provide quality metering and billing service to customers. This project will enable Hydro to meet its legislated requirements to ensure revenue protection and maintain the integrity of the metering installations.

Upgrade Power Transformers

(2026–2027)

Contents

Upgrade Power Transformers (2026–2027)

Location: Various

Investment Classification: Renewal

Asset Category: Terminal Stations

Estimated Cost: $2,106,800

1.0 Introduction

Power transformers are used to transform or convert the voltage of an electrical circuit. By modifying voltage levels, the electrical system can be operated in an economically sound manner. Power transformers consist of several components, including bushings, tap changers, and transformer oil, which affect the lifespan and operation of the transformer.

2.0 Project Description and Justification

Newfoundland and Labrador Hydro ("Hydro") completes regular condition assessments, scheduled maintenance, and testing, to identify concerns with insulating oil and paper deterioration, oil moisture content, oil leaks, component rusting, tap changer component wear or damage, damaged or deteriorated bushings, failure of the protective devices, and cooling fan failures.

Under the scope of the 2026–2027 project, five transformers will be refurbished. The following transformer upgrades and/or refurbishments are planned for 2026–2027:

- Replacement of bushings; and
- Tap changer upgrades.

Bushing replacements as well as tap changer upgrades being proposed in this project are in accordance with Hydro's Terminal Station Asset Management Strategy.[1]

Following the receipt of the 2025 Capital Budget Application ("CBA") Board of Commissioners of Public Utilities Order No. P.U. 28(2024), Hydro conducted a review of the classification of its programs within the 2025 CBA and determined that, due to the nature of the assets being replaced, the scope of work

[1] Provided as Appendix F to Schedule 1 of this application.

contained in Upgrade Power Transformers proposals was more appropriately defined as a project. As a result, Hydro has provided the information within this proposal as required by the provisional CBA Guidelines[2] relating to projects.

3.0 Asset Overview

3.1 Asset Background

The power transformers in the scope of this project are operational. The performance of these assets allows these units to remain in service; however, reliability could be compromised if not replaced in a timely manner once the replacement criterion is reached.

The justification for each transformer is either condition-based or to provide improved condition monitoring as outlined in the Terminal Station Asset Management Strategy. All work identified is to minimize the risk of failure and to maintain or improve the long-term reliability of each asset.

3.2 Historical Reliability

Hydro doesn't compile data on power transformer reliability. The primary objective of this project is to maintain the existing reliability of the power transformers included in its scope by replacing or refurbishing deteriorated components of those power transformers.

A listing of sustained forced outages for the last five years is shown in Table 1.[3]

[2] "Capital Budget Application Guidelines (Provisional)," Board of Commissioners of Public Utilities, January 2022.
[3] Please note that outages for Holyrood Transformer T8 on January 6, 2023 and January 9, 2023, were missed in Table 1 of the Upgrade Power Transformers (2025–2026) program of the 2025 CBA.

Table 1: Power Transformer Outages and Durations from 2020 to 2024

Start Date	Transformer	Outage Duration (Minutes)
29-Sep-2024	Oxen Pond ("OPD") T2	5,754
13-Sep-2024	Bottom Brook T3	222
09-Jul-2024	Bottom Brook T3	160
25-Jul-2023	Bay d'Espoir ("BDE") T6	105,169
6-Jun-2023	St. Anthony Diesel Plant T1	214,994
25-May-2023	Daniel's Harbour T2	194,440
09-Jan-2023	Holyrood T8	283
06-Jan-2023	Holyrood T8	251
6-Aug-2022	Grandy Brook T1	241
3-Jul-2022	BDE T5	171,902
28-Apr-2022	Sunnyside T1	5
28-Apr-2022	Sunnyside T4	5
22-Apr-2022	Deer Lake ("DLK") T2	337
21-Mar-2022	Holyrood T10	1,475
21-Mar-2022	Holyrood T5	1,376
12-Nov-2021	Holyrood T2	87,485

3.3 Asset Condition

Hydro plans to complete work in the following job activities for power transformers under this capital project, and is providing asset condition information for each:

- Power transformer on-load tap changer ("OLTC") refurbishment; and
- Power transformer bushing replacement.

3.3.1 Asset Condition – Power Transformer OLTC

The power transformer OLTC asset condition categories represent severity based on the condition of the OLTC inferred from Tap Changer Activity Signature Analysis ("TASA") Condition and Stenestam[4] Condition. The categories are defined as follows:[5]

[4] The Stenestam ratio is calculated from measured levels of methane (CH_4), ethylene (C_2H_4), ethane (C_2H_6), and acetylene (C_2H_2) in the latest DGA results for a given OLTC, Stenestam ratio = ($CH_4 + C_2H_4 + C_2H_6$) ÷ C_2H_2. An alphabetical Stenestam condition value is then mapped from these ratios as follows: A = < 0.5, B = > 0.5 to < 5, C = > 5.

[5] A Category 1 assessment indicates that both the TASA Condition and Stenestam Condition equal A. A Category 2 assessment indicates either TASA Condition or Stenestam Condition equal B without either having a worse letter grade. A Category 3 assessment indicates either TASA Condition or Stenestam Condition equal C without having a worse letter grade. A Category 4 assessment indicates that the TASA Condition equals D.

- Category 1: Asset Condition = A;
- Category 2: Asset Condition = B;
- Category 3: Asset Condition = C; and
- Category 4: Asset Condition = D.

The transformers selected for tap changer upgrades are based on condition or the original equipment manufacturer's recommended number of operations at which to complete a refurbishment. Within the 2026 project, DLK T2 is classified as Category B and requires a tap changer oil replacement due to poor oil quality to minimize the risk of tap changer and/or transformer failure.

3.3.2 Asset Condition – Power Transformer Bushings

The power transformer bushings asset condition categories represent severity, as defined by Hydro, based on voltage/test tap leaks, insulator condition and bushing C1 and C2 ratings (as per Doble test results).[6] The categories are defined as follows:

- Category 1: Asset Condition = A; No voltage/test tap leaks, acceptable C1 and C2 ratings;
- Category 2: Asset Condition = B; Voltage/test tap leaking, damaged insulator skirt, C1 "I" rating, C2 "I" rating;
- Category 3: Asset Condition = C; Voltage/test tap leaking, C1 "D" rating, C2 "B" rating; and
- Category 4: Asset Condition = D; C1 "B" rating.

The condition of the transformers within the 2026 project that require bushing replacements to mitigate transformer failure is provided in Table 2.

[6] The C1 and C2 ratings of 'I', 'D' and 'B' mean "investigate," "deteriorated," and "bad," respectively.

Table 2: Asset Condition – Power Transformer Bushings

Transformer	Condition	Category
BDE T1	High Voltage Bushing Replacements: The existing bushing is the same make and model that failed on BDE T5 and BDE T6 in 2022 and 2023, respectively, and must be replaced with the OEM recommendation.	B
BDE T6	High Voltage Bushing Replacements: The existing bushing is the same make and model that failed on BDE T5 and BDE T6 in 2022 and 2023, respectively, and must be replaced with the OEM recommendation.	B
Bear Cove ("BCV") Reactor R1	Neutral Bushing Replacements: The existing bushing has an internal leak.	B
OPD T2	Low Voltage Bushing Replacements: X1 and X2 bushings have leaking voltage taps. X3 bushing has high C2 power factor and capacitance compared to the nameplate values.	B

4.0 Analysis

4.1 Evaluation of Alternatives

Hydro considered the following alternatives:

- Deferral; and
- Complete Refurbishments.

4.1.1 Deferral

Tap Changer Overhauls/Refurbishment

The scope of work includes tap changer refurbishments for four transformers. The tap changers for these units are in deteriorated condition. The continued operation of these units in their present condition increases the risk of failure. Deferral of this work is not a viable alternative.

Bushing Replacements

The scope of work includes bushing replacements for two transformers. The bushings for these units are in deteriorated condition. The continued operation of these units in their present condition increases the risk of failure. Deferral of this work is not a viable alternative.

4.1.2 Complete Refurbishments

The tap changer refurbishments and bushing replacements, as identified in a planned, strategic manner as outlined in this proposal, are prudent. This approach enables Hydro to complete the identified power transformer upgrades in a manner that supports its mandate to provide safe, reliable, least-cost electricity in an environmentally responsible manner.

4.2 Least-Cost Evaluation

Hydro has not identified any viable alternatives to facilitate a least-cost evaluation.

4.3 Recommended Alternative

Hydro recommends proceeding with the proposed work as identified herein. Deferral of this work increases the risk of transformer failure.

4.3.1 Risk of Asset Stranding

For all assets included in this scope of work, there is no undue risk that these capital additions will be stranded before their useful life has been reached, as there are no plans to retire any existing terminal stations.

4.3.2 Risk Mitigation

Hydro assessed the pre- and post-implementation risk of the scope of work for the project in accordance with Hydro's Capital Risk Assessment process, as outlined in Section 7.0 of Schedule 1. The outcome of this assessment is provided in Table 2.

Table 2: Risk Scoring Pre- and Post-Implementation

	Impact	Likelihood	Score
Pre-Implementation	5	3	**15**
Post-Implementation	5	1	**5**
		Risk Mitigated	**10**
		Risk Mitigated per $1 Million	**4.7**

5.0 Scope of Work

Based on current conditions and asset data, Hydro plans to refurbish five power transformers. The scope includes the design, procurement and installation associated with bushing replacements for BDE T1, BDE T6, OPD T2 and BCV R1, and tap changer oil replacement for DLK T2.

Hydro plans to complete the refurbishments of BDE T1 and BDE T6 in 2026, and BCV R1, OPD T2, and DLK T2 in 2027.[7]

5.1 Project Budget

The estimate for this project is shown in Table 3.

Table 3: Project Estimate ($000)[8]

Project Cost	2026	2027	Beyond	Total
Material Supply	418.5	40.0	0.0	**458.5**
Labour	180.9	127.6	0.0	**308.4**
Consultant	75.0	22.5	0.0	**97.5**
Contract Work	801.0	74.0	0.0	**875.0**
Other Direct Costs	14.5	20.4	0.0	**34.9**
Interest and Escalation	66.1	88.8	0.0	**154.9**
Contingency	149.0	28.4	0.0	**177.4**
Total	**1,705.0**	**401.8**	**0.0**	**2,106.8**

[7] Based on asset condition and outage and resource availability at the time of execution, Hydro may advance or defer the replacement of specific assets to ensure efficient and effective implementation of this project.
[8] Numbers may not add due to rounding.

5.2 Project Schedule

The schedule for this project is shown in Table 4.

Table 4: Project Schedule

Activity	Start Date	End Date
Planning:		
Initial planning and scheduling.	January 2026	May 2026
Design:		
Conduct site visits and complete detailed design.	May 2026	November 2027
Procurement:		
Ordering and delivery of equipment.	March 2026	September 2027
Construction:		
Install new equipment.	August 2026	November 2027
Commissioning:		
Commissioning.	August 2026	November 2027
Closeout:		
Complete closeout documentation.	October 2027	December 2027

6.0 Conclusion

The scope of work identified is required to refurbish five power transformers to allow Hydro to continue to provide safe, reliable, least-cost electricity in an environmentally responsible manner. The transformers have been identified for refurbishment based on condition to mitigate the risk of transformer failure.

Overhaul Hydraulic Units

(2026)

Contents

List of Appendices

Overhaul Hydraulic Units (2026)

Location: Various

Investment Classification: Renewal

Asset Category: Hydraulic Plant

Estimated Cost: $2,023,600

1.0 Introduction

Preventive maintenance ("PM") is performed on all hydraulic units within Newfoundland and Labrador Hydro's ("Hydro") fleet. Yearly inspections, called PM6 inspections, are performed on all hydraulic units. More detailed inspections, identified as PM9 inspections, are executed on all hydraulic units at a frequency of six years. PM9 inspections incorporate PM6 inspection items with additional recommendations from the original equipment manufacturer ("OEM") and required refurbishments to support the long-term reliability of the hydraulic unit. Unit 7[1] at the Bay d'Espoir Hydroelectric Generating Station ("Bay d'Espoir") and Unit 1 at the Hinds Lake Hydroelectric Generating Station ("Hinds Lake") require PM9 inspections and associated refurbishment in 2026.

Following the receipt of the 2025 Capital Budget Application ("CBA") Board Order No. P.U. 28(2024), Hydro conducted a review of the classification of its programs within the 2025 CBA and determined that, due to the nature of the assets being replaced, the scope of work contained in the Overhaul Hydraulic Units proposal was more appropriately defined as a project. As a result, Hydro has provided the information within this proposal as required by the provisional CBA Guidelines[2] relating to projects.

2.0 Project Description and Justification

Hydro's hydraulic generation units make up 954 MW of the generation capacity available on the Island portion of the system. Regular PM on these assets plays a crucial role in Hydro's ability to meet system load requirements. The Overhaul Hydraulic Units project consists of inspections and associated refurbishments, which are typically completed every six years on all major hydraulic units on the Island. On occasion, these inspection intervals and scopes must be modified by advancing or deferral overhauls

[1] Hydro has proposed a supplemental project for the life extension of Unit 7 to be executed from 2025 to 2028, if approved. The scope of work for this PM9 project has been expanded to include short-term remediation work to address deficiencies identified in 2023 as urgent and unable to be delayed until 2028.
[2] "Capital Budget Application Guidelines (Provisional)," Board of Commissioners of Public Utilities, January 2022.

of particular units to align work with other capital projects, outage schedules, and provide operational synergies.

The overhaul frequency and scope of work are based on OEM recommendations and Hydro's operational experience, and involve partial dismantling of the turbine and generator to inspect, test, clean, and refurbish the required unit(s). The work within these overhauls is required in this specific timeframe to address items historically present after six years of continual operation.

Completing these overhauls will ensure continued reliable operation of the hydraulic units, significantly contributing to reducing forced outages and unit deratings and directly decreasing unplanned maintenance outages. The units proposed under this project, Bay d'Espoir Unit 7 and Hinds Lake Unit 1, received their last PM9 inspections in 2019 and require their next PM9 inspections in 2026 to maintain reliable operation.

Based on Hydro's established inspection interval, these units were due for PM9 inspection in 2025. However, Hydro deferred the PM9 inspection on both units by one year due to the operational synergies gained by deferring this work.[3]

3.0 Asset Overview

3.1 Asset Background

Units to be overhauled in 2026 are as follows:

- Bay d'Espoir Unit 7: Rated for 154.4 MW, last overhauled in 2019; and
- Hinds Lake Unit 1: Rated for 75.0 MW, last overhauled in 2019.

Bay d'Espoir produces an average of 2,650 GWh annually, making it the largest hydroelectric generating facility on the Island and consists of two powerhouses feeding seven units. Powerhouse 1, commissioned in 1967, relies on three buried penstocks[4] to feed six generating units. Powerhouse 2,

[3] Bay d'Espoir Unit 7 was deferred to 2026 to allow the completion of the Bay d'Espoir Unit 2 overhaul in 2025, as approved in Board Order No. P.U. 28(2024) in relation to Hydro's 2025 CBA. Completing the Unit 2 overhaul in 2025 allowed Hydro to align this work with the extended outages required for Bay d'Espoir Units 1 and 2 in 2025 due to the Penstock 1 Life Extension project. Hinds Lake Unit 1 was deferred to 2026 to align with the previously approved Rewind Stator project in Hinds Lake that began in 2025, also included in Hydro's 2025 CBA and approved within the same Order.

[4] The three penstocks split at Powerhouse 1 for each supplying water to two hydraulic generating units. All six units in Powerhouse 1 are equipped with a spherical valve, also known as a main inlet valve, allowing one unit to run while the other can be serviced, or both units to be quickly isolated from the penstock water.

commissioned in 1977, has one separate penstock that supplies Unit 7, the largest hydroelectric generating unit in Hydro's fleet. Unit 7 is operated to meet system load requirements on the Island Interconnected System, and also has synchronous condenser capabilities.[5]

Hinds Lake Unit 1 produces an average of 340 GWh annually, and is located on the west coast of the Island near the community of Howley. Hinds Lake Powerhouse, commissioned in 1980, has a single unit and penstock configuration used to meet system load requirements on the Island Interconnected System.

Both Bay d'Espoir Unit 7 and Hinds Lake Unit 1 are currently in working condition and available for service, except during planned maintenance or forced outages.

3.2 Historical Reliability

This project plays a key role in allowing Hydro to minimize the Derated Adjusted Forced Outage Rate ("DAFOR")[6] of its hydraulic units to ensure the provision of reliable service to customers. Hydro tracks performance data for its hydraulic units using the DAFOR; this data is filed quarterly with the Board of Commissioners of Public Utilities ("Board").[7]

3.3 Asset Condition

3.3.1 Bay d'Espoir Unit 7

In 2019, Hydro executed a turbine refurbishment project on Unit 7,[8] which provided an opportunity for detailed inspection and measurement of critical equipment as the unit was fully disassembled for the first time since commissioning. A Level 2 Condition Assessment was carried out by Hatch Ltd. in 2023 ("2023 Condition Assessment"),[9] with the latest condition information and operational data available intended to enable Hydro to plan for appropriately-timed capital investment and provide Hydro with an independent, third-party review of the inspection findings by contractor Voith Group ("Voith") during

[5] A hydraulic generator operating as a synchronous condenser uses a generator, typically from a hydroelectric plant, to provide reactive power to the grid for voltage regulation and grid stabilization, rather than generating active power (electricity).
[6] DAFOR is a metric that measures the percentage of time that a unit or group of units is unable to generate at its maximum continuous rating due to forced outages or unit deratings.
[7] Most recent "Quarterly Report on Asset Performance in Support of Resource Adequacy for the Twelve Months Ended March 31, 2025," Newfoundland and Labrador Hydro, April 30, 2025.
[8] The scope was included within the Hydraulic Generation Refurbishment and Modernization project, which was approved as part of Hydro's 2019 CBA in Board Order No. P.U. 46(2018).
[9] The Unit 7 Condition Assessment (2023) – Bay d'Espoir project was approved as part of Hydro's 2023 CBA in Board Order No. P.U. 2(2023).

the Turbine Refurbishment project in 2019.[10] During these inspections, critical components of the unit, including the turbine, generator, and embedded parts, were identified by the contractor as requiring intervention during the next major outage to ensure continued reliable operation of the unit.

The 2023 Condition Assessment concluded that the unit requires major intervention within the next five years, the majority of which will be addressed through the proposed Bay d'Espoir Unit 7 Life Extension project, with execution completed in 2028.

The scope of this PM9 has been expanded to include short-term remediation work to address deficiencies identified during the 2023 Condition Assessment as being urgent and unable to be delayed until 2028. It will also include necessary inspection work to ensure a full understanding of up-to-date asset condition is known prior to critical design decisions in the life extension project, along with items identified through lessons learned on Hydro's other generating units. The execution of this PM9 is critical to ensure the reliable operation of the unit until the life extension work proposed in this project can be executed.

3.3.2 Hinds Lake Unit 1

Hinds Lake Unit 1 is currently experiencing issues with turbine vibration and excessive shaft seal leakage. The vibration levels on the unit have been gradually increasing, though they are not currently in an area of operational concern. However, with the scheduled rewind project in 2026, Hydro has decided it is prudent to address this issue at this time, coinciding with the unit's return to service and rebalancing. Additionally, the unit has experienced ongoing shaft seal leakage, which has been monitored over the past several years. Given the extended outage, Hydro has also decided to address this leakage in 2026. In light of the current condition and age of the Hinds Lake unit, Hydro expanded the scope of the PM9 inspection, as noted in Section 5.2, to include additional corrective activities to address these issues.

[10] The 2023 Condition Assessment and the 2019 Voith Report are included as Attachments 1 and 4, respectively of the"Life Extension Application – Bay d'Espoir Unit 7," Newfoundland and Labrador Hydro, June 20, 2025.

3.4 Condition-Based Remaining Life

3.4.1 Bay d'Espoir Unit 7

As identified in the 2023 Condition Assessment, Unit 7 requires a major intervention within the next five years, which will be addressed through the proposed Bay d'Espoir Unit 7 Life Extension project that is currently before the Board.

3.4.2 Hinds Lake Unit 1

The Hinds Lake unit has been in operation for almost 45 years since commissioning in December 1980, and is approaching the age at whereby routine capital maintenance investments to extend the service life of the asset will begin to exponentially increase, due to critical equipment nearing or surpassing the end of its service life. This phenomenon is known as the "bathtub curve." This concept, which theorizes a relationship between equipment age and failures, has been presented by The Liberty Consulting Group in previous reliability assessments, stating "*Equipment failures in relation to equipment age generally exhibit a "bathtub-shaped curve." Incidents of failure tend to be high when equipment is new and again after 30–50 years, depending on equipment type.*"[11]

In light of the current condition and age of the Hinds Lake unit, Hydro expanded the scope of the PM9 inspection to complete a Level 2 Condition Assessment of the turbine and associated components, to determine the remaining life and develop a plan for lifecycle renewal through long-term capital investment.

4.0 Analysis

4.1 Evaluation of Alternatives

Hydro evaluated the following alternatives:

- Planned overhauls on a six-year interval;
- Deferral; and
- Alternative strategies – pooling and clustering options.

[11] "Supply Issues and Power Outages Review: Island Interconnected System – Executive Summary of Interim Report," The Liberty Consulting Group, April 24, 2014, sec. D, p. 57.

4.1.1 Planned Overhauls on a Six-Year Interval

Under this alternative, Hydro would perform PM9 inspections at a typical frequency of six years, as described in Section 2.0. However, on a case-by-case basis, these inspection intervals and scopes are modified to either pull ahead or defer the overhaul to align work with other capital projects and provide operational synergies, as was the case for the units in this proposal, which have been deferred by one year.

4.1.2 Deferral

Hydro would typically perform PM9 inspections at a frequency of six years, as described in Section 2.0. To determine the exact time interval between overhauls, Hydro considers several factors, including but not limited to asset condition and criticality, frequency of operation, and reliability. Reduction in the frequency of hydraulic unit overhauls is not typical as it would increase the risk of unit failures; however, on a case-by-case basis, these inspection intervals and scopes are modified to align work with other capital projects and provide operational synergies, as was the case for the units in this proposal, which have been deferred by one year. Further, the work must be completed in advance of the 2028 work scope for the proposed Bay d’Espoir Unit 7 Life Extension project.

4.1.3 Alternative Strategies – Pooling and Clustering Options

As noted in Section 4.1.1, PM9 inspections are typically performed every six years. However, Hydro deferred the PM9 inspection on both Bay d’Espoir Unit 7 and Hind Lake Unit 1 by one year due to the operational synergies gained by deferring this work. Bay d’Espoir Unit 7 was deferred to allow the completion of the Bay d’Espoir Unit 2 overhaul in 2025. Completing the Unit 2 overhaul in 2025 allowed Hydro to align this work with the extended outages required for Bay d’Espoir Units 1 and 2 in 2025 due to the previously approved Penstock 1 Life Extension project.[12] Hinds Lake Unit 1 was deferred to align with the previously approved Rewind Stator project[13] in Hinds Lake, that began in 2025, and would require an extended unit outage in 2026.

This alignment of both overhauls to account for work on other units and unit major upgrades allows Hydro to mitigate potential cost increases while eliminating an additional occurrence of reduced

[12] “Penstock 1 Section Replacement and Weld Refurbishment – Bay d’Espoir Hydroelectric Generating Facility,” Newfoundland and Labrador Hydro, December 7, 2022, approved in Board Order No. P.U. 6(2023).

[13] “2025 Capital Budget Application,” Newfoundland and Labrador Hydro, July 12, 2024, sch. 7, proj. 1, approved in Board Order No. P.U. 28(2024).

capacity caused by maintenance-based outages. Hydro has mitigated the risks of a delayed inspection to maximize the benefits to ratepayers achieved through pooling this work.

4.2 Least-Cost Evaluation

As Hydro has not identified any alternatives to the completion of PM9 inspections, no least-cost evaluation was performed.

4.3 Recommended Alternative

To align work with other capital projects and provide operational synergies, Hydro recommends a delayed proceeding with the planned PM9 inspection and associated refurbishments on the reduced pace of a seven-year interval for the PM9 inspection on Bay d'Espoir Unit 7 and Hinds Lake Unit 1. This approach allowed for the alignment of Bay d'Espoir Units 1 and 2 in 2025 with the Penstock 1 Life Extension project, and Hinds Lake Unit 1 with the 2025–2026 Rewind Stator project.

4.3.1 Risk of Asset Stranding

Hydraulic generating units have a typical service life of 80–100 years when properly maintained. This overhaul project is a critical asset management activity necessary to ensure safe and reliable operation and maximize the service life of both assets. Bay d'Espoir Unit 7 and Hinds Lake Unit 1 were commissioned in 1977 and 1980, respectively, and have been in operation for over 45 years. Throughout these years, Hydro has performed both preventative and corrective maintenance on these units; therefore, Hydro considers the risk of asset stranding to be negligible.

4.3.2 Risk Mitigation

Hydro assessed the pre- and post-implementation risk of the scope of work for the 2026 project in accordance with Hydro's Capital Risk Assessment process, as outlined in Section 7.0 of Schedule 1. The outcome of this assessment is provided in Table 1.

Table 1: Risk Scoring Pre- and Post-Implementation

	Impact	Likelihood	Score
Pre-Implementation	4	4	**16**
Post-Implementation	4	1	**4**
		Risk Mitigated	**12**
		Risk Mitigated per $1 Million	**5.9**

5.0 Scope of Work

5.1 Bay d'Espoir Unit 7

This project involves a partial dismantling of Bay d'Espoir Unit 7 to inspect, test, clean, refurbish, and replace defective components based on information from the maintenance records for the unit. The records provide details on the history, present condition, and any unusual maintenance problems of the units. This PM9 inspection involves:

- Cleaning and inspecting rotor and stator assembly;
- Electrical testing on rotor/stator assembly;
- Calibrating and testing of turbine and generator protection devices;
- Verifying bearing and seal clearances; and
- Completing a thorough inspection of the turbine and draft tube.[14]

Hydro will complete other identified refurbishment work on Unit 7. This expanded scope has identified the addition of:

- Non-destructive examination of all rotor rim guidance blocks and key assemblies;
- Grouting of the scroll case and adjacent areas impacted by concrete voids;
- Replacement of the servomotor piston seals;
- Replace/readjust the operating ring temporary guide pads;
- Re-weld runner cavitation; and
- Inspect end-winding caps at the bottom of the unit.

Appendix A provides further information on the additional project scope, including which items from the 2023 Condition Assessment that Hydro is addressing within the PM9. The completion of this scope will help to ensure the reliable operation of Unit 7 until the execution of the proposed life extension work scope planned for 2028.

[14] Please note that there is no duplication between the PM9 inspection checklist of the draft tube as proposed within this project, and the Perform Level 2 Condition Assessment – Intake 4 and Unit 7 Draft Tube (2025) – Bay d'Espoir project which was approved as part of Hydro's 2025 CBA in Board Order No. P.U. 28(2024).

5.2 Hinds Lake Unit 1

This project involves a partial dismantling of Hinds Lake Unit 1 to inspect, test, clean, refurbish, and replace defective components based on information from the maintenance records for the unit. The records provide details on the history, present condition, and any unusual maintenance problems of the units. This PM9 inspection involves:

- Cleaning and inspecting rotor and stator assembly;
- Electrical testing on rotor/stator assembly;
- Calibrating and testing of turbine and generator protection devices;
- Verifying bearing and seal clearances; and
- Completing a thorough inspection of the turbine and draft tube.

Hydro will complete other identified refurbishment work on Unit 1. This expanded scope has identified the addition of:

- Replace shaft seal and bearing components;
- Complete a wicket gate circle;
- Complete runner repairs; and
- Perform a Level 2 condition assessment of the turbine and associated components.

5.3 Project Budget

Table 2 contains the overall project estimate for 2026.

Table 2: Overall Project Estimate ($000)

Project Cost	2026	2027	Beyond	Total
Material Supply	377.1	0.0	0.0	**377.1**
Labour	847.4	0.0	0.0	**847.4**
Consultant	250.0	0.0	0.0	**250.0**
Contract Work	125.0	0.0	0.0	**125.0**
Other Direct Costs	106.7	0.0	0.0	**106.7**
Interest and Escalation	91.5	0.0	0.0	**91.5**
Contingency	225.9	0.0	0.0	**225.9**

Total	**2,023.6**	**0.0**	**0.0**	**2,023.6**

1 Table 3 and Table 4 provide the individual estimates for the Bay d'Espoir Unit 7 and Hinds Lake Unit 1
2 PM9 inspections and associated refurbishment.

Table 3: Bay d'Espoir Unit 7 PM9 Inspection Estimate ($000)

Project Cost	2026	2027	Beyond	Total
Material Supply	247.0	0.0	0.0	**247.0**
Labour	434.5	0.0	0.0	**434.5**
Consultant	100.0	0.0	0.0	**100.0**
Contract Work	75.0	0.0	0.0	**75.0**
Other Direct Costs	16.6	0.0	0.0	**16.6**
Interest and Escalation	51.7	0.0	0.0	**51.7**
Contingency	142.5	0.0	0.0	**142.5**
Total	**1,067.3**	**0.0**	**0.0**	**1,067.3**

Table 4: Hinds Lake Unit 1 PM9 Inspection Estimate ($000)

Project Cost	2026	2027	Beyond	Total
Material Supply	130.1	0.0	0.0	**130.1**
Labour	413.0	0.0	0.0	**413.0**
Consultant	150.0	0.0	0.0	**150.0**
Contract Work	50.0	0.0	0.0	**50.0**
Other Direct Costs	90.1	0.0	0.0	**90.1**
Interest and Escalation	39.8	0.0	0.0	**39.8**
Contingency	83.3	0.0	0.0	**83.3**
Total	**956.3**	**0.0**	**0.0**	**956.3**

5.4 Project Schedule

The schedule for this project is shown in Table 5.

Table 5: Project Schedule

Activity	Start Date	End Date
Planning: Open work order and plan and develop detailed plan and schedules.	January 2026	March 2026
Procurement: Develop contracts for material procurement, tender, and award contract.	January 2026	April 2026
Construction: Perform PM9 Inspection and additional work identified.	April 2026	November 2026
Commissioning: Run up both units to confirm operation and release to operations.	May 2026	November 2026
Closeout: Close work order, complete all documentation, and complete lessons learned.	December 2026	December 2026

6.0 Conclusion

Hydro performs time-based PM annually on all major hydraulic units on the Island Interconnected System. At a frequency of six years, Hydro performs inspections that incorporate annual activities in addition to more detailed inspection activities, called a PM9 inspection. On occasion, this six-year interval must be modified due to other considerations or to provide operations with flexibility. Hydro recommends proceeding with the reduced pace of seven years for the PM9 inspection on both Bay d’Espoir Unit 7 and Hinds Lake Unit 1. This approach will provide operational synergies, align work with the extended outages in 2026 due to the Hinds Lake Rewind Stator project, and allow for the completion of the Bay d’Espoir Unit 2 overhaul in 2025 during the Penstock 1 outage. Based on Hydro’s operational experience, it is recommended that this project continue to support the reliable and safe operation and long-term reliability of the hydraulic units within Hydro’s fleet.

Appendix A

Project Scope Table

Item No. (2023 Hatch Condition Assessment Report)[1]	Component/Topic	Status	Deficiency Description	Do-Nothing Consequence	Recommended Actions	Justification	References to 2023 Hatch Condition Assessment Report	Hydro Action (2026 PM9 Scope)
5	Stator Frame	Good	Metallic debris in frame and bottom end caps.	Serious in-service failure with damage to equipment and forced outage.	Clean and inspect to prevent accumulation. Perform during next planned outage or available opportunity.	Life extension.	Section 3.4.1	Inspect end-winding caps at the bottom of the unit.
7	Stator Armature Winding	Poor	Significant bubbling of the paint over bars surface belonging to slot 196 in the area where the bar is going into the bottom cap is sign of possible cold joint of the two halves of the same coil being brazed inside the cap.	Serious in-service failure with damage to equipment and forced outage.	Monitor local temperature with thermal strips. See report for details.	Monitoring the development of the hot spot allows remedial action to be planned before an in-service failure happens.	Section 3.4.3	Inspect end-winding caps at the bottom of the unit.
19	Runner Cavitation	Poor	Cavitation damage at several locations on the runner. The runner has been weld repaired several times and the cavitation damage is an ongoing problem.	Cavitation will continue and may cause structural damage to the runner. Cavitation can also cause poor hydraulic performance. If no action is taken, the runner will continue to cavitate. Hatch estimates that if NL Hydro operates the units within the known cavitation limits and performs regular inspections of the runner, the estimated service life is 5-10 years. Voith recommended to replace the runner within 5 years of 2019 report.	Supply a new stainless-steel runner.	A stainless-steel runner can be more cavitation resistant and not require painting like the current carbon steel runner. A new hydraulic profile and design can provide increased efficiency and reduce the likelihood of cavitation. Runner replacement with estimated 2% increase in efficiency is optimal solution according to Hatch Uprate Report (H371822-0000-2A1-066-0002). It is possible to perform cavitation repairs on runners, but this cannot be performed indefinitely. There is risk to weld deformations causing hydraulic tolerance issues and structural issues with layered weld repairs. Hatch does not recommend additional weld repairs beyond the extent currently performed. As NL Hydro does not have blade templates, the likelihood of performing extensive weld repairs within the hydraulic tolerance is very low.	Section 3.13.1	Reweld runner cavitation to ensure reliable operation until runner replaced in 2028.
26	Operating Ring and Bearings	Poor	Significant surface damage on the upper and lower operating ring bearing journal surfaces. Operating ring has deformed over time is now an oval shape. Issues with temporary bearing pads installed in 2019.	Bearing pads will continue to come out of place and cause damage to the operating ring and the head cover. Grease from the operating ring bearing is not contained and may contaminate turbine pit equipment. Sever damage may prevent gates from opening.	Inspection and Rehabilitation of Operating Ring and Supply of New Bearing Pads. As an option, a new operating ring with a split should be considered by NL Hydro as the bearing pads can be changed without major disassembly of the unit.	As the current bearing pads have already caused issues, regular maintenance and monitoring is required. Expected service life based on bearing pad life. Operating ring life expected to be 40 years.	Section 3.10.2	Installation of temporary operating ring guide pads to ensure reliable operation until operating ring replaced in 2028.
27	Gate Servomotor Scoring	Fair	NL Hydro believes that there was leaking in the servomotors prior to 2019. Scoring on the ID of the cylinder wall discover in 2019 and not addressed. Scoring on the piston.	Leakage around piston and loss of pressure.	Inspection, rehabilitation, and replace wear components. Recommend to complete work in parallel with operating ring.	Life extension.	Section 3.10.1.1	Replacement of the servomotor piston seals.

[1] The 2023 Hatch Condition Assessment Report can be found in "Life Extension Application – Bay d'Espoir Unit 7," Newfoundland and Labrador Hydro, June 20, 2025, sch. 1, att. 1.

Item No. (2023 Hatch Condition Assessment Report)[1]	Component/Topic	Status	Deficiency Description	Do-Nothing Consequence	Recommended Actions	Justification	References to 2023 Hatch Condition Assessment Report	Hydro Action (2026 PM9 Scope)
29	Spiral Case Access Door Leakage	Poor	Water leakage around the spiral case access door.	It's not possible to provide a confident outlook if nothing is done. If the condition has been in existence for 30+ years as reported by NL Hydro, it could continue as is for another 15 or 20 years. Or it could become a more urgent issue if the leakage rate increases rapidly. Exact consequences are unclear as the root cause is not identified. The current leakage rate does not appear to be causing other significant issues. NL Hydro could continue to monitor the flow rate.	Hatch recommends monitoring and collect leakage data. If the average flow rate increases month over month for more than three (3) consecutive months, or if there is a sustained average flow rate over 3.0 L/s over a given month, that NL Hydro investigate the problem further and perform the following recommended repairs.	Reduce risk of unplanned outages and sudden failure or issues.	Section 3.11.4.1	Grouting of scroll case to ensure reliable operation until 2028.
					Seal weld stay ring flange to discharge ring. This will likely cause distortion of the discharge ring surface where the bottom ring mounts to. Therefore, field machining of embedded components is required. This field machining would be recommended in either situation as to ensure proper alignment of the bottom ring to head cover, ensure level mounting surfaces, and ensure the bottom ring flange with the Oring has a proper mounting surface to seal.	This will resolve the most likely source of the water source. Not guaranteed to prevent all water leakage around spiral case access door.		
					Lead abate, blast, clean, NDE, and paint the spiral case, stay ring, stay vanes, discharge ring, and draft tube liner down to the maintenance platform. Perform local repairs as necessary.	Improve water passage surfaces and provide life extension to the embedded components. May reduce leakage if holes are present.		
					Remove spiral case baffle plate, inspect, repair as needed, and re-install baffle plate.	Less likely source of leakage but may improve leakage around access door.		
					Pressure tests all embedded piping.	Ensure embedded piping doesn't have leaks. Likely not the main source of the access door leakage, but may be a contributing factor if an embedded component has leakage.		
N/A- Hydro Proposed	Non-Destructive Examination (NDE) of all rotor rim guidance blocks and key assemblies	Unknown	The design of the rotor on Unit 7 is similar to the rotor on the Upper Salmon (USL) Unit. The rotor is design with a 'floating rim' that can lead to undesired stresses within guidance blocks and key assemeblies as experienced on the USL unit.	Potential failure of components in short term, risk to long-term reliability of unit.	Non-Destructive Examination (NDE) of all rotor rim guidance blocks and key assemblies	Reflect lessons learned in 2023 within *Rotor Rim Shrinking and Stator Recentering at the Upper Salmon Hydroelectric Generating Station* Project.	N/A	Perform NDE.

Replace Roof

(2026–2027)

Hopedale

Table of Contents

Replace Roof (2026–2027)

Location: Hopedale

Investment Classification: Renewal

Asset Category: Properties

Estimated Cost: $1,981,600

1.0 Introduction

The Hopedale Diesel Generating Station building was constructed in 1991 and originally consisted of three diesel generating units with an installed capacity of 1,562 kW. The addition of a fourth generating unit in 2013 required an extension of the existing building envelope and the addition of a new fire protection system. The facility is the sole source of power for the community of Hopedale, and as such, it is required to provide the electrical supply to approximately 305 customers on a continuous basis.

The generating station roof for both the original building envelope and the building extension is comprised of an exposed fastener and a metal roof assembly. The roof for the original building envelope has been in place since the time of installation in 1991 and has reached the end of its service life. The building extension roof has been in service for 12 years. In recent years, the formation of leaks in the facility has increased in frequency for both roof sections. These leaks disrupt operations and pose a risk to the sensitive equipment that is housed within the facility. The continued formation of leaks and ingress of water could result in equipment damage and result in a plant outage.

The rooftop exhaust fans located on the original building envelope roof have also reached the end of their service life. The exhaust units require frequent repair and no longer provide adequate ventilation for the engine hall.

Newfoundland and Labrador Hydro ("Hydro") is proposing the replacement of the entire powerhouse roofing system and rooftop exhaust fans to restore integrity to the building envelope and improve the interior temperature conditions for personnel and generating unit efficiency. Hydro is proposing to cluster the replacement of the Hopedale powerhouse roof with the replacement of the rooftop exhaust fan system to maximize execution efficiency, as both systems have reached the end of their useful service lives.

2.0 Project Description and Justification

The Hopedale Diesel Generating Station roof has experienced a recent increase in the formation of leaks. These leaks disrupt operations and pose a risk to the sensitive equipment housed within the facility.

While Hydro has completed corrective maintenance as required, the repairs have provided short-term relief, and the leaks continue to develop. The continued formation of leaks and ingress of water could result in equipment damage and result in a plant outage, eliminating the sole source of generation for the community.

Hydro is proposing to install a pre-formed, standing seam metal roofing system for the roof replacement. These roofing systems are fully interlocking and provide a weather-tight seal. In a standing seam roofing system, the panel seams are connected above the level of the metal roof panels. As seams are typically the weak point for water infiltration with any kind of building material, especially roofing, replacing the entirety of the existing roofing system and rooftop exhaust fans at once to prevent designing joins, and raising the seams above water level are key advantages to prevent future leaks. Hydro is proposing to install this system over the entirety of the powerhouse roof to ensure roofing integrity is maintained for the complete building envelope for the next 30 years.

As part of the roof replacement project, the existing rooftop exhaust fans will also be replaced. Their replacement is required as they have reached the end of their service life, require frequent repair, and no longer provide adequate ventilation for the engine hall.

This project involves the replacement of the powerhouse roofing and exhaust fan systems. The replacement is required to restore the integrity of the roof by mitigating the risks associated with the infiltration of water and restoring reliable ventilation to the engine hall.

3.0 Asset Overview

3.1 Asset Background

The Hopedale Diesel Generating Station was built in 1991. In 2013, the facility underwent a significant upgrade to extend the engine hall to accommodate the addition of another generating unit. The original portion of the building envelope roof and the rooftop exhaust fans are now 34 years old, as shown in Figure 1. The roofing section for the building extension, shown on the right in Figure 1, is 12 years old.

Figure 1: Hopedale Diesel Generating Station Roof

3.2 Historical Reliability

Hydro completes regular maintenance to ensure the reliability of the roofing and rooftop exhaust systems, including patching and repair of trouble areas. In recent years, an influx of issues, as described in Section 3.3, has raised concerns suggesting the roofing and exhaust systems have exceeded their useful service lives.

3.3 Asset Condition

The condition of the Hopedale Diesel Generating Station roof has deteriorated to the point of requiring replacement. Repairs have been made as required to stop and prevent leaks with little success. It is evident that the original portion of the existing roof is at the end of its life, and repairs are no longer a viable alternative.

The extension roof began experiencing leaks within a short period after installation. Repairs were completed within the warranty period, but leakage issues continued to arise. A coating system was applied in 2015 in an attempt to stop the leaks, which worked for a brief period; however, water infiltration has continued to cause issues. In 2021, a fire suppression panel required replacement due to water damage caused by the roof leaks.

The rooftop exhaust fans have seen an increase in repairs in recent years, and no longer provide adequate ventilation to the engine hall. Two of the fans are in working, yet poor, condition. The third fan will only run for a short period before tripping, signalling an electrical issue with the fan motor. The fans require annual maintenance, in which personnel are required to access the rooftop to tighten and/or replace belts. When issues arise, personnel are accessing the rooftop units more frequently to troubleshoot and correct problems, further contributing to wear on the roofing system. When the fans are not working, the engine hall can experience temperatures up to 40^{o}C during the summer, which creates an unsafe working environment for personnel and affects the performance of the diesel units.[1]

3.4 Condition-Based Remaining Life

The roofing system and rooftop exhaust fans on the original building envelope are 34 years old and have reached the end of their useful life. This is demonstrated by the recent history of roof leaks, indicating that the roofing system has failed. Two of the three rooftop exhaust fans are in poor condition, while the third is considered inoperable. The fans are no longer able to provide adequate ventilation to the facility.

The building extension roof has been in service for 12 years, but leaks have developed, and the water infiltration has introduced risks to the electrical equipment housed within. Attempts to repair the leaks have been made, but efforts to access the areas which require repair are further contributing to leakage in the roofing system.

4.0 Analysis

4.1 Evaluation of Alternatives

The following alternatives were considered for this project:

- Deferral;
- Upgrade life extension; and
- Like-for-like replacement.

[1] The diesel units work more efficiently in cooler air. Doors are opened to help with air movement when temperatures rise to this level, but this practice allows dust inside of the plant which obstructs air filters and can negatively affect electrical and instrumentation equipment.

4.1.1 Deferral

The Hopedale Diesel Generating Station roofing and rooftop exhaust fan systems have exceeded their service life and are no longer able to provide an adequate level of weather protection or reliable ventilation for the building. Hydro has completed numerous repairs to address roof leaks in the facility, which have provided only short-term relief from water infiltration before the leaks recur. Two of the three rooftop exhaust fans are in functional but poor condition, causing interior building temperatures to reach levels that affect personnel safety and generating unit efficiency, especially in the summer months.

Leaks disrupt operations within the facility and jeopardize the operation of sensitive electrical equipment housed in the generation hall, with the potential to impact system reliability. A generation outage at the Hopedale Diesel Generating Station could be highly detrimental to the customers that rely on the generating plant as their sole source of power, and could result in increased costs associated with temporary mobile diesel power while equipment issues are addressed.

Failure to complete the proposed replacement will result in the continued deterioration of the roofing system and the reoccurrence of leaks throughout the facility, increasing the risk of damage to electrical equipment and jeopardizing the provision of reliable service to the community of Hopedale. The frequency of issues with the rooftop exhaust fans will continue as the equipment ages, and the interior temperatures will not improve until the fans are replaced. For this reason, deferral of the proposed work is not considered a viable alternative.

4.1.2 Upgrade Life Extension

Hydro completes regular maintenance on the roofing system and rooftop exhaust fans to prolong the life of the assets. However, these options have now been exhausted as the roofing system and rooftop exhaust fans have reached the end of their service lives, and accessing the roof to complete leak repairs is inducing further damage to the roof.

Additionally, the requirement to access the rooftop for exhaust fan preventative and corrective maintenance, which is occurring more frequently due to the age and condition of the fans, is also further damaging the roof. As such, upgrade life extension is not considered to be a viable option.

4.1.3 Like-for-Like Replacement

The generating station roofing system and rooftop exhaust fans have reached the end of their service life. Replacement of the existing roofing system with a comparable metal roofing system will restore the integrity of the exterior envelope of the facility for the next 30 years and reduce the risks associated with water infiltration. The roof will be replaced with a standing seam metal roof, which uses vertical seams to hide fasteners and provide better weather resistance. Replacement of the existing belt-driven exhaust fans with direct drive exhaust fans will reduce the frequency of rooftop maintenance, as belt tightening/replacement will no longer be required.[2]

Hydro is proposing to cluster the replacement of the Hopedale powerhouse roof with the replacement of the rooftop exhaust fan system to maximize execution efficiency and eliminate patching/joins, which is key to preventing future leaks.[3]

4.2 Least-Cost Evaluation

Hydro has not identified any viable alternatives to facilitate a least-cost evaluation.

4.3 Recommended Alternative

Like-for-like replacement has been determined to be the only viable option to satisfy Hydro's long-term operational needs.

The Hopedale Diesel Generating Station exterior envelope is required to provide a weather-tight facility in which to house the generating equipment. The existing roofing system for the original building section has not undergone any major refurbishment since its installation in 1991. The building extension roof, while 12 years old, is in deteriorating condition, and repairs are no longer a viable option. The rooftop exhaust fans are located on the original building, require frequent repair, and no longer provide adequate ventilation for the engine hall. Given the age and condition of these assets, a complete replacement is recommended.

Hydro is proposing to cluster the replacement of the Hopedale powerhouse roof with the replacement of the rooftop exhaust fan system to maximize execution efficiency, as both systems have reached the

[2] Hydro considered replacing the rooftop exhaust fans with wall-mounted fans to eliminate the requirement to access the roof for maintenance; however, there was insufficient space within the existing walls of the facility for this installation.

[3] The size and geometry of the roof penetration is dependent on the exhaust fan specification. Retrofitting the exhaust fan into an existing roof penetration will require resizing/patching of existing openings, which will increase the risk of leaks to the roofing system.

end of their useful service lives. Replacing the entirety of the roofing system and rooftop exhaust fans simultaneously also eliminates patching and joins, which is key to preventing future leaks.

4.3.1 Risk of Asset Stranding

The Hopedale Diesel Generating Station is the only source of power to the community, and as such, it is required to provide the electrical supply to approximately 305 customers on a continuous basis. For this reason, Hydro considers the risk of asset stranding to be negligible.

4.3.2 Risk Mitigation

Hydro assessed the pre- and post-implementation risk of the scope of work for the 2026–2027 project in accordance with Hydro's Capital Risk Assessment process, as outlined in Section 7.0 of Schedule 1. The outcome of this assessment is provided in Table 1.

Table 1: Risk Scoring Pre- and Post-Implementation

	Impact	Likelihood	Score
Pre-Implementation	4	4	**16**
Post-Implementation	4	2	**8**
		Risk Mitigated	**8**
		Risk Mitigated per $1 Million	**4.0**

5.0 Scope of Work

This project involves the replacement of the existing exposed fastener roofing and exhaust fan system at the Hopedale Diesel Generating Station.

The scope includes the following:

- Completion of Hazardous Materials Assessment of existing roof and exhaust fan systems;
- Completion of detailed design for new roofing and mechanical exhaust systems;
- Removal and disposal of existing powerhouse roofing and mechanical exhaust systems; and
- Supply and installation of new powerhouse roofing and mechanical exhaust systems.

5.1 Project Budget

The Hopedale powerhouse roof replacement will be executed as a two-year project. The estimate for this 2026–2027 project is shown in Table 2.

Table 2: Project Estimate ($000)[4]

Project Cost	2026	2027	Beyond	Total
Material Supply	0.0	0.0	0.0	**0.0**
Labour	87.8	50.0	0.0	**137.7**
Consultant	67.1	93.6	0.0	**160.7**
Contract Work	0.0	1,262.0	0.0	**1,262.0**
Other Direct Costs	9.3	9.7	0.0	**19.0**
Interest and Escalation	10.1	130.1	0.0	**140.1**
Contingency	16.4	245.6	0.0	**262.0**
Total	**190.6**	**1,791.0**	**0.0**	**1,981.6**

5.2 Project Schedule

The schedule for this project is shown in Table 3.

Table 3: Project Schedule

Activity	Start Date	End Date
Planning:		
Budget review, scope statement development, and risk assessment.	January 2026	March 2026
Design:		
Engage consultant, detailed design, and preparation of tender package.	May 2026	August 2026
Procurement:		
Tender and award construction contract.	January 2027	February 2027
Construction:		
Complete roof and exhaust fan replacement.	July 2027	August 2027
Closeout:		
Project closeout.	November 2027	November 2027

[4] Numbers may not add due to rounding.

6.0 Conclusion

The Hopedale powerhouse roofing and exhaust fan systems have exceeded their service life and are no longer able to provide an adequate level of weather-tightness or reliable ventilation. In recent years, the formation of leaks in the facility has increased in frequency, thus increasing the risk of damage to sensitive electrical equipment housed within the plant and jeopardizing the reliability of service to the community. The rooftop exhaust fans, located on the original building, require frequent repair and have reached the end of their service life. The replacement of these systems is required to restore the integrity of the roof and mitigate the risks associated with the infiltration of water, and restore reliable ventilation to the engine hall.

Perform Software Upgrades and Minor Enhancements – Information Technology

(2026–2027)

newfoundland labrador hydro

Contents

Perform Software Upgrades and Minor Enhancements – Information Technology (2026–2027)

Location: Various

Investment Classification: General Plant

Asset Category: Information Systems

Estimated Cost: 1,747,100

1.0 Introduction

This project focuses on the modernization and enhancement of Newfoundland and Labrador Hydro's ("Hydro") Information Technology ("IT") software applications. These applications are essential to the ongoing delivery of Hydro's core business functions.

Hydro's IT assets include software, hardware, and data systems that support a broad range of internal operations. These systems are fundamental to functions such as:

- Health and safety compliance;
- Financial management and accounting;
- Human resources and workforce administration;
- Customer service and billing;
- Supply chain and procurement operations;
- Facilities and asset management;
- Engineering and project execution;
- Environmental monitoring and compliance;
- Legal and regulatory affairs;
- Strategic planning and risk management;
- Corporate communications and stakeholder relations;
- Administrative services;

- Document control; and
- IT.

Historically, the administration of Information Systems ("IS") sat within Nalcor Energy ("Nalcor") and was charged to Hydro through an administration fee; however, post-amalgamation of Nalcor and Hydro, effective January 1, 2025, these assets are now owned by Hydro, a regulated utility, and are not exempt from the *Public Utilities Act*. Therefore, any IS expenditures for new IT assets, as well as sustaining capital on existing IT assets, will now be subject to application to the Board of Commissioners of Public Utilities pursuant to the *Act.*

As a result, the sustaining capital projects associated with software upgrades and minor enhancements of IT assets is now part of Hydro's annual capital budget application. Hydro has created a separate project for the capital expenditures related to IT assets, recognizing the distinct nature and purpose of IT software as compared to Operational Technology ("OT") software, used specifically for grid operations.[1]

2.0 Project Description and Justification

Hydro relies on software applications to support its core business functions. As technology advances and business requirements become increasingly complex, this project allows Hydro to modernize and strengthen its IT software environment to keep pace with evolving system and operational demands. These enhancements improve system functionality, ensure seamless integration with other platforms, and reduce the risk of service disruptions. The enhancements will also strengthen Hydro's cybersecurity posture and help mitigate the risk of privacy breaches. By investing in the modernization of its software systems, Hydro is reinforcing operational continuity, protecting its reputation, and ensuring its readiness to meet future demands.

For 2026, Hydro proposes to complete the following work as part of this project:

JD Edwards Upgrade

Hydro is upgrading its JD Edwards ("JDE") Enterprise Resource Planning ("ERP") system to ensure the platform remains current, secure, and aligned with the vendor's latest standards. The JDE environment

[1] Capital expenditures related to OT are included in "Perform Software Upgrades and Minor Enhancements – Operating Technology (2026–2027)." This project can be found in the Programs and Projects Under $750,000 section of this application, at the end of Schedule 7.

was last updated in 2023; this next upgrade will bring both the tools and application code to the most recent supported release. This will ensure continued vendor support, enhanced cybersecurity protection, and compatibility with infrastructure and other IT systems. Upgrading will not only mitigate cybersecurity risks and reduce the potential of service disruptions but also enable Hydro to take advantage of new functionality, performance improvements, and user experience enhancements.

Content Manager Upgrade

Hydro is upgrading its OpenText Content Manager ("Content Manager") system, which is currently out of standard support and will reach the end of sustaining support by the time the upgrade is complete. A mandatory upgrade to a new version is required to continue to receive sustained vendor support. As Hydro's enterprise document and records management platform, Content Manager supports the secure handling of electronic records across the organization. Upgrading to the latest supported release is essential to maintain system stability, data integrity, and compliance with privacy and information security standards. Without this upgrade, Hydro will be unable to receive critical patches and vendor assistance, increasing operational and cybersecurity risks. This initiative aligns with Hydro's commitment to risk mitigation, information governance, and modernization of digital infrastructure, ensuring efficient and secure document management.

Ad Hoc Requests

As part of this project, Hydro will also accommodate unforeseen but justifiable upgrade and enhancement requests received in 2026 and 2027, within the approved budget, where possible. Hydro's systems and applications are reviewed regularly to effectively plan necessary upgrades and enhancements; however, unforeseen requests for upgrades and enhancements may be received as business and technical needs change. Such unplanned work will be reported in Hydro's 2026 and 2027 Capital Expenditure and Carryover Reports, consistent with previous reporting of work relating to budgeted but undetermined expenses, such as in-service failures, and similar work in the Perform Software Upgrades and Minor Enhancements – Operational Technology (2026) project.[2]

[2] Hydro's 2026 Capital Expenditures and Carryover Report is to be filed on or before April 1, 2027.

3.0 Asset Overview

3.1 Asset Background

Hydro's software systems and applications support core business functions and are used daily by employees to manage the business. These systems are regularly assessed to plan necessary upgrades and enhancements. The software systems and applications planned for upgrade and enhancements in 2026 are:

JDE

JDE is a comprehensive ERP software suite developed by Oracle. It integrates various business processes, including finance, human resources, supply chain management, asset management and customer relationship management. The latest upgrade was implemented in 2023, with the software having been installed in 2018. The software provides a unified platform for managing core business functions, enhancing decision-making, and supporting digital transformation initiatives.

Content Manager

Content Manager is Hydro's document and records management system, used for information management and governance. It provides Hydro with secure capture, storage, efficient retrieval and disposal of content to regulatory and legal requirements for records management, including those outlined in the *Management of Information Act*. A mandatory upgrade to a new version is required to continue to receive sustained vendor support.

3.2 Historical Reliability

Hydro's experience has demonstrated the importance of upgrading software applications to maintain vendor support, mitigate risks, and utilize modern technologies. These practices are essential not only for preventing operational errors and improving efficiency but also for minimizing vulnerabilities that could expose the organization to cyber threats. Proactively addressing these risks helps ensure software compatibility, system integrity, and business continuity.

3.3 Asset Condition

Software systems and applications managed under this project have variable ages, conditions, and asset lifecycles. The decisions regarding software upgrade and enhancement requirements are driven by technology advancements, changes in business requirements, evolving compatibility with key systems and hardware, and vendor-released version upgrades.

The selection of JDE and Content Manager for upgrades and enhancements as part of this project scope, as well as the ad-hoc requests to take place over the course of the project, will ensure the solutions will maintain optimal functionality, remain compatible with other systems, receive sustained vendor support, and benefit from comprehensive and up-to-date security features.

4.0 Analysis

4.1 Evaluation of Alternatives

Hydro evaluated the following alternatives:

- Deferral;
- Upgrade life extension; and
- Like-for-like replacement.

4.1.1 Deferral

Under this alternative, systems would be operated without any upgrades or enhancements, negatively impacting the efficiency and security of Hydro's operations. In the case of JDE, Hydro risks losing reliability, security and performance of the asset, as the upgrades will mitigate evolving forms of cyber attacks, ensure JDE remains compatible with an array of other software that is used in the business, enhance functionality to allow for optimal leveraging of tools and options, and ensure compliance with tax regulations. Hydro's current version of Content Manager will no longer be supported by the vendor.

The release of upgrades is controlled by the applicable vendors. Hydro must review available upgrades, assess associated cybersecurity risks and determine the appropriate timing to implement upgrades for the organization. As such, Hydro does not consider this a viable alternative.

4.1.2 Upgrade Life Extension

Under this alternative, upgrades and enhancements will be performed by software and infrastructure specialists familiar with the technologies in 2026 and 2027. Failing to upgrade an IT system can lead to security vulnerabilities, making the organization more susceptible to cyber threats and data breaches. Outdated systems often experience performance issues, increased downtime, and inefficiencies that hinder productivity and disrupt operations. Over time, compatibility problems will arise, preventing integration with newer technologies and limiting the organization's ability to adapt to evolving business needs.

Upgrading and enhancing existing systems extends the useful life of previous investments and can be performed at a fraction of the cost of the implementation of a new system. Upgrades will improve system functionality, provide seamless integration with other technology platforms, and reduce the risk of cyber incidents and service disruptions.

4.1.3 Like-for-Like Replacement

Prior to upgrading or enhancing solutions, Hydro will consider replacement with an alternative system. Replacing software applications with new solutions would include engaging vendors through the Request for Proposals process. Replacement is not recommended for JDE or Content Manager as the existing software systems are widely used and performing well, and upgrades or minor enhancements will address any issues identified with these systems. Replacement is an inherently more expensive, resource-intensive, and time-consuming alternative and therefore is not a viable alternative at this time.

4.2 Least-Cost Evaluation

Hydro has not identified any viable alternatives to facilitate a least-cost evaluation.

4.3 Recommended Alternative

Hydro recommends upgrading and enhancing the identified software systems. Failing to upgrade or enhance software can lead to several significant risks. Security vulnerabilities may remain unpatched, exposing the system to potential cyber threats and data breaches. Performance issues can arise, resulting in slower operations and reduced productivity. Compatibility problems with newer hardware and software can cause integration challenges and operational disruptions. Additionally, outdated software may not comply with current regulatory standards, leading to potential legal and financial repercussions. Overall, neglecting software upgrades and enhancements can compromise the efficiency, security, and reliability of business operations.

4.3.1 Risk of Asset Stranding

There is minimal risk for asset stranding. The software systems proposed to be upgraded or enhanced under this project are widely used in multiple business and functional areas throughout the organization. In addition, these software systems and applications have large user groups. The software being upgraded is well-represented and utilized in the market for similar tools, and the respective vendors are continually implementing vital upgrades, as is the case with the Content Manager and JDE.

4.3.2 Risk Mitigation

Hydro assessed the pre- and post-implementation risk of the scope of work for the 2026–2027 project in accordance with Hydro's Capital Risk Assessment process, as outlined in Section 7.0 of Schedule 1. The outcome of this assessment is provided in Table 1.

Table 1: Risk Scoring Pre- and Post-Implementation

	Impact	Likelihood	Score
Pre-Implementation	4	4	**16**
Post-Implementation	4	2	**8**
		Risk Mitigated	**8**
		Risk Mitigated per $1 Million	**4.6**

5.0 Scope of Work

A preliminary analysis has identified the following software systems to be updated or upgraded as part of the project scope:

- Upgrade JDE EnterpriseOne;
- Upgrade Hydro's current version of Open Text Content Manager; and
- Complete unforeseen, justifiable requests for upgrades and enhancements used to meet changing business needs.

The detailed project scope will be confirmed during the planning and design stages of the project. The scope of unforeseen requests for upgrades and enhancements to meet changing business needs will be determined when the requests are reviewed and justified for inclusion in the project.

5.1 Project Budget

The estimate for this project is shown in Table 2.

Table 2: Project Estimate ($000)[3]

Project Cost	2026	2027	Beyond	Total
Material Supply	50.0	0.0	0.0	**50.0**
Labour	266.7	104.2	0.0	**370.9**
Consultant	258.0	772.6	0.0	**1,030.6**
Contract Work	0.0	0.0	0.0	**0.0**
Other Direct Costs	0.0	0.0	0.0	**0.0**
Interest and Escalation	18.6	80.1	0.0	**98.6**
Contingency	56.6	140.3	0.0	**196.9**
Total	**649.9**	**1,097.2**	**0.0**	**1,747.1**

The project cost will be allocated using Hydro's Intercompany Transactions Guidelines under the IS Administrative Fee and allocated based on users. Hydro's regulated business segment will be responsible for approximately 57% of the total cost, the entities related to the Muskrat Falls assets will be responsible for approximately 6% of the cost, and the remaining lines of business will accrue the remainder.

[3] Numbers may not add due to rounding.

5.2 Project Schedule

The schedule for this project is shown in Table 3.

Table 3: Project Schedule

Activity	Start Date	End Date
Planning: Open project, review schedule, create requests for proposal(s), confirm scope.	January 2026	June 2026
Design: Confirm detailed design, create project plans.	February 2026	July 2026
Procurement: Award requests for proposals (if required) and secure resources.	February 2026	August 2026
Construction: Build software enhancements, go live with enhancements.	February 2026	April 2027
Closeout: Project closeout.	November 2027	November 2027

6.0 Conclusion

Hydro maintains many software systems and applications to support its business processes. Upgrades and enhancements maintain and improve the functionality and security of these systems and applications. This project includes planned upgrades and enhancements, and allows Hydro to respond to unforeseen requests for system upgrades and enhancements that cannot be deferred to a subsequent year.

Replace Teleprotection Equipment

(2026–2028)

Contents

Replace Teleprotection Equipment (2026–2028)

Location: Various

Investment Classification: General Plant

Asset Category: Telecontrol

Estimated Cost: $1,499,800

1.0 Introduction

To protect critical high-voltage electrical equipment and/or generating units from damage and to ensure system stability, Newfoundland and Labrador Hydro ("Hydro") operates various types of protection equipment at its terminal stations and generating facilities. One form of protection used at many of these sites utilizes equipment that depends on communications between sites; that is, signals are transmitted and received between opposite ends of a communications link to open circuit breakers when abnormal system conditions are detected. To facilitate this, teleprotection multiplexing equipment transmits either hard-wired inputs or line current data between the protection equipment at either end of the link.

This project is required to replace teleprotection multiplexors that have reached the end of their useful service life. Failure of a teleprotection multiplexor could result in widespread and/or extended outages, or catastrophic damage to high-voltage electrical equipment and/or generating units.

This project is proposed to be completed over three years with an estimated budget of $1,499,800.

2.0 Project Description and Justification

Communications multiplexors are used to combine data from multiple sources into one data stream for transmission over a communications medium to another site. Hydro utilizes multiplexors for various types of data, including voice, and also for teleprotection.

Teleprotection involves the transmission of signals between protection equipment at opposite ends of a communications link, such as a transmission line, to open circuit breakers to remove high-voltage electrical equipment and/or generating units from service during abnormal system conditions.

The failure of a multiplexor to operate correctly could result in the following impacts:

- Damage to high voltage equipment due to abnormal fault currents remaining on the system for an extended period of time;
- Damage to a generating unit due to failure of a headgate to drop; and
- Greater spread and impact of outages that occur due to failure of teleprotection signals to operate primary protection equipment; in this case, backup protection will operate; however, this may expand the number of breakers required to isolate a fault and thus impact more of the grid.

Eighteen of Hydro's existing teleprotection multiplexors have reached the end of their useful service life. This project is required to replace these teleprotection systems in a planned manner in order to avoid system impact due to equipment damage. If high-voltage electrical equipment and/or generating units are damaged, there will be an extended equipment outage until the equipment can be repaired or replaced. Depending on system conditions at the time of damage, there may be customer impact during the time the damaged equipment is unavailable.

In addition, current multiplexors do not allow for remote management and monitoring capabilities. This leads to an increased requirement to perform site visits in order to respond to alarms and perform troubleshooting that would be eliminated with newer technology.

3.0 Asset Overview

3.1 Asset Background

Hydro has 51 teleprotection multiplexing systems, represented by two different types of technologies based on the types of mediums they communicate over. Forty of Hydro's multiplexing systems operate over microwave radio links or fibre-optic links, while 11 systems operate over powerline carrier links. Of the former, 18 of these were installed between 2000 and 2004 and have reached the end of their useful service life, which is typically about 20 years.

Each system comprises at least two multiplexors—one at each end of a communications link. Depending on the size of the terminal station, there could be up to three teleprotection multiplexors per system. These teleprotection systems are in continuous operation unless there is a maintenance outage on the associated transmission line or generating unit.

Table 1 contains a list of the teleprotection multiplexors to be replaced under this project.

Table 1: Age of Teleprotection Multiplexors to be Replaced

Service / Asset	Type	Equip Age[1]
Granite Canal Headgate Teleprotection	Dry Contact	23
Hinds Lake (“HLK”) Headgate Teleprotection	Dry Contact	26
Upper Salmon Station Headgate Teleprotection	Dry Contact	23
Bay d’Espoir (“BDE”) Unit 7 Headgate Teleprotection	Dry Contact	24
TL203 (Western Avalon (“WAV”)–Sunnyside)	Dry Contact	22
TL204 (BDE–Stony Brook (“STB”))	Dry Contact	26
TL231 (BDE–STB)	Dry Contact	26
TL232 (STB–Buchans)	Dry Contact	26
TL218 (Holyrood–Ochre Park (“OPD”) – 3 Units)	Dry Contact and C37.94	24
TL236 (Hardwoods (“HWD”) – OPD)	Dry Contact and C37.94	24
TL235 (STB–Grand Falls Frequency Converter)	Dry Contact	24
TL243 (HLK–Howley (“HLY”))	Dry Contact	23
TL245 (Deer Lake – HLY)	Dry Contact	23
TL266B and TL242B (HWD–Sop’s Arm (“SOP”))	C37.94	24
TL201B and TL217B (WAV–SOP)	C37.94	24
TL201A and TL217A (WAV–SOP)	C37.94	24
TL268A and TL265A (SOP–HRD B)	C37.94	24
TL268B and TL265B (SOP–HRD B)	C37.94	24

3.2 Historical Reliability

The current teleprotection multiplexors have performed reliably throughout their lifetime.

3.3 Asset Condition

There are maintenance concerns with the current teleprotection multiplexing systems. The current technology lacks remote management capability. This means that the devices cannot be configured or monitored remotely, resulting in increased site visits to troubleshoot issues. In addition, some alarms generated by the devices require site visits to clear the alarms manually.

[1] Age as of 2026.

4.0 Analysis

4.1 Evaluation of Alternatives

Hydro evaluated the following alternatives:

- Deferral;
- Upgrade life extension; and
- Like-for-like replacement.

4.1.1 Deferral

Under this option, the existing teleprotection multiplexors would remain in service. This poses a risk to the reliable operation of the Island Interconnected System since these multiplexors have reached the end of their useful service life and are at higher risk of mis-operation or failure. This could result in damage to high voltage electrical equipment and/or generating units, as well as outages which may be extended or widespread depending on the equipment damaged and system conditions. As such, deferral was not considered to be a viable alternative.

4.1.2 Upgrade Life Extension

Under this option, Hydro could update select components of the multiplexing systems; however, the risk of mis-operation remains unless all components are replaced, since all components are 21–25 years old, and past their expected useful life of 20 years. As such, upgrade life extension was not considered to be a viable alternative.

4.1.3 Like-for-Like Replacement

Under this option, the existing, obsolete teleprotection multiplexors would be removed, and new, modern multiplexors would be installed. The new multiplexors would be consistent with Hydro's current multiplexing equipment standard and related Communications Engineering Standards. The new units will also allow employees to monitor conditions and review alarms remotely, reducing the number of on-site visits required. The new multiplexors would provide a service life of 20+ years.

4.2 Least-Cost Evaluation

Hydro has not identified any viable alternatives to facilitate a least-cost evaluation.

4.3 Recommended Alternative

Hydro recommends replacement of the end-of-life teleportation multiplexors for 18 systems with the modern equivalent. This is required to address the risk of mis-operation or failure of these aged devices, which could result in extended or widespread outages due to damage to high-voltage electrical equipment and/or generating units.

4.3.1 Risk of Asset Stranding

Teleprotection is used as part of electrical utility best practice for the protection of high-voltage utility electrical equipment and generating units. The risk of asset stranding of the new teleprotection multiplexors is low in that the equipment they protect is an integral part of the electrical system, and will be required as long as the assets are in service.

4.3.2 Risk Mitigation

Hydro assessed the pre- and post-implementation risk of the scope of work for the project in accordance with Hydro's Capital Risk Assessment process, as outlined in Section 7.0 of Schedule 1. The outcome of this assessment is provided in Table 2.

Table 2: Risk Scoring Pre- and Post-Implementation

	Impact	Likelihood	Score
Pre-Implementation	5	3	**15**
Post-Implementation	5	1	**5**
		Risk Mitigated	**10**
		Risk Mitigated per $1 Million	**6.7**

5.0 Scope of Work

The scope of work includes the following activities:

- Removal of 18 existing teleprotection systems at each end of the associated communication link;
- Design of new teleprotection systems;
- Procurement of new teleprotection multiplexors;
- Complete lab setup and testing for new systems; and

- Installation and commissioning of new multiplexors over three years.

5.1 Project Budget

The estimate for this project is shown in Table 3.

Table 3: Project Estimate ($000)[2]

Project Cost	2026	2027	Beyond	Total
Material Supply	580.0	0.0	0.0	**580.0**
Labour	206.5	176.2	104.7	**487.4**
Consultant	33.8	33.8	28.1	**95.6**
Contract Work	0.0	0.0	0.0	**0.0**
Other Direct Costs	17.5	14.5	2.6	**34.5**
Interest and Escalation	42.8	63.7	75.9	**182.4**
Contingency	83.8	22.4	13.5	**119.8**
Total	**964.4**	**310.6**	**224.8**	**1,499.8**

5.2 Project Schedule

The schedule for this project is shown in Table 4.

Table 4: Project Schedule

Activity	Start Date	End Date
Planning:		
Project kickoff and schedule development.	January 2026	April 2026
Design:		
Detailed design of new teleprotection multiplexor systems.	February 2026	February 2028
Procurement:		
Procurement of new teleprotection multiplexors.	April 2026	June 2026
Pre-Construction:		
Lab setup and testing.	September 2026	April 2028
Construction and Commissioning:		
Install and commission new multiplexor systems.	May 2026	August 2028
Closeout:		
Project close-out including as-builts.	June 2026	November 2028

[2] Numbers may not add due to rounding.

6.0 Conclusion

Teleprotection multiplexors play a critical role in the protection of high-voltage electrical equipment and generating units. They send signals over communications links to affect the isolation of equipment from abnormal system conditions. Hydro has 18 teleprotection multiplexing systems that are at the end of their useful service life and thus at heightened risk of failure or misoperation. In order to prevent equipment damage, which could result in extended or widespread outages, Hydro recommends the replacement of these end-of-life teleprotection multiplexing systems with modern systems over a three-year period.

Refurbish Water Treatment Systems

(2026–2027)

Holyrood

Contents

List of Attachments

Refurbish Water Treatment Systems (2026–2027)

Location: Holyrood

Investment Classification: Renewal

Asset Category: Thermal Plant

Estimated Cost: $1,460,800

1.0 Introduction

The Holyrood Thermal Generating Station ("Holyrood TGS") includes three thermal generating units that provide a total capacity of 490 MW, and is an essential component of the Island Interconnected System. The Holyrood TGS utilizes water treatment systems that process both raw and generated wastewater during operation.

The Water Treatment Plant ("WTP") converts raw water from Quarry Brook to deionized boiler feed water for both steam production and domestic water use. The Waste Water Treatment Plant ("WWTP") treats wastewater generated by Units 1–3 and other site systems before its release. The WWTP will be required to process plant run-off and other site wastewater for 25 years post-steam generation.

As per the 2024 Resource Adequacy Plan,[1] as part of the R*eliability and Resource Adequacy Study Review* proceeding, the Holyrood TGS shall remain available for a "Bridging Period"[2] until 2030, or until such time that sufficient alternative generation is commissioned, adequate performance of the Labrador-Island Link is proven, and generation reserves are met. As the water treatment systems are critical to the generation function and environmental compliance of the Holyrood TGS, capital investment in its water treatment assets is necessary to support system reliability and maintain Newfoundland and Labrador Hydro's ("Hydro") ability to meet customer demand during peak periods. These assets require refurbishment to extend their service life and to maintain safe, least-cost, reliable, and environmentally responsible operation of the water treatment systems at the Holyrood TGS.

[1] "2024 Resource Adequacy Plan – An Update to the Reliability and Resource Adequacy Study," Newfoundland and Labrador Hydro, rev. August 26, 2024 (originally filed July 9, 2024).

[2] Hydro considers the Bridging Period to be from the present to 2030. During the Bridging Period, the system would rely primarily on existing sources of generation capacity to maintain reliability while new generation capacity is being built. The primary, readily available supply options in this period are extending the retirements of the Holyrood TGS, Stephenville Gas Turbine and the Hardwoods Gas Turbine until their capacities can be adequately replaced.

2.0 Project Description and Justification

The scope of this project entails the refurbishment of the water treatment systems at the Holyrood TGS. The scope was derived through the completion of an independent condition assessment[3] and reflects the minimum refurbishment and inspection requirements necessary to extend the service life of the assets. Refurbishments include resin replacement and out-of-service inspections for the cation, anion, mixed beds, condensate polisher vessels, and batch reactor vessel, and replacement of the inlet piping in the clarifier tank. This recommendation also aligns with the Holyrood TGS Condition Assessment and Life Extension Study,[4] which recommended a project in 2026 for the refurbishment of the WTP and WWTP equipment. Hydro's proposed scope is driven by recommendations from Sections 6.5.1.2, 6.5.1.11, 6.5.1.17, and 6.5.2.5 of the condition assessment report provided as Attachment 1. Hydro notes that this report includes additional recommendations that are not within the scope of this project, as the remaining recommendations are for continuation of monitoring or require additional engineering/justification prior to inclusion as a capital project.

The three boilers at Holyrood TGS require treated feed water in order to produce suitable steam for power generation. The process of removing impurities from the water is completed through the ion exchange reactions created by the WTP vessel resins. The WTP resins have surpassed their anticipated lifespan, and replacement of the resin is required before the water quality diminishes and becomes unacceptable for steam generation. Resins must be removed to complete the out-of-service inspection, and recommended industry practice is to complete this inspection at the time of resin replacement.

Non-Destructive Testing ("NDT") of the clarifier inlet piping completed in 2024 noted significant corrosion, pitting, and scaling, indicating that the pipe is near the end of its useful life and replacement is necessary for continued reliable operation of the water treatment system.

The WWTP batch reactor tank is an important component to service the WWTP, which will remain in service after final steam production. Out-of-service inspections are necessary to ensure that the tanks are structurally sound, suitable for operation, and not at risk of releasing chemicals into the environment. Release of chemicals could lead to a fire hazard or exposure risk for personnel.

[3] "Holyrood TGS Water and Wastewater Treatment Systems Condition Assessment," Wood PLC, February 3, 2025.
[4] "*Reliability and Resource Adequacy Study Review* – Assessment to Determine the Potential Long-Term Viability of the Holyrood Thermal Generating Station," Newfoundland and Labrador Hydro, March 31, 2022, att. 2.

The results of the out-of-service inspection for the WTP and WWTP vessels will be used to inform any immediate work to be completed and to develop future maintenance and capital plans.

This project will ensure the safe and reliable operation of the existing water treatment system equipment without the need for full replacement.

3.0 Asset Overview

3.1 Asset Background

3.1.1 WTP Anion, Cation, and Mixed Bed Vessels

The WTP major process systems and their associated vessels primarily include the anion, cation, and mixed bed systems. These systems were replaced in 1997, and external inspection indicates the vessels are in good condition and have had minimal issues since being installed. The cation, anion, and mixed bed systems each utilize synthetic resins that remove impurities from water by ion exchange. The replacement interval of synthetic resin used in WTPs varies depending on the specific operating conditions and quality of the resin; however, replacement is typically recommended every ten years.[5]

3.1.2 Condensate Polishers

Each of the three generating units at the Holyrood TGS utilizes a full-flow condensate polishing system, installed during the addition of Unit 3 in 1979, with an expected useful service life of 25 years. Similar to the WTP anion, cation, and mixed bed systems, the condensate polishers remove impurities from condensed steam through ion exchange, where the impurities are exchanged for other ions in synthetic resins. This process helps maintain the purity of the water returning to the boilers, aiding in the prevention of issues such as corrosion and scaling.

3.1.3 WTP Clarifier Inlet Piping

The first step of raw water treatment at the Holyrood TGS occurs in the clarifier, where suspended matter is removed from the raw water before demineralization, to prevent fouling of the ion exchange resins. This process requires inlet piping to extend to the tank center, ensuring that the raw water is being introduced at the correct location. The clarifier inlet piping was installed during the original

[5] The average age of the synthetic resin at the Holyrood TGS is approximately 14 years.

clarifier system installation in 1969 and has an expected useful service life of 40 years. The clarifier inlet piping was inspected in 2024, and temporary repairs were completed.[6]

3.1.4 WWTP Batch Reactor

The WWTP Batch Reactor consists of a batch-stirred reactor and mechanical filter press that treats effluent from the periodic basin once specified basin effluent levels are reached. The batch reactor was last replaced in 1994 and has an expected useful service life of 30 years.

3.2 Historical Reliability

While there have been no disruptions to system reliability attributed to the condition of the WTP and WWTP vessels included in this proposed scope of work, resin replacement, internal vessel inspection, and refurbishment are required to ensure the continued reliable supply of treated water for thermal generation steam production.

3.3 Asset Condition

As noted above, a Level 1 Condition Assessment of the WTP and WWTP systems was completed by Wood PLC and is provided as Attachment 1 to this proposal. This high-level assessment included external visual inspections of the vessels and a review of historic inspection and condition assessment data, with recommendations for future condition assessments and refurbishments. There were no deficiencies requiring immediate remediation noted; however, the WTP and condensate polisher resins were recommended for replacement, as they had surpassed the recommended ten-year replacement interval. As the resin is required to be removed for internal inspection, it was recommended that the internal American Petroleum Institute ("API") inspections be completed at the time of resin replacement. The consultant also recommended internal inspection of the WWTP batch reactor vessel and replacement of the clarifier inlet piping in the WTP.

[6] Temporary repairs were completed during the 2024 inspection as there was insufficient time during the outage to complete replacement. The inspection contractor recommended replacement of the piping during the next available outage.

4.0 Analysis

4.1 Evaluation of Alternatives

The alternatives considered for this project include:

- Deferral;
- Refurbish water treatment systems; and
- Like-for-like replacement.

4.1.1 Deferral

Under this alternative, the refurbishment and inspection scopes would not be completed in 2026–2027. Deferral of the synthetic resin replacement in the anion, cation, mixed beds, and condensate polishers' vessels could increase the risk of impurities being present in the boiler feed water. Unpurified water entering the boiler can lead to a build-up of deposits, which is a precursor to scaling, corrosion, fouling, and boiler tube failure. If the water chemistry falls outside of the limits of normal operating conditions, unit generation may continue for up to a week with water chemistry within a range of marginal differential of normal operating conditions, or may require immediate unit shutdown if water chemistry surpasses the acceptable threshold.

Forgoing inspection of the WTP vessels and the WWTP batch reactor could cause any unknown internal pitting/indications/cracks to grow larger and develop into leaks. Unplanned repairs to these vessels would remove the vessels from service and potentially disrupt unit generation.

Deferral of the replacement of the clarifier intake piping is an unacceptable risk to the WTP system. The NDT and temporary repairs completed in 2024 indicated that replacement would be required in 2026. The clarifier is the first step of water filtration in the WTP, and there is no backup for this component. Unplanned replacement of the intake piping would result in a forced outage of the WTP until the replacement could be executed.

As such, deferral of the proposed refurbishments presents an unacceptable risk to the reliable operation of the Holyrood TGS.

4.1.2 Refurbish Water Treatment Systems

This alternative is comprised of the completion of refurbishments to the water treatment systems, through a combination of life extension upgrades and like-for-like replacements, as required. The identified refurbishment scopes include like-for-like replacement of the clarifier intake piping and resins in the condensate polishers, anion, cation, and mixed bed vessels, which have exceeded their useful service lives and must be replaced. API inspections will be completed for the identified WTP water treatment vessels and WWTP batch reactor.

4.1.3 Like-for-Like Replacement

As the condition assessment will aim to determine the remaining life of system components, Hydro believes it to be premature and unnecessarily costly to consider like-for-replacement at this time.

4.2 Least-Cost Evaluation

Hydro has not identified any viable alternatives to facilitate a least-cost evaluation.

4.3 Recommended Alternative

Hydro recommends proceeding with the upgrade and life extension of the water treatment systems. This alternative will extend the service life of the assets and ensure the continued safe and reliable operation of the Holyrood TGS.

4.3.1 Risk of Asset Stranding

The risk of asset stranding is less imminent as a result of the decision to extend Holyrood TGS to remain available through the Bridging Period. As Hydro expects continued operation of all three units at the Holyrood TGS through the Bridging Period, until its capacity can be adequately replaced to ensure reliable operation for customers, capital expenditures for this facility to operate as a generator continue to be required. Depreciation is required to be calculated on an accelerated basis (i.e., monthly depreciation = capital investment ÷ remaining months of service life).[7]

[7] Due to the extension of the Holyrood TGS through the Bridging Period, Hydro filed an application with the Board of Commissioners of Public Utilities to extend the Holyrood Accelerated Depreciation Deferral Account. The extension of the account and related amendments were approved in Board Order No. P.U. 1(2024). Hydro was also directed to file a report on the account in its next general rate application.

4.3.2 Risk Mitigation

Hydro assessed the pre- and post-implementation risk of the scope of work for this project in accordance with Hydro's Capital Risk Assessment process, as outlined in Section 7.0 of Schedule 1. The outcome of this assessment is provided in Table 1.

Table 1: Risk Scoring Pre- and Post-Implementation

	Impact	Likelihood	Score
Pre-Implementation	5	3	**15**
Post-Implementation	5	1	**5**
		Risk Mitigated	**10**
		Risk Mitigated per $1 Million	**6.8**

5.0 Scope of Work

This project involves the refurbishment of the water treatment systems at the Holyrood TGS. The scope of work includes:

- Internal API Inspection and resin replacement for WTP vessels, including:
  - Condensate Polisher Vessels (6);
  - Cation Vessels (3);
  - Anion Vessels (3); and
  - Mixed Bed Vessels (2).
- Replacement of WTP clarifier inlet piping (e.g., including design, procurement, and installation); and
- Internal API Inspection of the WWTP batch reactor.

5.1 Project Budget

The estimate for this 2026–2027 project is shown in Table 2.

Table 2: Project Estimate ($000)[8]

Project Cost	2026	2027	Beyond	Total
Material Supply	159.5	521.3	0.0	**680.8**
Labour	111.5	95.4	0.0	**206.8**
Consultant	20.9	5.9	0.0	**26.9**
Contract Work	138.3	94.3	0.0	**232.6**
Other Direct Costs	0.0	0.0	0.0	**0.0**
Interest and Escalation	27.2	93.6	0.0	**120.8**
Contingency	67.0	125.7	0.0	**192.8**
Total	**524.5**	**936.3**	**0.0**	**1,460.8**

5.2 Project Schedule

The anticipated schedule for this project is shown in Table 3.

Table 3: Project Schedule

Activity	Start Date	End Date
Planning:		
Budget review, scope statement, schedule development, and risk assessment.	January 2026	February 2026
Design:		
Consultant engagement and design for clarifier intake piping.	February 2026	April 2026
Procurement:		
Procure resin.	February 2026	May 2027
Tender API internal inspection contract.	March 2026	April 2026
Tender intake piping contract.	April 2026	May 2026
Construction:		
Clean, inspect vessels, and replace resin.	June 2026	November 2027
Replace clarifier intake piping.	August 2026	August 2026
Closeout:		
Project completion, interest cut-off, lessons learned, and as-built drawings.	November 2027	December 2027

[8] Numbers may not add due to rounding.

6.0 Conclusion

The WTP and WWTP are necessary components of the Holyrood TGS. The WTP is required for operation during steam production, and the WWTP, which is required to treat plant wastewater, will be required to process plant run-off and other site wastewater for 25 years post-steam generation. Hydro is proposing to complete the necessary inspection, resin replacement, and refurbishment of the WTP and WWTP vessels to maintain safe and reliable operation of the Holyrood TGS.

Attachment 1

Holyrood TGS Water and Wastewater Treatment Systems Condition Assessment

Wood PLC

newfoundland labrador hydro

wood.

Holyrood TGS Water and Wastewater Treatment Systems Condition Assessment

February 3, 2025

263277-0000-DD20-RPT-0001
Rev. 0

Holyrood TGS Water and Wastewater Treatment Systems Condition Assessment

FOR

Newfoundland & Labrador Hydro

REV.	DATE	REVISION(S)	PREPARED BY	CHECK	APP	CLIENT
0	3-Feb-25	Issued for Use	DW	AS	JP	
B	20-Dec-24	Issue for Review	DW	AS	JP	
A	2-Dec-24	Issue for Review	DW	AS	JP	

wood.	Holyrood TGS Water and Wastewater Treatment Systems Condition Assessment	Wood Canada Limited Job No. 263277	
		263277-0000-DD20-RPT-0001	REV. 0

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Appendices

Executive Summary

Wood has completed a condition assessment of the Holyrood Water Treatment Plant, Wastewater Treatment Plant, and the Underground Wastewater Treatment System. The purpose of the assessment is to determine the condition of the equipment associated with the wastewater and water treatment systems, identify potential equipment issues or components nearing end of life, review recent inspection reports, and provide findings and recommendations.

The condition assessment involved a site visit to complete a visual inspection, and the review of equipment drawings, current level 2 inspection proposals, previous and current inspection reports, the preventative maintenance program, the frequency of inspections and overhauls, and the history of upgrades.

The inspection of the Water Treatment Plant resulted in the following observations:

- The two raw water pumps and associated piping are showing moderate corrosion, but this is to be expected in the environment where they are installed. Facility staff have noted occasional problems with the motors, but they are otherwise reliable and there is redundancy.
- The clarifier, sand filter, and clearwell tanks are deteriorated with pitting and holes in the tank bottom sections. These have been temporarily repaired using Belzona® and Amerlock 400.
- The piping for the flocculent tank is polyvinyl chloride (PVC) and was installed in 1997. The piping, fittings and valves are beginning to fail and replacement parts for valves are difficult to source. The two floor mounted pumps near the tank are nearing the end of their service life.
- The coagulant tank and pumps showed no apparent issues, and no problems noted from facility staff.
- The two 50% caustic soda storage tanks and pumps also have no visible or known issues.
- The north and south bulk acid storage tanks have no noted issues, but the piping for both tanks have wall thicknesses more than 10% below the nominal thickness according to recent inspection results (but still well above the minimum thickness requirements of API 653).
- The melting tank was inspected in 2021 with some issues noted and recommended actions were completed prior to being put back into service. The two existing pumps were visually inspected during the site visit, however some of the fittings were wrapped and therefore could not be visually inspected.
- The caustic soda storage tank was inspected by Acuren in 2021, and all recommendations were confirmed completed prior to returning to service. The transfer pumps were not included in the inspection, but no apparent issues noted during the site visit.
- The three cation tanks are in good condition and there are no known issues except the condition of the rubber diaphragms is unknown, which sometimes crack and require replacement. The resin is due to be replaced and there is no record of any internal inspection since the initial installation in 1997.
- The three anion tanks are also in good condition with no known issues. These tanks were also installed in 1997 and were never internally inspected since installation. Therefore, the condition of the rubber diaphragms is unknown, and the resin is due for replacement.
- The two mixed bed tanks were installed in 1997 as well. These tanks are in good condition with no known issues, and no known issues mentioned by facility staff during the site visit. The mixed bed tanks have never had an internal inspection, and the resin is due for replacement.
- The stainless steel demineralization tank was fabricated and installed in 1969. In 2002, the tank was

dismantled, inspected, and reassembled. The tank appears to be in good condition, with no leaks or issues noted. However, one potential issue mentioned during the site visit is there is a concern that the tank is only welded on the outside and not the inside.

- The caustic regeneration skid pumps have had issues in the past and currently only one pump is in service, with the second pump out of operation for over a year. Radiography of the caustic regeneration skid piping was completed by Acuren in November 2024, but no critical issues were identified, and the calculated Remaining Useful Life (RUL) of the system was nearly 18 years.
- The acid regeneration skid was installed 27 years ago, and the radiography completed by Acuren in November 2024 did not identify any critical issues so the system could remain in service with continued monitoring as indicated.
- The caustic transfer pumps appear to have leaked at some point over the years, but there was no evidence of recent leaks while onsite and it was noted by facility staff that the pumps are reliable and do not have any recurring issues.
- The acid transfer pumps appear to be in good condition and are noted to be reliable, however, the heads of the pumps are plastic. It was mentioned that one of the heads exploded which could have been a serious incident if any personnel were in the immediate vicinity when this occurred.
- The condensate polishers and associated systems are original equipment:
    - The resin is approximately 10 years old and is due for replacement.
    - The support beams for the polishers are all severely corroded. Unit 2 support and polisher has dropped, pulling the pipe with it, resulting in the potential for the pipe to break at the flange, with some separation currently visible.
    - The sampling stations are original, and the conductivity meters seem to no longer be in use. All stations are showing signs of corrosion.
    - The caustic and acid storage tanks have recently been inspected and there are no areas of concern. The coatings on the tanks are beginning to break down but this is not considered significant.
    - The caustic and acid pumps all appear to be in poor condition. One of the pumps at unit 2 has been repaired three times in recent years. These have been designed with redundancy with only one pump operating at a time so if one pump experiences issues, it could be repaired while the other pump is in service.
    - The control panels for all three units have exceeded their expected lifespan. The unit 3 panel is located near an overhead door that gets left open in winter months which has caused snow and water to buildup on the panel. The auto control no longer works, and control is done manually which is tedious and time consuming. Hi-low level alarms are also no longer received at the unit 3 control panel and need to be checked manually.
    - The unit 3 flowmeters are also located near the overhead door that tends to be left open and therefore occasionally freeze which causes false readings.

The inspection of the Wastewater Treatment Plant resulted in the following observations:

- The caustic tank was inspected in 2021 and all issues identified for recommended refurbishment was confirmed to be completed prior to returning the tank to service.

- The caustic pumps were installed for 30 years but have only been used once in the past 25 years and are currently seized.
- The caustic piping between Pumphouse 1 and the Wastewater Treatment Plant was inspected by Acuren in November 2024 and no significant issues were identified. The piping was deemed suitable for continued service.
- The single polymer pump had no apparent issues, and no known problems were mentioned by facility staff. No redundancy is a potential concern.
- The two ferric chloride pumps appear to be original equipment and seem to be in fair to poor condition. There are no known issues with these pumps and the redundancy reduces issues if one pump requires service.
- The batch reactor appeared to be in good condition and no known issues with operation. Accessibility to light fixtures in the wastewater treatment plant for maintenance and repair was mentioned as an issue and causes issues with proper lighting levels in some areas.
- The sludge pumps have no known issues, but they are showing some moderate corrosion on the pump casings and have been in service for many years.
- The filter press has no major issues and the regular maintenance by facility staff maintains the reliable operation of the unit.
- There is only one recirculation/discharge pump and while there are no known issues, it is a major concern if this pump were to fail, and with no redundancy it would mean a shutdown.
- There are no known issues with pumps 8A/8B, however, there are occasional problems with the operators and the controls for the car wash system. The mis-operation of the pumps is due to a timer which is not working and operator error (failure to turn off pumps for car wash when finished). Full details included in the report.
- There are HVAC issues in the Wastewater Treatment Plant with the lower level being cold in the winter months. It could not be confirmed in the louvre control was operational but the built-in thermostats on the unit heaters no longer work and heater control is unreliable.

The Underground Water Treatment System resulted in the following observations:

- Pumps 5A and 5B are setup as lead/lag and controlled by the water level inside the sump. During the site visit it was noted that there were no issues with the pumps, and nothing noted from the visual inspection. However, there are no arc flash labels on the local disconnect switches, and corrosion was noted on the junction boxes and cable connectors.
- The two Oil Water Separators (OWS) are metal construction but all others onsite are plastic. Samples are taken weekly and if oil is detected, vacuum trucks are hired to remove the oil from the separators to eliminate the chances of contamination. Cathodic protection was tested and correct operation was confirmed.

Some general observations applicable to the Water Treatment and Wastewater Treatment Plants

- Local disconnect switches have no arc flash labels.
- Three MCCs for the condensate polishers and MCC 12 in the Wastewater Treatment Plant have outdated arc flash labels.

- There are areas throughout both facilities where the visibility is poor due to broken or blown light fixtures.

The following are the recommended actions for the Water and Wastewater Treatment Plants based on the observations from site, review of the available documentation, inspection results, and discussions from facility staff.

- The two raw water pumps and associated piping are noted by facility staff as reliable with occasional motor issues. Only one pump runs at a time, but it is recommended, to ensure no downtime, that a new pump be purchased as a spare and be ready for installation immediately if one of the existing pumps fails. Replacement of the instrument junction box and motor control station is also recommended due to recent issues when the second pump did not start up when required.
- The clarifier is deteriorated with pitting and holes in the tank bottom sections. The temporary repairs are sufficient in the short term, but the capital plan for 2026 should include the refurbishment of the clarifier tank, and the replacement of the intake line. A new recirculator motor should be purchased and existing Badgermeter flowmeter is antiquated and should be replaced.
- The three sand filter tanks are significantly deteriorated, and temporary repairs were completed, but filters 1, 2 and 3 are recommended to be replaced with new. This should be possible with the redundancy in the system and one tank could be replaced at a time. However, sand-filter no. 3 has the splitter box before the clearwell that No. 1 & 2 feed into. Replacing sand-filter no. 3 is best during a plant outage as a temporary by-pass line would be required to continue operation of sand-filters no. 1 & 2, if the plant was in full operation.
- The clearwell tank is also in poor condition with pitting and holes in the bottom sections. Replacement is recommended for this tank as there is no redundancy and refurbishment will likely be at a similar cost.
- The PVC piping and valves for the flocculent tank is reaching the end of its service life and components require replacement. Individual valve components were being replaced as required but exact models are no longer available, and full replacement is needed. Sections of the system can be isolated, and it is recommended that these sections be replaced immediately (one at a time to maintain operation). The two floor mounted pumps near the tank currently have no problems but replacement of one is recommended, or a new pump should be purchased and be ready for immediate install should one of these existing pumps fail. The other existing pump can maintain operations while the new pump is installed.
- The coagulant tank and pumps had no visible or recent issues and no recommendations at this time. The tank and pumps should be inspected within the next five years to confirm the system is deemed fit to remain in service up to the scheduled 2030 shutdown and beyond as required.
- The two 50% caustic tanks and pumps had no apparent or known issues, and the only recommendation is that the tanks and pumps be inspected in the next five years to ensure they are suitable to remain in service until 2030, or even later if the shutdown date is extended past 2030.
- The north and south bulk acid storage tanks and pumps have no noted issues and the recent inspection by Acuren has calculated a Remaining Useful Life (RUL) of well beyond the 2030 date for shutdown. It is recommended that another inspection should be completed if the scheduled shutdown date extends beyond 2030.

- Melting tank repairs were completed following the recommendations in the Acuren 2021 report. During the visual inspection onsite, the fittings were observed to be wrapped and while no issues were noted, these pumps and fittings should be inspected over the next five years to ensure they are fit for service up to 2030.
- For the caustic soda storage tank, all recommendations from the Acuren inspection report were completed prior to returning to service, and the transfer pumps had no observed or known issues. The tank and pumps should be inspected if the plant remains in service beyond the 2030 date.
- It is recommended that the three cation tanks undergo a resin replacement and during this replacement process, an internal tank inspection (to API 653) should also be completed. The best option for this would be to inspect one cation, one anion, and one mixed bed tank at a time as this would allow the plant to maintain operations while the tanks are out of service. The rubber diaphragms should also be inspected at this time to determine if repair or replacement are required.
- As above, the three anion tanks should be internally inspected in accordance with API 653, have the resin replaced, and rubber diaphragms inspected to confirm if they require repairs or replacement. Taking one anion tank out of service at a time for this work is recommended to allow operations to be maintained.
- The mixed bed tanks are also recommended to have internal inspection (to API 653) and also a resin replacement. During the inspection, the rubber diaphragm should be assessed to confirm if repairs or replacement is required. Recommend that one of the two tanks be inspected and have resin replaced at a time (along with one cation and one anion tank).
- The demineralization tank has been in service since 1969, and after it was dismantled, inspected, and reassembled in 2002, it has been in service since that time with no issues. However, since it was confirmed that the tank is welded on the outside only (and not inside), it is recommended that a fitness for service test be completed to determine if the single weld on the exterior is sufficient and meets applicable requirements; if the plumbness issue must be fixed; and an internal visual inspection of internal weld to determine if any signs of corrosion on the inner surface (as noted in 2024 report).
- The caustic regeneration skid has two pumps but only one pump is in operation. It is recommended that the pump that is not working be overhauled immediately, and a new pump be purchased. If the overhaul is unsuccessful, when the new pump is delivered to site it should be installed to re-establish redundancy in the system. The existing pump that is in service could fail at any time and this would interrupt the plant operation. The testing completed by Acuren in 2024 for the piping resulted in a calculated RUL of the system was nearly 18 years, so no recommendations for the piping.
- The acid regeneration skid had a radiography completed in November 2024 and no critical issues were identified, so the system can remain in service but should be inspected again in the next five years.
- The caustic transfer pumps appear to have leaked at some point over the years, but there was no evidence of recent leaks or issues while onsite. However, it is recommended that a new pump be purchased and ready for immediate install in case one of the existing pumps fail, and to maintain redundancy.
- The acid transfer pumps were noted to be reliable and no apparent issues noted while onsite. However, the heads of these pumps are plastic, and since this is a safety concern it is recommended that two new pumps be purchased to replace the existing. Alternatively, guards could be installed to contain the potential pump fragments from injuring any workers near the pumps, however

elimination of the hazard is always the best preventative measure to avoid potential injuries.

- The recommendations for the condensate polishers and associated systems are listed below:
    - Replace the resin in the polishers as it is approximately 10 years old and is due for replacement according to the industry standard (maximum 10 years).
    - All polishers to be inspected (in accordance with API 653) to determine if the wall thicknesses are compliant with minimum thickness requirements. Polishers to be refurbished or replaced depending on the results of the testing.
    - The support beams under the polishers are severely corroded and must be replaced or refurbished. If the polishers are replaced based on the recommended inspections, then new support beams should be installed.
    - The sampling stations are all showing high levels of corrosion and the conductivity meters do not appear to be used. It is recommended that the sampling stations be refurbished, and obsolete equipment be removed.
    - The caustic and acid storage tanks have recently been inspected and there are no areas of immediate concern. The coatings on the tanks are beginning to break down and while this is not considered significant, the tanks could be prepared and painted with minimal effort and cost.
    - The caustic and acid pumps all appear to be in poor condition. One of the pumps at unit 2 has been repaired three times in recent years. It is recommended that a new pump be purchased to replace the one on unit 2, and two additional pumps should also be purchased as spares to be used on one of the other units should one of those pumps fail. This will allow for partial redundancy and minimize impacts to production as having the pumps on site will reduce the amount of downtime.
    - The control panels for all three units have exceeded their expected lifespan and all three panels are recommended to be replaced with new modern PLC panels or integrated with the plant Foxboro DCS.
    - The unit 3 flowmeters are recommended to be refurbished, but if cost of refurbishment is determined to be equivalent to the cost of replacement, then the meters should be replaced.

The inspection of the Wastewater Treatment Plant and review of all available documentation and inspection reports resulted in the following recommendations:

- The caustic tank was inspected in 2021 and all issues identified for refurbishment were confirmed to be completed prior to returning the tank to service. No recommendations for this tank.
- The caustic pumps have been in service for 30 years but no longer work as they are seized. According to facility staff, these have only operated once in 25 years and therefore are not considered a critical component to operations. NL Hydro should determine if new pumps should be ordered or if existing pumps can be removed.
- The caustic piping between Pumphouse 1 and the Wastewater Treatment Plant was inspected by Acuren in November 2024 and with no issues noted, there are no recommendations.
- The polymer pump has no known or apparent issues but purchasing a new pump as a spare is

recommended since no current redundancy in the system and lead times for pumps are normally lengthy.

- The two ferric chloride pumps appear to be original equipment and are in fair to poor condition. There are no known issues with these pumps and the redundancy reduces issues if one pump requires service. No recommendations since with redundancy, if one pump fails the other can operate until a replacement is delivered.
- The batch reactor appears to be in good condition and no issues noted by facility staff however a full inspection is recommended for 2026 to ensure there are no hidden issues. Lighting in the area is also a concern, and light levels are poor due to location and condition of light fixtures. Light fixtures should be moved to more accessible locations for maintenance and directional light fixtures should be purchased to provide lighting for all areas of the space.
- The sludge pumps have no known issues, but they are showing some moderate corrosion on the pump casings and have been in service for many years so should be monitored. The coating on the pipe penetration through the floor is showing significant corrosion and should be repaired to avoid any interruptions in operations should the corrosion cause a pipe rupture.
- The filter press is said to be reliable and in good condition, and the visual inspection did not identify any issues. Facility staff perform regular maintenance on the unit and the only recommendation is to continue regular maintenance as required and according to manufacturer's recommendations.
- There is currently only one recirculation/discharge pump which serves the Batch Reactor and circulates effluent during treatment and discharges post treatment. There are no known issues, however it is a major concern if this pump were to fail and with no redundancy it would mean a shutdown. The purchase and installation of a new pump to provide redundancy is highly recommended.
- There are no known issues with pumps 8A/8B, however, the timer for the car wash system should be fixed to prevent the pump from running continuously if the operator forgets to turn it off after use. Alternatively, the car wash option could be removed to eliminate the issue.
- There are HVAC issues in the Wastewater Treatment Plant with the lower level being cold in the winter months and insufficient ventilation could cause health issues for personnel especially when chemicals are used and give off harmful vapors, etc. An engineering assessment of the HVAC system including all ventilation and heating components and controls. This will identify all issues and then a new design could be developed to address these issues.

The visual inspection of the Underground Water Treatment System and review of the documentation and reports resulted in the following recommendations:

- Pumps 5A and 5B have no apparent issues with the pumps, and nothing noted from the visual inspection. However, arc flash labels should be applied to ensure personnel in the area are aware of the hazards. Corrosion levels should be monitored frequently for the junction boxes and cable connectors, and when corrosion is deemed substantial, these should be replaced.
- The two Oil Water Separators (OWS) are metal construction but all others onsite are plastic. If issues arise and the OWS's require replacement, they should be replaced with plastic models. Cathodic protection system can then be removed. An internal inspection should be completed to confirm condition and determine if refurbishment or replacement is required.

1.0 Introduction

1.1 Background

The Holyrood Thermal Generating Station is equipped with a Water Treatment (WT) Plant, and a Wastewater Treatment (WWT) System that includes underground piping, oil water separators, equalization basins and a Wastewater Treatment Plant. The WT Plant processes raw water from Quarry Brook to demineralize water, removing as many impurities as possible, and is used for boiler feed water for steam production. The WWT Plant processes the effluent from the onsite periodic basin, one of the equalization basins. The periodic basin captures waste from air heater washes, boiler washes (on the fireside), and landfill leachate. When the level in the periodic basin reaches a certain depth, the effluent is then pumped over to the WWT Plant and into the batch reactor. The reactor solid waste is transported to the site landfill and the treated liquid is discharged into Indian Pond.

Included in the treatment of wastewater is the underground drainage system. A large portion of the system that delivers wastewater to the continuous basin was replaced in 2017. However, located on the South side of the main Powerhouse, and primarily all original equipment, are two oil water separators which filter any possible oil contaminants before discharging into Holyrood Bay or Indian Pond. The separators filter effluent from the Plant floor drains. This is a relatively large network, therefore only the equipment requiring further assessment is detailed in the following sections.

The systems consist of the following components:

1.1.1 Water Treatment Plant

- Raw water pumps
- Clarifier
- Three sand filters (1, 2 and 3)
- Clearwell & pumps
- Flocculent tank and pumps
- Coagulant tank and pumps
- Two (2) 50% Caustic Tank and two (2) pumps
- Two (2) Acid tanks (north and south) and two (2) pumps
- Melting tank and two (2) transfer pumps
- Caustic Soda storage tank and two (2) transfer pumps
- Three (3) cation tanks (A, B and C)
- Two (2) mixed bed tanks
- Demineralization tank
- Caustic regeneration skid
- Acid regeneration skid
- Caustic Transfer Pumps – to condensate polisher storage tanks

- Acid transfer pumps – to condensate polishers storage tanks
- Unit 1 Condensate Polishers, transfer pumps, caustic & acid storage tanks, and control panel
- Unit 2 Condensate Polishers, transfer pumps, caustic & acid storage tanks, and control panel
- Unit 3 Condensate Polishers, transfer pumps, caustic & acid storage tanks, and control panel

1.1.2 Wastewater Treatment Plant

- Caustic tank
- Two caustic pumps
- One Polymer pumps
- Two ferric chloride pumps
- Batch Reactor
- Two sludge pumps
- Filter press
- Recirculation/Discharge Pump.
- Pumps 8A/8B

1.1.3 Underground Wastewater Treatment System

- Pumps 5A/5B-transfer sludge from clarifier blow down (sludge removal) and sand filter backwashes to continuous basin for treatment
- Oil Water Separator No. 1 and No. 2

1.2 Previous Inspections

1.2.1 Water Treatment Plant

- North and South Caustic Soda tanks (2021)
- Caustic Soda Mixing tank (2021)
- Horizontal Caustic Soda Storage tank (2021)
- North and South Bulk Acid storage tank (2021), and
- Acid Tank Piping (2021)

1.2.2 Wastewater Treatment Plant

- Wastewater Treatment Plant (WWTP) Caustic tank (2021)

1.2.3 Underground Drainage System

- Oil Water Separator No. 2 cathodic protection (2014)

- Oil Water Separator No. 1 cathodic protection (2014)

1.3 Inspections Completed in 2024

1.3.1 Water Treatment Plant

- Clarifier
- One of three sand filters
- Clearwell
- Demineralization tank
- Acid and Caustic Skids

1.3.2 Wastewater Treatment

- Caustic delivery line (portion from WWTP to Pump House No. 2, and some areas in the underground utilidor)
- Batch Reactor sludge line

1.3.3 Condensate Treatment

- Unit 1 caustic and acid storage day tanks
- Unit 2 caustic and acid storage day tanks
- Unit 3 caustic and acid storage day tanks

1.4 Objective and Scope of Work

Thermal operations at the Holyrood Thermal Generating Station have been scheduled to continue until 2030, and possibly later, to support the construction of additional generation. Furthermore, the Wastewater Treatment Facility is required 25 years post steam to complete treatment of the landfill leachate. Hydro currently has a two-year Capital Project, tentatively scheduled for 2026-2027, to inspect and overhaul the equipment. The study aims to identify any Capital upgrades, prepare a Class C estimate and any additions to the current preventative maintenance program to continue reliable treatment and extend its serviceable life. For assets related to steam generation, the serviceable remaining life must be at least 10 years under this assessment. Work shall include but not limited to reviewing the following:

- equipment drawings
- the current level 2 inspection proposal developed by Hydro's service contractor
- previous & current inspection reports
- preventative maintenance practices/program
- inspection/overhaul frequencies
- history of upgrades

Scope required a field visit, review of the reports generated by the current service provider (who will be executing the level 2 inspections for much of the equipment) to identify potential equipment issues or components nearing end of life, recent inspection findings, and recommendations.

1.5 Available Information

The following summarizes the previous inspections completed on the relevant systems:

- Water Treatment Plant
  - North and South Caustic Soda tanks (2021)
  - Caustic Soda Mixing tank (2021)
  - Horizontal Caustic Soda Storage tank (2021)
  - North and South Bulk Acid storage tank (2021), and
  - Acid Tank Piping (2021)
  - Clarifier (2024)
  - Clearwell (2024
  - Demineralization Tank (2024)
  - Sand Filter #3 (2024)
- Wastewater Treatment Plant
  - Wastewater Treatment Plant (WWTP) Caustic tank (2021)
  - Sludge Line (2024)
  - Caustic Piping (2024)
  - Acid and Caustic Tanks (2024)
  - Acid Regen Skid (2024)
  - Caustic Regen Skid (2024)
- Underground Drainage System
  - Oil Water Separator No.2 cathodic protection (2014)
  - Oil Water Separator No. 1 cathodic protection (2014)

2.0 Site Inspection Team

The on-site inspection of the Holyrood water and wastewater treatment systems was performed on October 2nd, 2024. The site inspection and testing team (herein referenced as "inspection team") consisted of the following:

- **Newfoundland and Labrador Hydro** (herein referenced as NL Hydro). Provided site representation for historical background and guidance during the entire inspection.
  - Project Manager – Joanne Norman
  - Lab Technician – Jason Simms

  - Electrical Engineer – Cyprian Oton
- **Wood Canada Limited** (herein referenced as Wood). Oversaw and managed the site inspection and testing program. The following individuals were present during the inspection:
  - Mechanical - Doug Walters, P.Eng.
  - Electrical - Lewis Hann, P.Eng.
  - Electrical - Amy Sparkes, P.Eng.

3.0 Holyrood Water Treatment Plant – Wood Level 1 Inspection

3.1 General

The Water Treatment Plant at Holyrood Thermal Generation Station serves Unit 1, Unit 2 and Unit 3. This includes the major equipment elements:

- Clarifier system (1) and associated piping and components
- Sand filters (3) and associated piping and components
- Clearwell System (1) and associated piping and components
- Primary Cation and Anion demineralizer Trains – replaced in 1997
- Mixed Cation/Anion Beds (2) – replaced in 1997
- Bulk Acid and Caustic Storage Vessels
- Demin Water Storage Vessel – deconstructed and re-built in 2002.
- Condensate Treatment on each unit

In addition, there are other smaller components such as acid and caustic storage tanks, brine system, chemical injection systems, flocculent chemical injection systems, and pumps.

The inspection of the Water Treatment Plant was completed during an in-person site visit at the NL Hydro Holyrood TGS. The inspection was completed on the equipment included in the scope and details of these inspections are provided in this report.

3.2 Water Treatment Plant Inspection Results

The results of the water treatment plant inspection are as described in the sections which follow.

3.2.1 Raw Water Pumps

There are two raw water pumps at the WTP, but only one of these pumps run at a time. Through discussions on site, it was noted that there are occasional problems with the motors, but otherwise there are no major concerns. The equipment is old and appears to be in fair condition, but the two pumps provide redundancy. Recently it was noted from site that the when the working pump stopped running, the standby pump did not automatically start up and this is a major issue.

The piping and valves on the discharge side of the pumps is showing varying levels of corrosion, but this is to be expected in the wet, humid environment, and no issues were noted with the distribution system. The piping changes from steel to non-corrosive PVC immediately downstream of the pump discharge and no issues noted.

The disconnect switches for the pumps look new and in good condition, however there are no arc flash labels visible. Per CSA Z462: Workplace Electrical Safety, electrical equipment likely to require examination, adjustment, servicing, or maintenance while energized shall be marked with an arc flash label. The data shall be reviewed for accuracy at intervals not exceeding 5 years or when changes are made to the electrical system that can affect the information. The control station for the pumps is antiquated and some of the labels are barely legible and others are dyno-tape. There are some instruments, cable connectors, and conduit that are showing signs of corrosion and an unlabeled instrumentation junction box that looks to be held together using red tape that also has signs of corrosion.

The system is also equipped with a chemical injection system including the injectors and a mixer which is installed in a bypass line. This bypass line is only opened when chemicals are injected upstream. Chemical injection is not used frequently, and the bypass line is normally closed.

Regular maintenance and inspection should allow these pumps to serve the system to the end of 2030. If the date is extended five or more years past 2030, then replacement of one or both pumps should be considered at that time. The redundancy will provide reassurance that the system can fully operate without issue as long as one of the two pumps are in service.

Photo 1: Raw Water Pumps

3.2.2 Clarifier

The clarifier has a control valve which opens and closes based on the water level downstream in the Clearwell. The circulator pump was initially equipped with a belt drive but was since switched to a variable frequency drive (VFD) and there have been no issues since then. The splitter box was installed approximately 15 years ago.

The clarifier was recently inspected in August 2024 by Acuren, and the report noted that the tank wall and some of the inlets were thinning and pitting in some areas. The report indicated that there were 45 pits in the shell with depths greater than or equal to 0.250" in the tank shell (worst pit measured 0.250"). Based on the scanned readings and tank's age, the assumed thickness is 0.3125". API 653 standards specify a minimum required shell thickness of 0.100", which means pits exceeding 0.2125" in depth require repair. Of the 45 pits measured, only one exceeded the 0.250" depth. However, the report recommended repairing all pits with a depth of 0.125" or more. Also, recommended the application of an approved coating for areas of exposed bare steel and all those indicated as pitting. While onsite it was observed that many of these recommendations appeared to have been completed, and the report confirmed that the 0.250" pit was filled with weld and then a coat of Amerlock 400 was applied. Amerlock 400 was also applied to areas including those: that were buffed for X-rays, noted for pitting, indicated as critical areas, and all along the waterline.

For the inlet piping, the report indicated that there was significant corrosion and scaling (measured 0.600"-0.800") on the exterior of the piping. Due to the age and condition of the piping, replacement was recommended, preferably with different material. While on site it was noted that the inlet pipe was not replaced due to limited time available during the systems outage, but it was coated with the Amerlock 400 product.

The chemical dosing piping, which is no longer used was also recommended for removal as it could cause damage to the other equipment if it broke and fell into the tank. This was confirmed completed on September 16, 2024, as it was removed and capped to where it enters the bell. One of the unions on the system was also noted as leaking and tightening was recommended. The "Bell" assembly is supported by turnbuckles, and these were noted as showing signs of corrosion and was recommended to be monitored and to be replaced as required.

Another potential issue which was noted during the walk through was that the walkway above the clarifier is supported by the tank walls. There are no issues to date, and after doing some research, this type of setup appears to be common with other clarifier designs and there should be no future issue. The trough is also starting to corrode, and the level of corrosion should be monitored and documented with dated photos to illustrate advancing degradation.

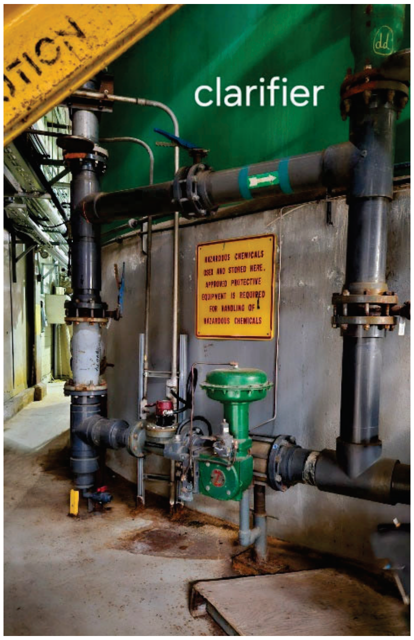
The tank currently has no major observable leaks however the thinning of the tank wall is a concern. Some repairs have already been completed and it was confirmed by Acuren that these repairs would extend the equipment's operation up to 2026. A level 2 condition assessment should be completed in 2026 to determine all deficiencies with the Clarifier and then confirm if further refurbishment would allow the tank to remain in service up to 2030, or if the tank would require a complete overhaul or even replacement. The clarifier is critical to plant operation and with no redundancy a failure would have a huge impact on generation. Therefore, the tank should be inspected in 2026 to ensure the current repairs are still sufficient, or if another round of aggressive refurbishment/overhaul is required. The demineralization tank has a storage capacity of 20,000 gallons of treated water and can supply the boilers during treatment plant shutdown but not for very long as the average demand for each thermal unit is approximately 60,000 gallons per day. A bypass line was installed for the clarifier in 2010, but again, this can only be used for short periods since it discharges into the sand filters. Bypassing the clarifier will lead to fouling and more frequent filter backwashing, and backwashing requires the sand filter to be temporarily taken out of service. The time and cost required to replace the existing clarifier with new must be determined and then compared to the estimated time to refurbish/overhaul the tank. If the time for both is similar, then tank replacement should be considered due to the importance of the clarifier in the treatment process. It is anticipated that the replacement of the tank would be much more costly and also require much more time to complete so pending the results of a level 2 inspection, right now a refurbishment/overhaul would be recommended.

The Badgermeter flowmeter, located behind the clarifier tank, looks to be antiquated. Due to the age of the flowmeter, if it were to fail, finding a suitable replacement may be difficult so it is recommended to ensure there is a suitable replacement or spare flowmeter available.

The recirculator motor on top of the clarifier was not confirmed to have a critical spare but should since the recirculator is an important component for the filtration process. With a single motor, there is no redundancy so if there is an issue, the recirculator will remain stationary until a new motor is installed, or the existing motor is refurbished. During this time, the settled solids will continue to accumulate in the tank and if the time to refurbish/replace the motor is extensive, the clarifier could fill with solids, lead to clarifier shut down, and potentially require manual removal of the solids. As described earlier, all disruptions to clarifier operation are detrimental to generation and should be avoided, if possible, and a spare motor will help reduce downtime if problems arise. The disconnect switch for the recirculator looks new and in good condition, but no arc flash label visible.

Visibility on top of the clarifier tank is poor due to broken light fixtures, spot lighting that has been added to the area to illuminate over the tank is not properly supported and have been angled over the tank using rope tied to the handrail of the platform.

The turbidity monitoring system looks new and in good condition, labels on the equipment indicate the system was serviced and calibrated in Jan. 2024 with the next service date in Jan. 2025.



Photos 2A & 2B: Clarifier Piping and Badgermeter Flowmeter.

Photo 3: Walkway Structural Support and Trough

3.2.3 Sand Filters

From the clarifier, the water is fed to the three sand filters. Water from the clarifier flows equally to each of the sand filters. The water is piped from sand filter #1, through filter #2 and #3, then to the splitter box, and onto the Clearwell. Similarly, sand filter #2 is piped through #3 into the splitter box and onto the Clearwell. Sand filter #3 is piped directly to the splitter box and then into the Clearwell.

A laser scan was completed by Acuren for the three filters, and each had issues with the bottom portion of the tank. Since then, the bottom section has been coated with Amerlock 400 (white section in photo below) to help with corrosion, and additional repairs were applied to #3 as described below. There are rust stains around the base of each filter, but some more than others. More detailed information is provided in the individual sections which follow.

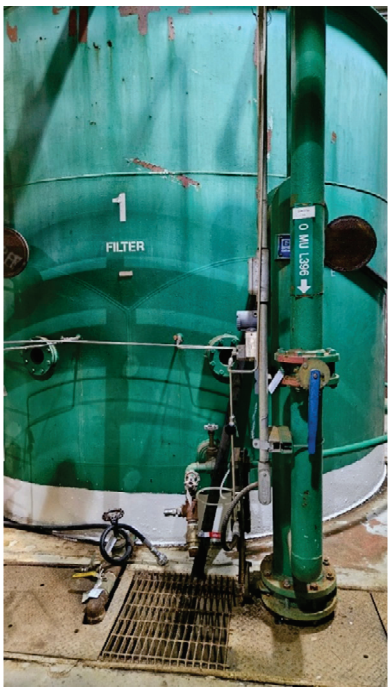


Photo 4A - Sand Filter #1 (typical)

Photo 4B – Plan View of Sand Filters #1 & #2

Photo 4C - Plan View of Sand Filter #3 (see piping from #1 & #2 routed through #3)

3.2.3.1 Sand Filters #1 and #2

The sand in filters #1 and #2 was replaced approximately 8-10 years ago. It was noted by facility staff and verified by industry standards that the sand should be replaced every 6-7 years and is now overdue for replacement. This will require the tanks to be drained, sand removed, and the strainers should all be replaced (or at least cleaned) and then reinstalled prior to the addition of the new sand. It is presumed that there will be severe pitting and through holes will be present in filters #'s 1 & 2 (as described below for filter #3). The efforts to inspect, restore the tank shell & floor thickness, replace sand & strainers are likely to exceed the cost of replacement. The recommendation is to replace all three sand filters based on the results of sand filter #3 findings and the results of the laser scan. While the sand filter #3 floor could not be inspected due to the narrow/restricted access to the area, the age and similarity between the clearwell and sand filters suggests the sand filter tank bottoms will likely have through holes as were discovered in the clearwell in 2024.

There is redundancy with three units so one could be replaced while the other two remained in service to reduce impact to operations. These two filters were not inspected internally by Acuren, only #3. It should also be noted that sand filter #3 has the splitter box before the clearwell and #'s 1 & 2 feed into this box. Replacing sand filter #3 is best during a plant outage since otherwise, a temporary by-pass line would be required to continue operation of sand filters #'s 1 & 2.

3.2.3.2 Sand Filter #3

Sand filter #3 was empty during the site investigation and was recently inspected internally by Acuren earlier this year. It was noted that the false floor was almost completely deteriorated. The tank bottom could not be inspected due to no available access and no viable means to create an access point since the shell and false floor were in such poor condition. The report indicated that the following procedure was used to fix three holes in the bottom shell:

- Belzona® 1212 was used to bond plates over the holes

- 0.250” steel doubler plates for through holes
- Belzona® 1321 for topcoat over the doubler plates
- Amerlock 400 applied around the entire bottom shell circumference at a height of approximately 12”

The coating and steel plates were only applied to the exterior of the filter as access is not possible due to confined space restrictions and limited space between the tank bottom and the false floor where the strainers are located. This work is considered a temporary fix for the failing structure.

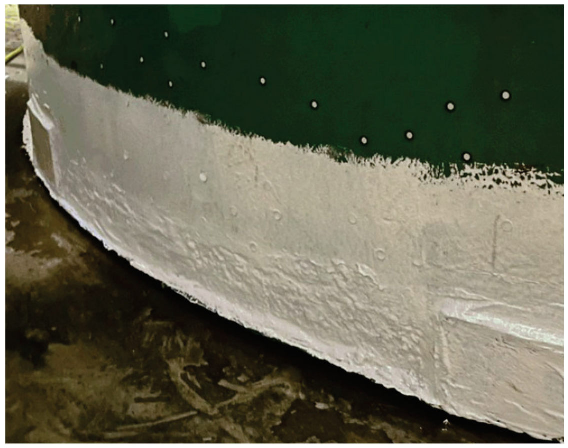


Photo 5: Sand Filter #3 – Repairs to Bottom Shell

The false floor also had holes which required repair and patch plates were welded in place, as per recommendations by Acuren. Weld build-up was added to pits in the false floor, and the strainers were removed to complete this internal work to ensure the plastic strainers were not damaged due to heat transfer during welding. Amerlock 400 was then applied to the entire false bottom and areas of pitting that didn’t require weld build up. Upon completion of this work, new strainers were installed.

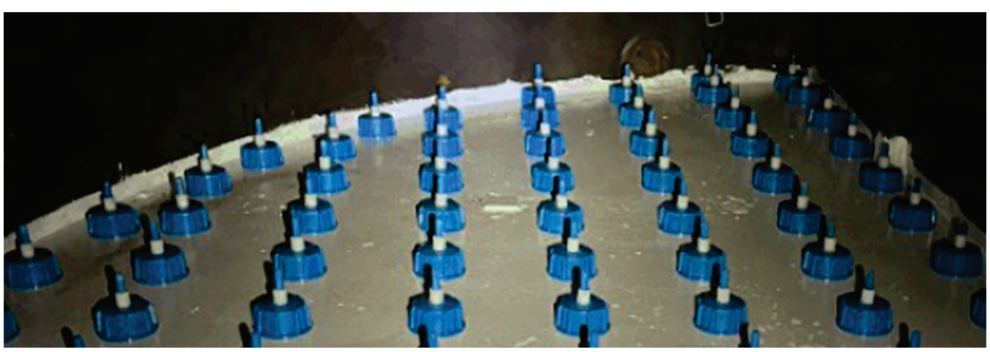


Photo 6: Sand Filter #3 – New Strainers Installed After False Floor Repairs

The splitter box was also observed to be in very poor condition during the site visit, however a new fin has been welded in place and has been coated with Amerlock 400 as well as the interior weld to the discharge pipe.

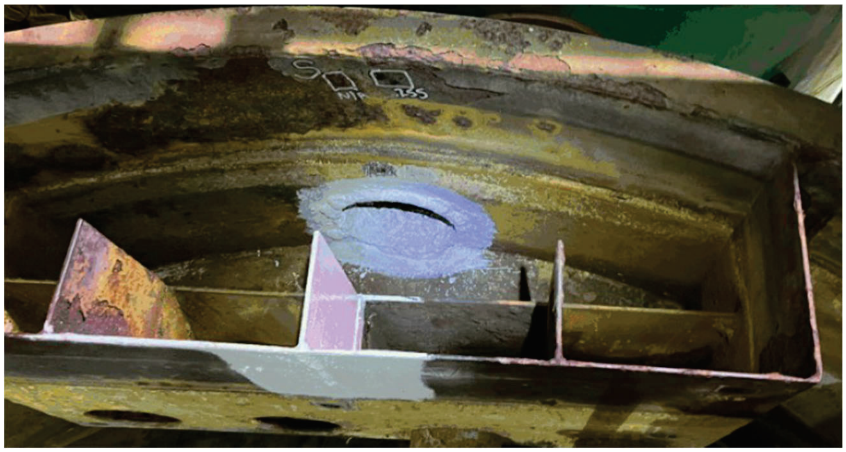


Photo 7: New Fin Welded in Splitter Box

The in-person inspection concluded that since all sand filters are the same age and are showing significant deterioration, it may be easier to replace all three tanks rather than attempting to refurbish. Catastrophic failure of these filters would cause major issues for the plant including worker safety, potential damage to other equipment, disruption to operations, etc. This will be an extensive undertaking from both financial and shutdown duration perspectives, but all three filters are in such poor condition this would be the best option. Taking one filter out of service at a time and completing each installation before starting the next would be ideal, but this will still be very challenging due to the physical size of the tanks, space limitations in the area, shared auxiliary equipment, and the existing piping systems in the space. As noted previously, sand filter #3 has the splitter box before the clearwell and #'s 1 & 2 feed into this box. Replacing sand filter #3 would best during a plant outage since otherwise, a temporary by-pass line would be required to continue operation of sand filters #'s 1 & 2.

3.2.4 Clearwell

The interior inspection report of the Clearwell provided by Acuren indicated that the bottom portion of the tank was in very poor condition. Several holes were identified in the tank's shell within the tank's critical zone and within 2" of the tank bottom. Many of these were formed during attempts to install the Belzona product and plates were installed in each of these areas. This illustrates how thin the walls of the Clearwell are and why refurbishment would be very extensive, time consuming, expensive, and would still be considered a temporary fix. The details of the inspection are listed below and provide evidence which leads to the recommendation of replacement versus refurbishment.

The shell was noted as significantly thinned in this portion of the tank for the full circumference and does not meet the minimum required thickness of 0.100" as per API 653. It was determined that this thinning is the result of external pitting in this area. The report recommended to restore the shell thickness in that portion of the well with Belzona®. Below is the detailed description of the repairs which were completed:

- Holes above the threshold were filled with Belzona 1111
- Belozona 1321 was then applied as a top-coat
- 0.250" steel doublers plates were installed for the through holes and Belzona 1321. Some additional holes were created in the area during scaling and preparation of repair and then were

repaired using the same procedure.
- National Association of Corrosion Engineers (NACE) Inspection was then completed by Acuren and passed.
- Amerlock 400 was then applied along the tank bottom and up the wall approximately 12".

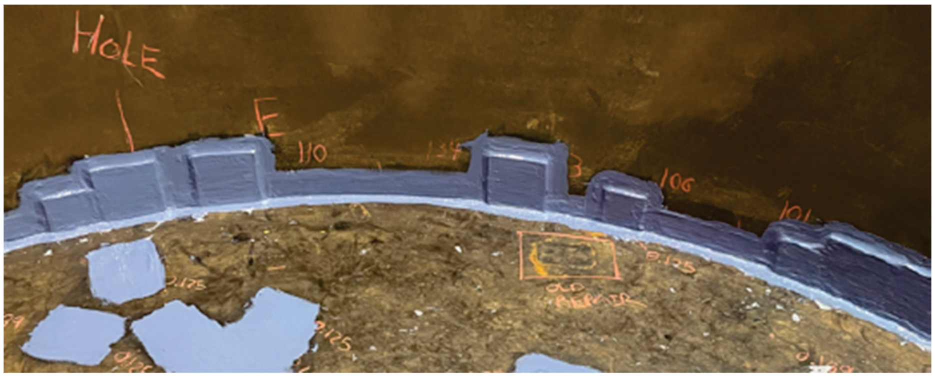


Photo 8: Repairs of Interior Shell for Clearwell

The floor of the Clearwell was measured with UT and construction was confirmed to be 0.250" thick plate. Pitting was found throughout the tank floor with pits ranging in depths from 0.0675"-0.313". Eight pits were noted to have 0.250" depths or more and were considered as through holes. Several other pit depths ranged from 0.125" up to 0.250". The recommendation was to restore the tank thickness by using Belzona wherever the pit depth was more than 0.150" (these areas would not meet the API 653 minimum required thickness). A similar procedure as described above was applied to the tank bottom, see photo below.

Photo 9: Repairs to Clearwell Bottom

Some minor issues (these were all confirmed by NL Hydro as completed) were also noted in the report including:
- Fouling at the outlet nozzle – all obstructions and debris was removed to ensure flow was not restricted.
- Redundant instrumentation tubing heavily corroded and dislodged – this was removed.

- 18″ x 36″ patch of exterior corrosion and pitting –coating applied to protect the area from further damage and monitor during next inspection.

The bottom of this tank is in very poor condition, and it is recommended that the Clearwell be replaced. The same concerns as listed for the sand filter replacement apply to the Clearwell, and it will be equally challenging to execute, but it is the best option to ensure continued operation, a safe work environment, and reliable service.

There are no apparent issues with the two pumps serving the Clearwell and they appear to be in good condition based on visual observation. However, the disconnect switches for the pumps have no visible arc flash labels. The control station for the pumps is antiquated and some of the labels are barely legible and others are dyno-tape.

The turbidity monitoring system looks new and in good condition and labels on the equipment indicate the system was serviced and calibrated in January 2024 with the next service date scheduled for January 2025.

Photo 10: Clearwell and Pumps

3.2.5 Flocculent Tank & Pumps

It was noted during the site visit that the polyvinyl chloride (PVC) piping was installed in 1997 and the valves are experiencing failures with the internal parts. The issue now is that the exact same models of valves are no longer available so they must be switched out entirely. Previously, parts of the existing valves could be swapped out and the system could remain in service. To replace an entire valve, it was initially thought that the system would have to be shut down. However. after reviewing the system onsite, it was noted there are two separate redundant lines. Therefore, by isolating and replacing one line at a time, the system could remain in service with minimal impact to operations.

No apparent issues were noted for the pumps, but they are nearing the end of their service life expectancy and replacement should be considered. These could also be replaced one at a time to minimize service interruption. The other option is to run one of the pumps to failure but if the other pump stops working before the new pump is purchased, delivered and installed then the system would be shutdown.

The disconnect switches for the pumps have no visible arc flash labels.

Photo 11 & 12: Flocculant Tank and Pumps

3.2.6 Coagulant Tank and Pumps

The results from the onsite inspection showed no apparent issues for the coagulant tank and pumps, and no known problems were indicated from facility staff.

The disconnect switches for the pumps and agitator have no visible arc flash labels.

Photo 13: Coagulant Tank and Pumps

3.2.7 Two (2) 50% Caustic Tanks (North and South) and Two (2) Pumps

While on site it was noted that the two caustic tanks were inspected in 2021, but the pumps were not included in this inspection. The inspection results are listed below and from discussions and visual inspections during the site visit, the tanks and pumps appear to be in good condition and no issues noted.

3.2.7.1 North 50% Caustic Tank

Photo 14 & 15: Caustic Tank (50%) and Pumps

The following tank elements were inspected on the tank as per API 653 and NL Hydro requirements:

- Tank: Bottom, Shell, and Roof (fixed),
- Nozzles and Attachments
- Coatings and Linings
- Foundation and Compound

Tank Feature	Currently Acceptable to API 653
General Bottom Plate Thickness	ACCEPTABLE
Bottom Plate Thickness in Critical Zone (3" from Shell)	ACCEPPTABLE
Annular Bottom Plate Thickness	NOT APPLICABLE
Bottom Welds and Shell-to-Bottom Weld	ACCEPTABLE
External Bottom Plate Projection	ACCEPTABLE
Shell Settlement	NOT INSPECTED
Edge Settlement	NOT INSPECTED
Shell Thickness	ACCEPTABLE
Roof Thickness	ACCEPTABLE
Nozzles and Attachments	NOT ACCEPTABLE

Table 1: North Caustic Soda Tank Inspection Results

As per the inspection results presented in the table above, the only features indicated as 'not acceptable' are the nozzles and attachments. This was due to the following:

- Internal corrosion was indicated on the 2.5" blind weld (nozzle 7)
- Ultrasonic Testing (UT) readings confirmed minimum nozzle neck thickness requirements for API 653 were not met for both 3" heating lines, 2.5" outlet, and 2.5" blind (nozzles 3, 4, 6 and 7).
- The 3" heating lines, 2.5" outlet, and 2.5" blind (nozzles 3, 4, 6 and 7) also did not contain repads (API 650 requirement).

The recommendations which were to be completed prior to returning to service were as follows:

- Repair internal weld on 2.5" blind (nozzle 7)
- Replace both 3" heating lines, 2.5" outlet, and 2.5" blind (nozzles 3, 4, 6 and 7).
- Install repads on both 3" heating lines, 2.5" outlet, and 2.5" blind (nozzles 3, 4, 6 and 7)

These repairs were recommended prior to returning the tank to service and were completed in 2021 to ensure the tank was safe to operate and avoid catastrophic failure or disruption to service.

3.2.7.2 South 50% Caustic Tank

As with the North tank, from discussions onsite and visual inspections, the tanks and pumps appear to be in good condition and no issues noted.

Photo 16: South 50% Caustic Tank (50%)

The same tank elements on the South tank were inspected (as per API 653 and NL Hydro requirements):

- Tank: Bottom, Shell, and Roof (fixed),
- Nozzles and Attachments
- Coatings and Linings
- Foundation and Compound

Tank Feature	Currently Acceptable to API 653
General Bottom Plate Thickness	ACCEPTABLE
Bottom Plate Thickness in Critical Zone (3" from Shell)	ACCEPTABLE
Annular Bottom Plate Thickness	NOT APPLICABLE
Bottom Welds and Shell-to-Bottom Weld	ACCEPTABLE
External Bottom Plate Projection	ACCEPTABLE
Shell Settlement	NOT INSPECTED
Edge Settlement	NOT INSPECTED
Shell Thickness	ACCEPTABLE
Roof Thickness	ACCEPTABLE
Nozzles and Attachments	NOT ACCEPTABLE

Table 2: South Caustic Soda Tank Inspection Results

The nozzles and attachments are shown as 'not acceptable' in the table above (as with the North tank). Specifically, this was due to the following issues:

- Internal corrosion was indicated on the 2.5″ outlet, 0.75″ temperature gauge, 2.5″ blind, and 1″ sight glass welds (nozzle 1, 2, 5 and 6)
- Ultrasonic Testing (UT) readings confirmed minimum nozzle neck thickness requirements for API 653 were not met for both 3″ heating lines, 2.5″ outlet, and 2.5″ blind (nozzles 1, 4, 5 and 7).

- Both 3″ heating lines, 2.5″ outlet, and 2.5″ blind (nozzles 1, 4, 5 and 7) also did not contain repads (API 650 requirement).

The recommendations which were to be completed prior to returning to service were as follows:

- Repair internal weld on 2.5″ outlet, 0.75″ temperature gauge, 2.5″ blind and 1″ sight glass (nozzles 1, 2, 5 and 6)
- Repair the porosity cluster noted on the first course of the vertical shell seam.
- Replace both 3″ heating lines, 2.5″ outlet, and 2.5″ blind (nozzles 1, 4, 5 and 7).
- Install repads on both 3″ heating lines, 2.5″ outlet, and 2.5″ blind (nozzles 1, 4, 5 and 7)

These repairs were confirmed completed in 2021 as they were recommended to be completed prior to returning the tank to service.

3.2.8 Two (2) Bulk Acid Storage Tanks (North and South) and Two (2) Pumps

The two acid tanks were inspected internally and externally by Acuren, in August 2021, while the tanks were out of service. While onsite, no issues with the acid tanks or pumps were noted. The tank inspection by Acuren was completed in accordance with API 653 and NL Hydro requirements and included inspection of the same tank elements as for the Caustic Tanks (see inspection results tables). An inspection of the acid tank piping serving both tanks was also inspected by Acuren and those results are presented below as well.

3.2.8.1 North Bulk Acid Storage Tank

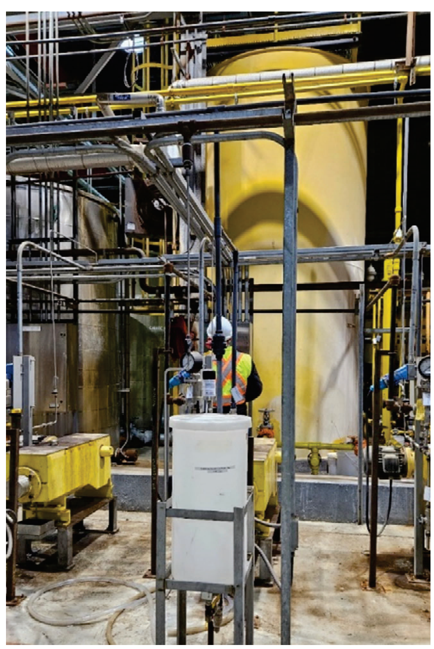


Photo 17: North Bulk Acid Storage Tank

Tank Feature	Currently Acceptable to API 653
General Bottom Plate Thickness	ACCEPTABLE
Bottom Plate Thickness in Critical Zone (3" from Shell)	ACCEPTABLE
Annular Bottom Plate Thickness	NOT APPLICABLE
Bottom Welds and Shell-to-Bottom Weld	ACCEPTABLE
External Bottom Plate Projection	ACCEPTABLE
Shell Settlement	NOT INSPECTED
Edge Settlement	NOT INSPECTED
Shell Thickness	ACCEPTABLE
Roof Thickness	ACCEPTABLE
Nozzles and Attachments	NOT ACCEPTABLE

Table 3: North Bulk Acid Soda Tank Inspection Results

As with the Caustic Soda tanks, the nozzles and attachments are shown in the table as 'not acceptable, with description of issues noted below:

- Internal corrosion was noted on the 3" inlet welds (nozzle 6) and 3" roof vent welds (nozzle 8).
- Magnetic Particle Testing (MT) revealed issues with the 2" sight glass weld on nozzle 5.
- Ultrasonic Testing (UT) readings indicated minimum nozzle neck thickness requirements for API 653 were not met for the 2" outlet, 2" sight glass, 2" drain, and 2" overflow (nozzles 1, 2, 3, and 4).
- 3" inlet (nozzle 6) is out of service due to severe corrosion.

The recommendations which were to be completed prior to returning to service were as follows:

- Repair 3" roof vent internal weld (nozzle 8).
- Repair external weld on 2" sight glass weld (nozzle 5).
- Repair two pinholes noted on first course internal vertical shell seam
- Replace 2" outlet, 2" sight glass (lower shell), 2" drain, and 2" overflow (nozzles 1, 2, 3, and 4).
- Replace 3" inlet (nozzle 6)

As for the other inspection reports, these recommended repairs were completed in 2021, prior to returning the tank to service.

3.2.8.2 South Bulk Acid Storage Tank

Photo 18: South Bulk Acid Storage Tank and Pumps

Tank Feature	Currently Acceptable to API 653
General Bottom Plate Thickness	ACCEPTABLE
Bottom Plate Thickness in Critical Zone (3" from Shell)	ACCEPTABLE
Annular Bottom Plate Thickness	NOT APPLICABLE
Bottom Welds and Shell-to-Bottom Weld	ACCEPTABLE
External Bottom Plate Projection	ACCEPTABLE
Shell Settlement	NOT INSPECTED
Edge Settlement	NOT INSPECTED
Shell Thickness	ACCEPTABLE
Roof Thickness	ACCEPTABLE
Nozzles and Attachments	NOT ACCEPTABLE

Table 4: South Bulk Acid Soda Tank Inspection Results

Again, the nozzles and attachments are shown in the table as 'not acceptable. Reasons for this were noted as follows:

- Visual Testing (VT) revealed Internal corrosion of 2″ outlet welds (nozzle 1) and internal corrosion and pinholes on the 2″ sight glass weld (nozzle 2).
- Magnetic Particle Testing (MT) revealed issues with the 3″ overflow weld (nozzle 3).

- Ultrasonic Testing (UT) readings indicated minimum nozzle neck thickness requirements for API 653 were not met for the 2" outlet, 2" overflow, 2" sight glass, and 3" inlet (nozzles 1, 2, 4, 5 and 6).

Recommendations were to be completed prior to returning the tank to service and included the following:

- Repair internal welds on 2" outlet welds (nozzle 1) and 2" sight glass weld (nozzle 2, lower shell).
- Repair external weld on 3" overflow (nozzle 3).
- Replace 2" outlet, 2" overflow, 2" sight glass, and 3" inlet (nozzles 1, 2, 4, 5 and 6).

These repairs were completed prior to returning the tank to service in 2021.

3.2.8.3 Acid Tank Piping (both tanks)

As stated earlier, Acuren completed an inspection on the carbon steel acid piping connected to both the north and south bulk acid storage tanks on August 19, 2021. Ultrasonic wall thickness readings were collected on the 2" Sch XS outlet acid line. The 2" outlet line extends from the bottom of both the south and north tanks, the lines merge and then continues to the acid skid. Four (4) readings were taken around the pipe circumference at random intervals for the length of the pipe, and the nominal wall thickness is 0.218".

A total of ten (10) areas measured along the piping had deviations greater than 10% from the nominal wall thickness for 2" pipe (0.218"):

UT Location	Description	NPS	0°/North	90°/East	180°/South	270°/West
1	Pipe	2	0.187	0.158	0.164	0.183
2	Elbow	2	0.283	NA	NA	0.270
3	Pipe	2	0.178	0.178	0.220	.188
4	Pipe	2	0.157	0.177	0.218	0.232
5	Pipe	2	0.155	0.188	0.214	0.185
6	Pipe	2	0.165	0.193	0.198	0.193
7	Pipe	2	0.170	0.192	0.194	0.180
8	Pipe	2	0.178	0.193	0.200	0.195
34	Pipe	2	0.172	0.186	0.197	0.184
35	Pipe	2	0.200	0.182	0.189	0.187
36	Pipe	2	0.188	0.188	0.200	0.177
37	Pipe	2	0.185	0.193	0.165	0.194

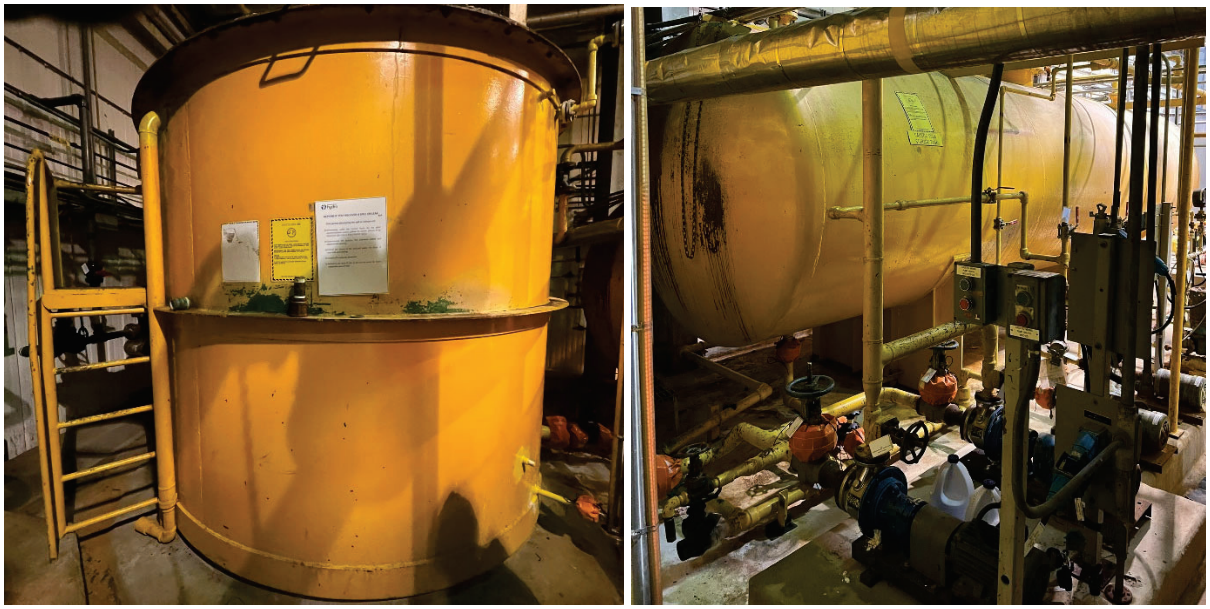
Table 5: Acid Piping Inspection Results

No recommendations were provided in the inspection report, but the wall thicknesses indicated with the red highlighting were more than 10% below the nominal thickness and the repairs were all completed in 2021.

3.2.9 Melting Tank and Two (2) Transfer Pumps

The melting tank was also included in the round of inspections completed by Acuren in 2021. The same inspection procedure was followed, and the same elements inspected as with the other tanks described previously. The pumps were not included in the inspection and as shown in the photos below, some of the fittings on the pumps were wrapped and this should be checked to ensure any issues are not getting worse. During the site visit, no issues were noted or provided by facility personnel.

Visibility around the melting tank and associated pumps is poor due to broken or blown light fixtures.



Photos 19 & 20: Melting Tank and Transfer Pumps

Tank Feature	Currently Acceptable to API 653
General Bottom Plate Thickness	ACCEPTABLE
Bottom Plate Thickness in Critical Zone (3" from Shell)	ACCEPTABLE
Annular Bottom Plate Thickness	NOT APPLICABLE
Bottom Welds and Shell-to-Bottom Weld	NOT ACCEPTABLE
External Bottom Plate Projection	NOT APPLICABLE
Shell Settlement	NOT INSPECTED
Edge Settlement	NOT INSPECTED
Shell Thickness	ACCEPTABLE
Roof Thickness	ACCEPTABLE
Nozzles and Attachments	NOT ACCEPTABLE

Table 6: Melting Tank Inspection Results

The inspection completed by Acuren determined that two tank features tested were not acceptable. The bottom welds, shell-to-bottom weld, and nozzles and attachment did not meet the minimum requirements of API 653, or NL Hydro as detailed below.

- Visual Testing (VT) of the bottom-to-shell weld was completed for the entire weld around the internal and external circumference of the tank – 85″ of the internal floor-to-shell was flagged for repair.
- VT of nozzles and manways: internal corrosion on 4″ outlet, 1″ sight glass (lower shell and top shell), 2″ inlet, 1″ sight glass (top shell), 3″ overflow, and 2″ dilution water inlet welds (nozzles 1, 2, 5, 6, 8 & 10).
- Ultrasonic Testing (UT) readings: 4″ outlet, 1.25″ sight glass (lower shell and top shell), 2″ inlet, 3″

overflow and 2″ dilution water inlet (nozzles 1, 2, 5, 6, 8 & 10) did not meet the minimum API 653 required nozzle neck thickness.
- 1.25″ high level alarm (nozzle 9) was not welded internally.

The following recommendations were to be completed prior to returning the tank to service:
- Repair the 85″ of floor-to-shell weld on the internal of the tank.
- 1.25″ internal nozzle to be welded (high level alarm (nozzle 9)).
- Replace 4″ outlet, 1″ and 1.25″ sight glasses (lower shell and top shell), 2″ inlet, 3″ overflow and 2″ dilution water inlet (nozzles 1, 2, 5, 6, 8 & 10).

As for the other tanks previously described, these repairs were completed in 2021 as they were recommended to be incorporated prior to returning the tank to service.

3.2.10 Caustic Soda Storage Tank and Two (2) Transfer Pumps

The horizontal caustic soda storage tank was inspected by Acuren inspected in 2021 while out of service. The results of the inspection are presented below, and the pumps were not included in the Acuren inspection. The pumps were observed during the site visit and no apparent issues were noted, and no known issued were mentioned.

Visibility around the area is poor due to broken or blown light fixtures.

Photos 21 & 22: Caustic Soda Storage Tank and Transfer Pumps

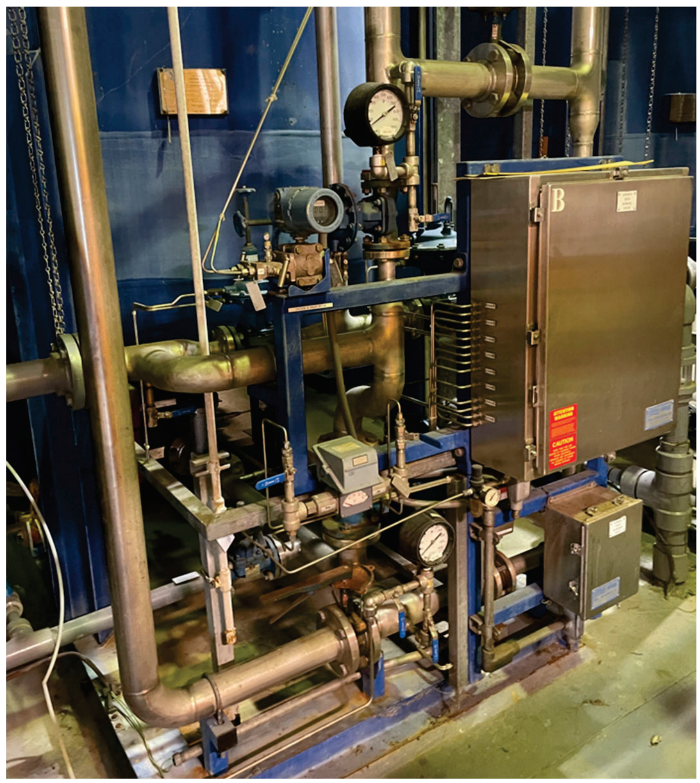
The inspection included the tank heads, shell, interior, support structure and nozzles. The only items that were noted for recommended repairs included:
- the internal nozzle to shell weld on 3″ drain (nozzle1), 2″ blind weld (nozzle 2), and 18″ manway (nozzle 3)

- corroded 3" caustic soda inlet to the repaired.

All other components of the tank were inspected visually and underwent ultrasonic testing, and no other concerns were noted. The tank heads, shell, interior and exterior and support structure were all deemed either satisfactory or in good condition. As stated earlier, the pumps were observed during the site visit and no apparent issues were noted or provided by facility staff.

3.2.11 Three (3) Cation Tanks (A, B and C)

The three cation tanks were installed in 1997, and the tanks appear to all be in good condition. During the inspection, a comment was made that the system was designed properly with high quality materials and there have been minimal issues since installation. It was also stated that if this system was built today, it would be a reverse osmosis (RO) system, but this system is reliable and working as designed.



Photos 23 & 24: Cation Tank and Associated Piping/Equipment

The tanks appear to all be in good condition and no known issues presented while onsite. However, some suggestions for future inspections were offered as listed below (some of which apply to each of the cation, anion and mixed bed tanks):

- Resin is due to be changed out – this is a costly product and has a significant delivery time
- NL Hydro would like one 'train' (i.e. train 'A' would include cation tank A, anion tank A and mixed

bed tank A) of tanks to be internally inspected (and then train B could be completed, followed by the remaining Cation C and Anion C tanks). This should include a Holiday Spark test which is a non-destructive and used to detect defects in coatings and linings, including pinholes, cracks, and voids. The tanks were all installed in 1997 and have had the same service since installation, and while the condition should be similar, the inspections will confirm the condition of each. Resin is required onsite before an internal inspection can be initiated as the existing resin must be removed, and due to the long lead times for the resin, it would be best to have it onsite and ready for adding to the system upon completion of the inspection (if the tank is deemed acceptable for continued service).

- Some rubber diaphragms were noted as cracking in the past, but this does not cause serious problems and can be replaced. It was not identified which tanks had this issue in the past but was a general statement. In the past these have been replaced, but Belzona® has rubber repair products which could possibly be used to repair these diaphragms instead of replacing to save time and reduce cost.

3.2.12 Three (3) Anion Tanks (A, B and C)

As noted for the cation tanks, the inspection and discussions with facility personnel indicated that the anion tanks appear to all be in good condition and have had minimal issues since they have been installed in 1997.

Photo 25: Anion Tank C (Cation Tank C in foreground)

While onsite, the cation, anion and mixed bed tanks were all reviewed and notes taken while walking with facility staff. The notes provided in the previous section for the cation tanks regarding the condition of the tanks and suggested future inspections to be scheduled also apply for the anion tanks (and mixed bed tanks) as well as a complete system. Please refer to the cation tank section for proposed future inspection information. All eight (8) tanks were installed in 1997, and the tanks appear to all be in good condition with minimal issues.

3.2.13 Two (2) Mixed Bed Tanks

As stated previously, the three cation, anion and two mixed bed tanks were all discussed as one system during the site visit and the notes in the cation section should be referred to for this condition and proposed recommendations. As with the other six tanks, the two mixed bed tanks appear to be in good condition and minimal issues since installation.

However, one issue was noted regarding the poor visibility around the mixed bed tanks due to broken/blown light fixtures.

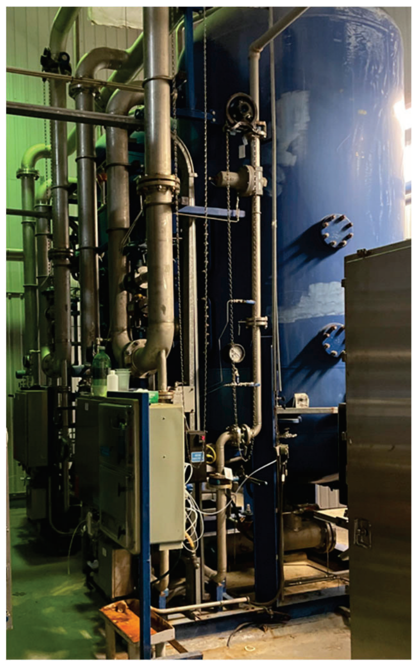


Photo 26: Mixed Bed Tanks (Edge of control panel in foreground)

3.2.14 Demineralization Tank

The demineralization tank is constructed of stainless steel and was fabricated in 1969. In 2002, the tank was disassembled, inspected, and then rebuilt. The tank appears to be in good condition with no leaks and no other known issues were noted during the site visit. While discussing the tank condition, a comment was made by an NL Hydro representative that tank is only welded on the outside, and not on the inside. This was noted by Acuren in a previous inspection on September 12, 2024. There have been no problems with the tank to date since it was reassembled and has been in service for over 20 years.

Photo 27: Demineralization Tank

The following is a summary of the recent inspection completed by Acuren. An internal visual inspection was completed on the tank when it was disassembled and then reconstructed inside of the process water treatment plant. The visual inspection was followed by NDE. Liquid Penetrant Testing (PT), Ultrasonic Thickness (UT), and Positive Material Identification (PMI). An external laser scan was also performed to check for plumbness and roundness. An analysis was completed to confirm the tank meets the reconstruction criteria of API 653.

Upon completion of the inspection, the results noted that welding was only completed on the outside of the tank shell, and not on the interior. Final conclusion was that the tank is "*deemed to be in overall serviceable condition*".

- Both Ultrasonic Testing (UT) and Liquid Penetrant Testing (PT) were completed to determine baseline thickness of the various tank components and to identify potential weld issues.
- nominal shell thickness was determined to be 3/16" (4.76mm), and 1/4"(6.35mm) for the floor.
- API 650 Annex AL "Aluminum Storage Tanks", Table AL.5b minimum requirements were confirmed to be met.
- PMI results determined the material of construction to be AA-5052 grade aluminum.
- Both roundness and plumbness checks were completed on the tank using a long-range laser scanner paired with software analysis.

As noted previously, the main issue noted was Acuren's concern with the welding, but the roundness was also mentioned as not meeting API 653 requirements:

- construction weld defect - full penetration butt welds should have been completed during the reconstruction of the tank. During inspection it was noticed that no welding was completed on the internal side of the tank.
    - Acuren recommended an engineering fitness for service to ensure suitability for service.
- roundness analysis was completed using a laser scanner and the tank did not meet the requirements for API 653.
    - Acuren recommendation – complete an engineering fitness for service test to ensure suitability for service.

3.2.15 Caustic Regeneration Skid

The caustic system pumps have had issues and only one of these is currently in service. The out of service pump has been down for over a year. This eliminates the redundancy included in the original design and if the working pumps fails, the process must be shutdown.

During the site visit it was stated that a radiography of the caustic regeneration skid piping was scheduled for late October 2024. Acuren completed the radiography on November 6, 2024, and the final report was received on November 28, 2024.

The results indicate that there was an erosive loss of 40.5% in the piping at C-REGEN-CML-16-DR. This was the 'worst case' for the piping tested and equates to a calculated remaining useful life (RUL) of 17.9 years. The regeneration skid was assigned an integrity status rating of "suitable for continued service". Therefore, with the RUL of nearly 18 years, and no concerns to continue in service, the skid should be able to remain in use for the planned service life of this plant, but it was recommended to continue to monitor for leaks and maintenance staff should schedule quick visual inspections monthly. No other issues with the existing system were noted.

Photo 28: Caustic Regeneration Skid

3.2.16 Acid Regeneration Skid

The acid regeneration skid was installed 27 years ago, and the piping is rubber lined. It was stated during the site visit that it is expected that this will start to breakdown soon, and some valves have already been replaced.

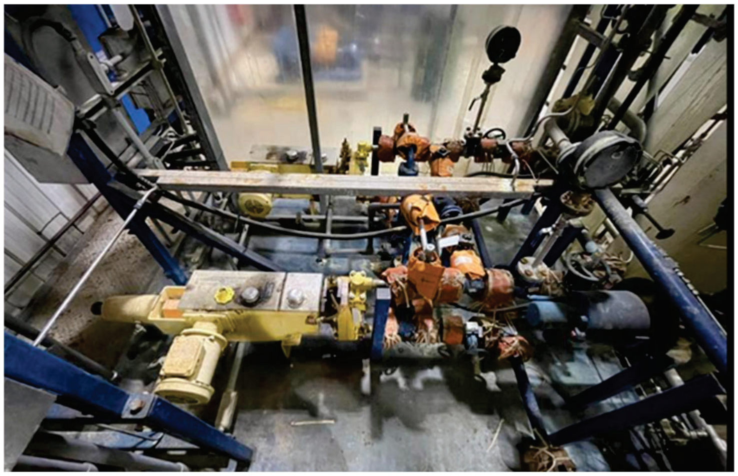


Photo 29: Acid Regeneration Skid

A radiography was completed by Acuren on November 6, 2024, and final report was submitted November 28, 2024. The results of the radiography indicate the following concerns:

- Erosive wall loss of 42.5% at A-REGEN-CML-10-DR, which calculates to an RUL of 14.7 years.
- Pitting was found in condition monitoring locations (CML)'s: 01, 03 ,05, 14, and 19
- Manufacturing Defects found in CML's: 04, 06, 07, 08, and 12

These issues are not considered critical, and the system was assigned an integrity status of "Suitable for Continued Service". It was recommended to continue to monitor each of the areas noted in the next scheduled inspection.

With no other issues noted by facility staff, or observed during the site visit, the inspection results suggest that the skid could remain in service for approximately 15 years, which greatly exceeds the proposed timeline of the 2030 shutdown. However, an inspection within the next five years is recommended to confirm there are no issues which are developing.

3.2.17 Caustic Transfer Pumps

The two caustic transfer pumps serve the condensate polisher storage tanks. As shown in the photo, the existing pumps appear to be leaking (or were at some time), but according to facility staff the pumps are reliable and do not have significant issues. The pumps should be monitored on a regular basis however to ensure the leaks do not return (or increase).

Photo 30: Caustic Transfer Pumps (2)

3.2.18 Acid Transfer Pumps

The acid transfer pumps were described as reliable and with no major issues. One concern was raised however regarding the plastic heads on the pumps. It was noted that one of these ‘exploded’ one day and if anyone had been in the area at the time it could have been serious. Measures should be considered to prevent this from happening in the future by placing guards around the pumps or replacing them with pumps with more conventional construction. On the day of the site visit, these pumps were observed and there were no apparent issues.

Photos 31 & 32: Acid Transfer Pumps (2)

3.2.19 Unit 1 Condensate Polishers

The unit 1 condensate polishers were confirmed to be original equipment and could not be inspected visually as they are insulated. It is unclear why the units are insulated, and this may not be required, and it is assumed that these units are reaching the end of their expected service life. The resin is approximately 10 years old, and replacement should also be considered as this is a common industry standard for resin replacement.

There is severe corrosion on some of the support beams for the polishers as shown in the second photo below. To replace these would be difficult if the polishers remained in service but the structure could possibly be reinforced.

Photos 33 & 34A: Unit 1 Condensate Polishers

Photo 34B: Unit 1 Polisher Corrosion on Structural Supports

Unit #1 Polisher MCC-A1-3 is antiquated and has outdated arc flash labels.

Photo 34C: Unit 1 MCC

The sampling station is original equipment. The Beckman conductivity meters are not in use any longer. The sampling valves look to be in reasonable condition, a few look to be new, however the sampling tubes and tube support are heavily corroded. The sodium after polisher looks new but the bottom of the enclosure seems to be corroding.

Photos 34D, 34E & 34F: Unit 1 Sampling Station and Sodium after Polisher

3.2.19.1 Caustic & Acid Day Tanks & Transfer Pumps

During the site visit it was noted that inspections for the unit 1 caustic and acid day tanks was scheduled to take place in late October 2024. The inspections were completed on November 6, 2024, and the final reports were submitted November 28, 2024. The results are as follows:

- Caustic Day Tank: Shell & Nozzles - no corrosion issues found.
- Acid Day Tank:
    - Shell: no corrosion issues found
    - Nozzle: nozzle 5 was installed as Schedule 40.

Although the nozzle was installed as Schedule 40, the measured thickness of 0.118" is still above the 0,100" minimum required, so there are no issues.

It was also noted that the coating on the tanks was beginning to breakdown, but the corrosion on the exterior of the tank was not considered significant and the average shell thickness confirmed the level of corrosion was not excessive.

Photo 35A & 35B: Unit 1 Caustic Transfer Pumps and Day Tank (left) and Acid Transfer Pumps and Day Tank (right)

The caustic pumps for Unit 1 are designed to run one pump at a time. Both pumps appear to be in poor condition, but the redundancy means if one pump requires refurbishment, the other can still serve the system.

The acid transfer pumps are set up in the same operating sequence and thus have redundancy should one of the pumps experience issues. These pumps also appear to be in poor condition.

Disconnect switches for the pumps have no visible arc flash labels.

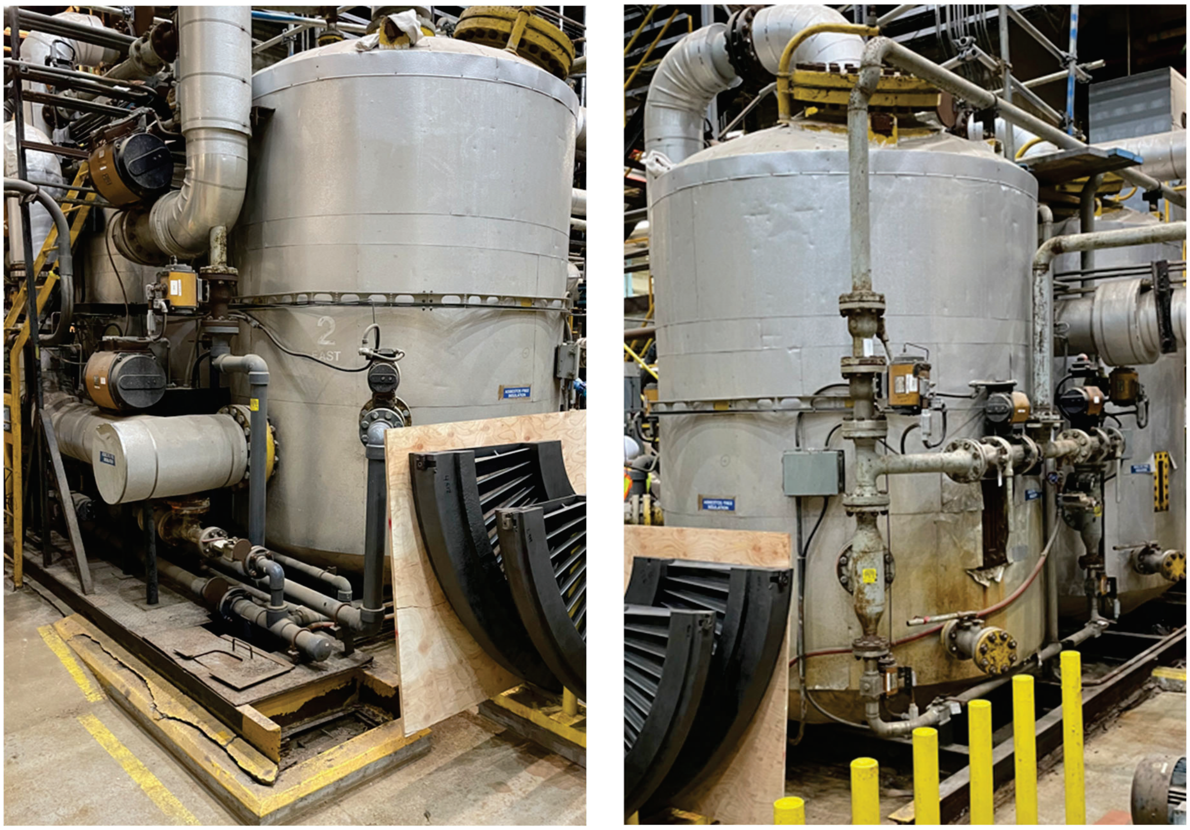
3.2.19.2 Control Panel

The control panel is original equipment and has exceeded its lifespan. The automatic controls are unreliable and require an experienced operator to step the system through the control sequence. Most of the mimic panel lights are blown as the "push to test" button no longer illuminates the lights.

Photo 36: Unit 1 Control Panel

3.2.20 Unit 2 Condensate Polishers

Similar to Unit 1, Unit 2 condensate polishers include all original equipment, they are insulated, and the polishers could not be inspected directly. The same assumption applies with respect to the equipment reaching the end of its service life expectancy. The resin was also confirmed to be approximately 10 years old in this unit and should be considered for replacement.



Photos 37 & 38: Unit 2 Condensate Polishers (see deteriorating supports)

The visual inspection of Unit 2 revealed severe corrosion of the beams under the polishers with some of the webs corroded through. In one area, one of the pipes appears to be cracking at the flange as the unit has dropped due to lack of support and is pulling the pipe down as well. To replace these beams would be difficult if the polishers remained in service but with this unit shifting it may be necessary to prevent the piping from breaking at the flange. See photo below.

Photos 39A & 39B: Unit 2 Piping Starting to Separate due to Polishers Dropping

Unit #2 Polisher MCC-B1-3 is antiquated and has outdated arc flash labels and has some surface corrosion.

Photo 40A: Unit 2 MCC

The sampling station is original equipment. The conductivity meters do not seem to be in use any longer. Most of the sampling valves look to be in reasonable condition, the diluted acid sampling valve is heavily corroded and the panel around where the valve is mounted has corroded away. The sampling tubes, tube support, and panel is corroding. The sodium after polisher looks new and in good condition.

Photos 40B, 40C, & 40D: Unit 2 Sampling Station and Sodium After Polisher

3.2.20.1 Caustic & Acid Day Tanks & Transfer Pumps

Both tanks were inspected by Acuren on November 6, 2024, and the final report was received on November 28, 2024. The inspection results for the caustic and acid tanks for Unit 2 are presented below:

- Caustic Day Tank: Shell & Nozzles - no corrosion issues found.

- Acid Day Tank: Shell & Nozzles - no corrosion issues found.

The tank shells far exceeded the minimum required thickness (MRT) as per API 653, and nozzles were also within the recommended MRT. It was noted that the coating on the tanks was beginning to breakdown, but the corrosion on the exterior of the tank was not considered significant and the average shell thickness confirmed the level of corrosion was not excessive.

Photo 41 & 42: Unit 2 Caustic Transfer Pumps and Day Tank (left) and Acid Transfer Pumps and Day Tank (right)

The caustic and acid transfer pumps are setup for redundancy as only one of each set runs at a time. The pumps all appear to be in poor condition and one of the acid pumps has been repaired three times in recent years and this pump as a minimum should be considered for replacement.

Disconnect switches for the pumps have no visible arc flash labels.

3.2.20.2 Control Panel

The control panel is original equipment and has exceeded its lifespan. The typical lifespan of electrical panels is 25-50 years which can vary depending on factors such as maintenance, usage, quality of the original equipment, etc. The automatic controls are unreliable and require an experienced operator to step the system through the control sequence. Most of the mimic panel lights are blown as the “push to test” button no longer illuminates the lights.

3.2.21 Unit 3 Condensate Polishers

The unit 3 condensate polishers are also the original equipment and are insulated. Again, the equipment could not be inspected directly but it is assumed to be reaching the end of its expected service life as it has been in operation for over 50 years since it is original to the building construction. The resin is about 10 years old which is due for replacement based on industry standard recommendations for 10 year replacement.

In discussions with on-site personnel, it was stated that the flow meters for unit 3 have frozen occasionally since they are close to the exterior wall and the overhead door is sometimes left open in the winter. This sometimes causes false readings which affects the actuated valves they control, and they do not open/close as required. These large valves are noted to be very difficult to open/close manually when automation issues occur. Overall, a comment was made that the ‘system is just very old’.

Photos 43A & 43B: Unit 3 Condensate Polishers

Unit #3 Polisher MCC-BAB-3 is antiquated and has outdated arc flash labels and has small amounts of surface corrosion.

Photo 44A: Unit 3 MCC

The sampling station is original equipment. The conductivity meters do not seem to be in use any longer. The sampling valves look to be in reasonable condition, the sampling tubes look adequate, and the tube support area and panel front is corroding. The sodium after polisher looks new but the enclosure has some minor surface corrosion.

Visibility around the condensate polisher is poor due to broken or blown light fixtures.

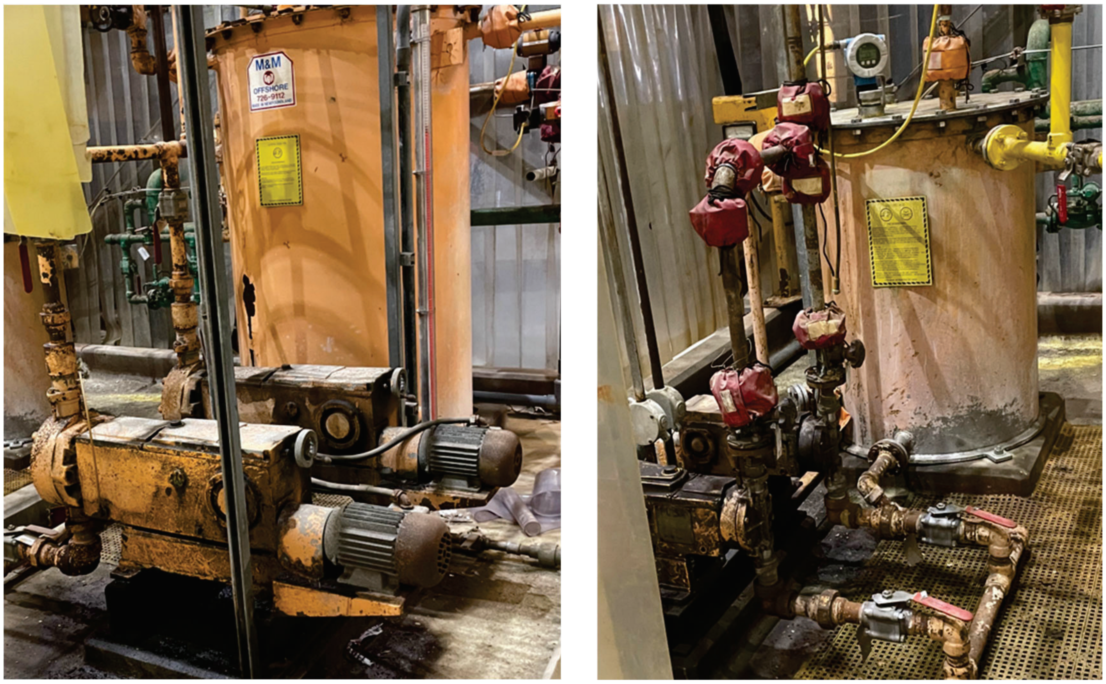
Photo 44B: Unit 3 Sampling Station

3.2.21.1 Caustic & Acid Day Tanks & Transfer Pumps

The caustic and acid tanks were both inspected by Acuren on November 6, 2024, and the final report was received on November 28, 2024. The inspection results for the caustic and acid tanks for Unit 3 are presented below:

- Caustic Day Tank: Shell & Nozzles - no corrosion issues found.
- Acid Day Tank: Shell & Nozzles - no corrosion issues found.

The tank shell thickness measurements exceed the minimum required thickness (MRT) as per API 653, and nozzles were also within the recommended MRT. The tank coatings were also evaluated and were noted as beginning to breakdown, but the corrosion on the exterior of the tank was not considered significant based on the average shell thickness recorded.



Photos 45A & 45B: Unit 3 Caustic Transfer Pumps and Day Tank (left) and Acid Transfer Pumps and Day Tank (right)

The caustic and acid transfer pumps are setup for redundancy as only one of each set runs at a time. The pumps all appear to be in poor condition.

3.2.21.2 Control Panel

The control panel is original equipment and has exceeded its lifespan. The panel is located near an exterior door which gets left open, causing snow and water buildup on the panel during days of poor weather. This has caused the panel to deteriorate and corrode resulting in the panel to not operate properly. The auto control no longer works so control is done manually which is tedious and raises safety concerns. The level alarms are no longer received and need to be checked manually, and the pneumatic tubing freezes up due to moisture in the air and cold temperatures when the door gets left open. Most of the lights on the mimic screen have blown as the “push to test” button no longer illuminates the lights.

Photo 46: Unit 3 Control Panel

4.0 Wastewater Treatment Plant Inspection

4.1 General

The wastewater treatment facility is common to the whole plant. The wastewater treatment plant serves to process plant run-off and other site wastewater year-round up to the year 2041. The WWTP treats the wastewater generated at the plant, including Unit 1, Unit 2 and Unit 3, as well as common areas. The wastewater equalization building was removed during a 2021-2022 project and was replaced with basin covers and a new pumphouse was constructed.

Effluent from the thermal plant floor drains, boiler blow down lines, overflow from the general service cooling tanks and the clarifier blow down lines is treated in the continuous basin. The treated effluent then flows through an oil-water separator before discharging into the basin where is undergoes a retention process. Run off is then filtered through a final oil-water separator prior to discharging into Indian Pond.

The periodic basin is a different system than the continuous and processes waste from air heater washes, boiler washes (on the fireside), batch reactor waste and landfill leachate. When the level in the basin reaches a setpoint level, the effluent is pumped to the wastewater treatment plant and into a batch reactor. The solid waste in the reactor is transported to the site landfill and the treated liquid is discharged into Indian Pond. The WWTP process includes the following major equipment elements:

- Mechanical settler
- Solids filter press

The inspection of the Wastewater Treatment Plant was completed during an in-person site visit at the NL Hydro Holyrood TGS. The inspection was completed on the caustic tank, caustic pumps, polymer pump, and more.

4.2 Wastewater Treatment Plant Inspection Results

The results of the Wastewater Treatment Plant inspection are as follows.

One thing noted during the site visit was the Wastewater Treatment Plant MCC 12 has outdated arc flash labels.

4.2.1 Caustic Tank

An internal and external out-of-service inspection of this caustic tank was previously completed in August 2021.

Photo 47: WWTP Caustic Tank

The table below indicates the tank features which were inspected and if acceptable according to APT 653 requirements.

Tank Feature	Currently Acceptable to API 653
General Bottom Plate Thickness	ACCEPTABLE
Bottom Plate Thickness in Critical Zone (3" from Shell)	ACCEPTABLE
Annular Bottom Plate Thickness	NOT APPLICABLE
Bottom Welds and Shell-to-Bottom Weld	ACCEPTABLE
External Bottom Plate Projection	NOT INSPECTED
Shell Settlement	NOT INSPECTED
Edge Settlement	NOT INSPECTED
Shell Thickness	ACCEPTABLE
Roof Thickness	ACCEPTABLE
Nozzles and Attachments	NOT ACCEPTABLE

Table 7: WWTP Caustic Tank Inspection Results

As shown in the table, the nozzles and attachments were deemed to be 'not acceptable' based on the following issues:

- Three (3) locations of porosity were noted on the internal vertical shell seam on the first shell course.
    - First one located 51" from the floor
    - second 65" from the floor
    - third 68 ¼" from the floor
- 3" pump suction (nozzle 4) did not meet the minimum required nozzle neck thickness of API 653.

The following recommendations were to be completed prior to returning the tank to service:

- repair the three (3) locations of porosity which were found on the internal vertical shell seam on the first course.
- replace the 3" pump suction (nozzle 4) which does not meet the minimum required nozzle neck thickness.

These repairs were completed in 2021 prior to returning the tank to service, so the tank is deemed to be fit to remain in service. From the latest onsite inspection, there are no apparent issues after inspecting the caustic tank.

4.2.2 Two (2) Caustic Transfer Pumps

The two caustic transfer pumps are approximately 30 years old and during the site inspection it was mentioned that these were not used for the last 15 years. More information was provided from the facility personnel since the site visit and confirmed that the pumps were used to transfer caustic from the WWTP back to the water treatment plant. The site person has only witnessed these pumps in operation once in the past 25 years (this was about 12 years ago). However, they tried to use them within the past five years, and they appear to be seized.

Photo 48: Caustic Transfer Pumps (2)

The disconnect switches for the pumps have no visible arc flash labels.

4.2.3 Caustic Piping

The WWTP piping was recently inspected by Acuren on November 8, 2024. The piping between Pumphouse 1 and the WWTP is shown in the photo below labelled as 'Overhead', and the piping in the Utilidor is also shown in the photos.

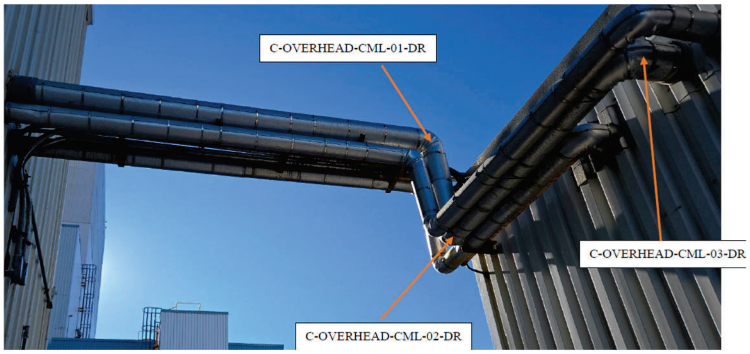


Photo 49: Overhead Caustic Piping (Exterior)

Photos 50 & 51: Caustic Piping (Utilidor)

The inspection has indicated a "Suitable for Continued Use" equipment status, but the details of some issues are noted below:

- Utilidor piping – 38.7% wall thickness loss UTILIDOR CML No. 1 & 3 but still has a calculated remaining useful life (RUL) of 31.9 years.
- Overhead piping - weld erosion noted on 3" line but wall thickness still above the nominal thickness.

In June 2014, a leak in the caustic soda pipe located between the Stage I Pumphouse and the Wastewater Treatment Plant (WWTP) was investigated, and a report was developed. It was discovered that the heat tracing for the caustic piping was turned off. Since the caustic soda has a freezing point of 120°C, it must be maintained above this temperature. There are two separate heat tracing runs, one for piping exterior to the wastewater treatment plant and the other for interior piping. The systems were tested and operated as per design when the thermostats were adjusted. If the temperature of the caustic soda is too high, it leads to 'caustic stress corrosion cracking (CSCC).

The caustic piping between Pumphouse 1 and the WWTP was confirmed to be carbon steel and was insulated. Due to the location and salt-laden air combined with the precipitation, the cladding was penetrated and lead to external corrosion and pipe wall loss. Precipitate was also noted on the exterior of the piping, and another hole was found in this piping. The recommendations of the report were implemented and there have been no issues with this piping.

4.2.4 One (1) Polymer Pump

The polymer pump observed on site and facility personnel did not note any issues with the pump. There is only one pump for this system so any issues in operation should be addressed immediately and preventative maintenance should be completed in accordance with manufacturer's recommendations to ensure the system is ready for use whenever needed.

Photo 52: Polymer Pump

4.2.5 Two (2) Ferric Chloride Pumps

The two ferric chloride pumps appear to be the original pumps to the building and seem to be in fair to poor condition. No issues were noted on site and there is redundancy which allows for repair or replacement of a pump which has failed. With the age of the equipment and observed condition, the operation of the pumps should be checked and maintained regularly in accordance with manufacturer's recommendations to ensure no interruptions to operations or processes for the plant.

Photo 53: Ferric Chloride Pumps (2) and Tote

The disconnect switches for the pumps have no visible arc flash labels.

4.2.6 Batch Reactor

During the site visit it was mentioned that the batch reactor does not have many issues, and it is a relatively simple process. Caustic soda is added to the batch tank to increase the pH to 8. The acid precipitates the metals and when the agitator is turned off, they settle to the bottom, and then the clean water is pumped out. The sludge at the bottom of the reactor is then pumped to the filter press, and into dumpsters. The dumpsters are then taken to the landfill where it will eventually be picked up again and then retreated again. NL Hydro plans to have a full inspection of the reactor under the upcoming 2026-2027 project, which will include internal inspection to measure shell thickness. This should be fine as it was stated by facility staff that there are no issues with the reactor.

Photos 54 & 55: Batch Reactor

It was noted during the site visit that some of the light fixtures above the batch reactor have blown and the lighting in the area is poor. The locations of these light fixtures are not easily accessible and therefore maintenance of the fixtures is left undone.

The agitator disconnect switch has no visible arc flash label and the termination junction box on the motor has corrosion.

4.2.7 Sludge Pumps

The two sludge pumps appear to be original, but it was confirmed with site personnel that there are no issues with them. They are showing some moderate corrosion on the pump casings, but the redundancy allows for one pump to be repaired or replaced while the other can maintain service. Due to the age of the pumps and the environment in which they operate, operation should be monitored during preventative maintenance as per manufacturer's recommendations ensure any issues are identified early.

Photo 56: Sludge Pumps

The disconnect switches for the pumps have no visible arc flash labels.

4.2.7.1 Sludge Piping

Acuren completed the ultrasonic testing inspection for the sludge piping on October 31, 2024. The final confirmation was the piping tested was suitable for continued service. The piping inspection included the 3″ wastewater piping from the storage tank to the pump suction. Thirteen (13) UT locations were tested over this section and the piping in the concrete floor could not be tested.

The only recommendation based on the UT inspection was to repair the coating on the pipe penetration through the concrete floor as it has lost all of its coating and now has significant corrosion (see photo below).

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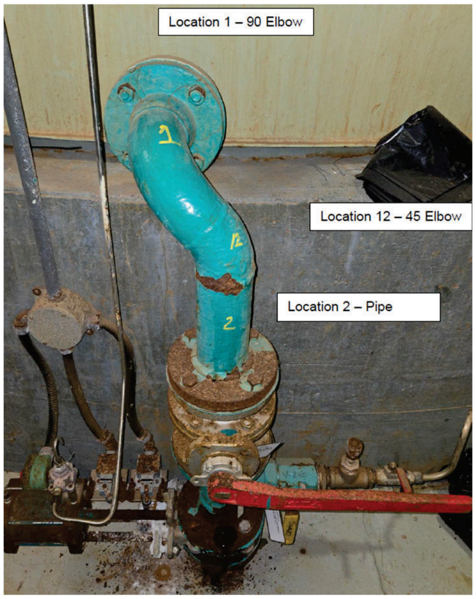
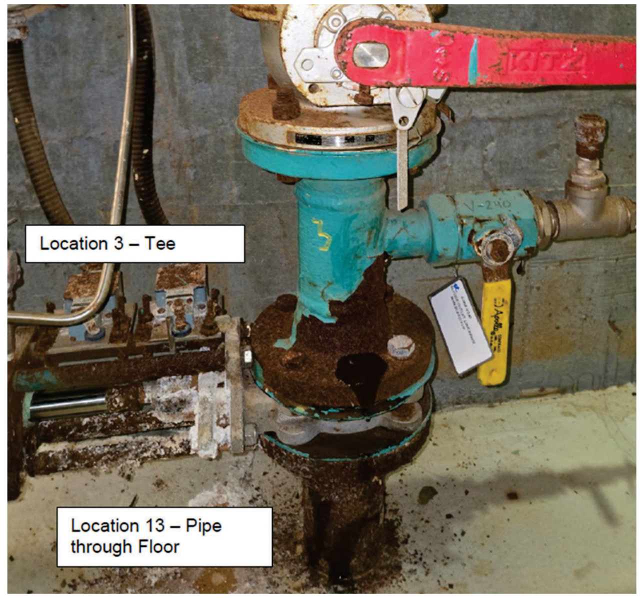




Photos 57 & 58: Sludge Piping

4.2.8 Filter Press

The filter press was confirmed to be working well with minimal issues and the visual inspection did not reveal any issues of concern. The only minor issue reported is that the rubber seals occasionally need to be replaced, but this can be done by maintenance on site.

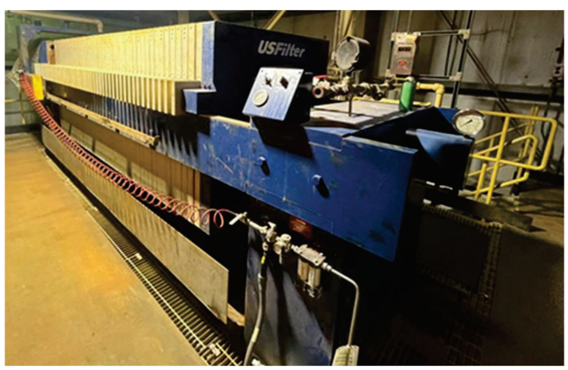


Photo 59: Filter Press

4.2.9 Recirculation/Discharge Pump

This pump circulates the effluent in the batch reactor during treatment and discharges post treatment. The pump appears to be original, and it was confirmed that the pump has been working fine with no issues. One concern is that there is only one pump, and it was mentioned during the site visit that if this pump stops working it would be a major issue. Therefore, it is strongly recommended that a second pump be added for redundancy due to the importance of this pump in the treatment process. This would eliminate any downtime should the existing pump fail. Alternatively, a spare pump could be purchased to be installed if the existing required replacement, but this would require the system to be shutdown for this installation, and interruption of the treatment process. Installation of a second pump for redundancy is the recommended option.

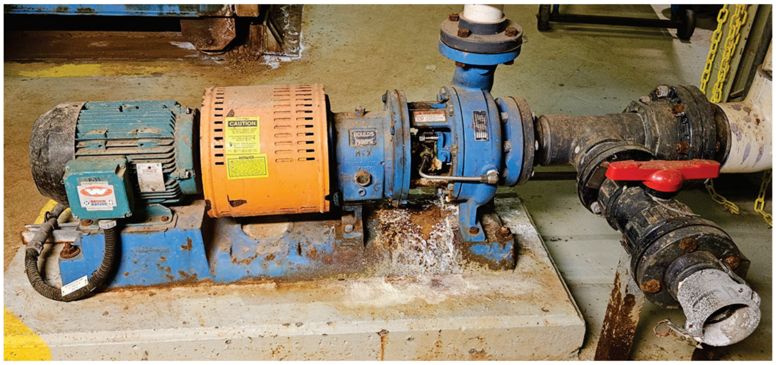


Photo 60: Recirculation/Discharge Pump

The disconnect switch for the pump has no visible arc flash labels, conduit connector on one side of disconnect switch has corroded.

4.2.10 Pumps 8A/8B

Pumps 8A and 8B are located in Pumphouse 1 and they pump to the raw water sump and firewater system.

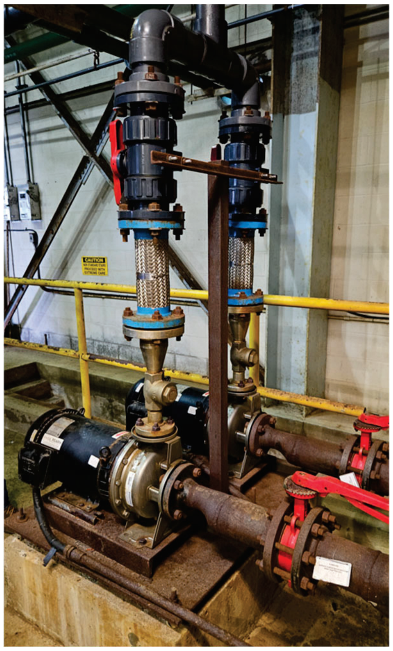


Photo 61: Pumps 8A/8B

During the inspection, these pumps were noted as previously being 'problematic', but after the addition of the recirculation line, it is now working fine.

However, another addition to the system which has caused some issues recently is the 'makeshift' car wash supply and raw water / fire water control panel. The control panel has "P-8A" and "P-8B" start and stop buttons and sometimes the wrong button is pushed which causes issues. "P-8A" is for the car wash but the timer no longer works so if the operator forgets to come back into the building and turn the pump off it will run continuously. "P-8B" is sometimes pushed by mistake when they want to use the car wash, and this switch has no timer and will run until someone turns it off. If the timer on the car wash pump worked, then this would fix the problem (providing people only turn on the car wash pump as required).

Photo 62: 'Makeshift' Control Panel for Pumps 8A/8B

4.2.11 HVAC Issues

While onsite the HVAC issues for the WWTP were discussed. In the winter months, the heat from the unit heaters rises to the roof and the rooms below become very cold. The three rooftop exhaust fans then discharge this warm air to the outside. The unit heaters also have control issues and built-in thermostats do not work. Adding to the cold inside air temperatures is the cold outside air which is brought into the building and is pulled through the space via the rooftop exhaust fans.

The HVAC equipment currently includes the following:

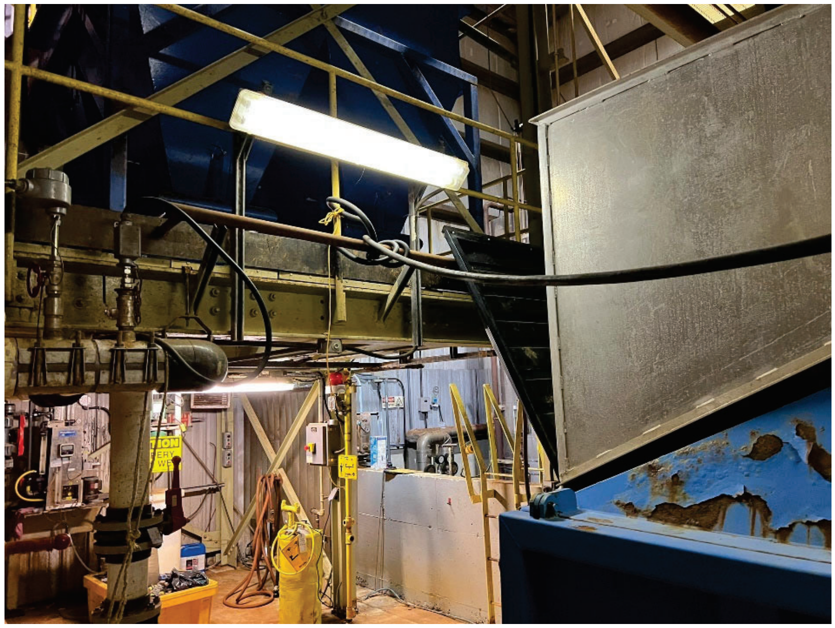
- Three (3) rooftop exhaust fans (originally there was only 1)
- Two (2) louvres on the lower level
- Several electric unit heaters through the building


Photos 63 & 64: Existing Air Intake Louvre and Typical Unit Heater

At the time of the site visit, it was not confirmed that the controls for the louvres were working as it was not clear where the signal came from, but it assumed to be linked to the exhaust fans (ie. louvres to open on a start signal from the fans). The louvres were in fair to poor condition but whether they automatically open and close through the control system is not confirmed.

As mentioned earlier, the duct heaters have built-in thermostats, but these do not work so they do not shut off and run continuously. With the cold inside temperatures in the winter many of these unit heaters would not shut down even if the thermostats were working. Unit heaters have various levels of corrosion. Cable is strung in a haphazard way, looped around handrails to power a unit heater that is sitting on a catwalk near the caustic tank.

The sequence of operation for the HVAC system is not known at this time, and is assumed to not be working as designed, all of which could be contributing to the heating and ventilation control problems.



Photos 65: Cable routed haphazardly to unit heater

5.0 Underground Wastewater Treatment System Inspection

5.1 Pumps 5A/5B

These pumps transfer sludge from clarifier blow down and sand filter backwashes and discharge to the continuous basin for treatment.

Photos 66 & 67: Pumps 5A/5B and Associated Electrical Equipment

These pumps are located in the well near the entrance to the main powerhouse, under the yellow checker plate covers shown in the photo above. The pumps are setup in a lead/lag setup and controlled by the water level inside the sump. One pump will start up as the lower cut-in water level is reached and if the water keeps rising and reached the second setpoint level then the second pump will start up. It was stated during the site visit that there were no issues with the pump operation and there was nothing noted from the visual inspection.

The disconnect switches for the pumps have no visible arc flash labels, and the junction boxes and cable connectors have varying degrees of corrosion.

5.1.1 Oil Water Separators (OWS)

5.1.1.1 OWS No.1 and No.2

These two OWSs are metal construction, but all others on site are plastic. Samples are taken once a week and tested. If oil is detected, a vacuum truck is hired to remove the water and eliminate the potential for contamination.

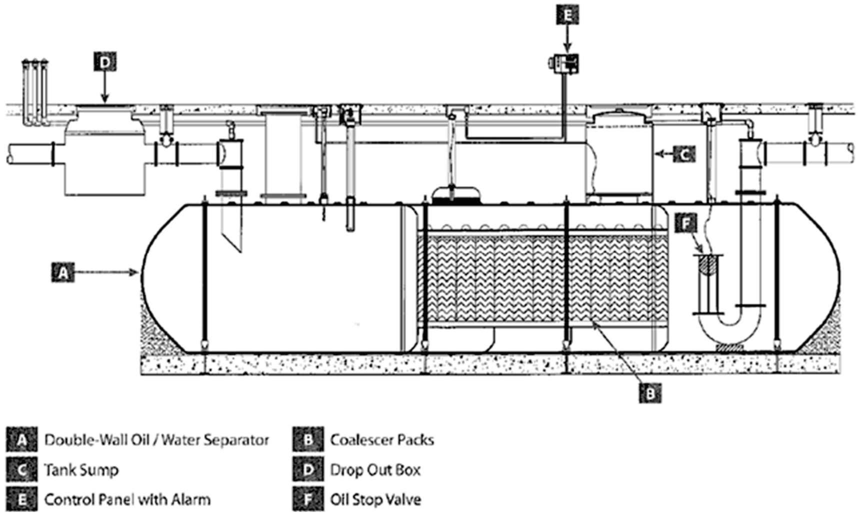


Photo 68: Typical Equipment Design

Photo 69: OWS No.2

5.1.1.2 OWS Cathodic Protection

During the site visit, the cathodic protection for OWS No.2 was tested and it appears to be working. Functionality of the cathodic protection test meters needs to be verified if steel tank is to be kept in service. It was confirmed from facility personnel after the site visit that cathodic protection tests are completed monthly on OWS No.1 and No.2, and results are logged in a spreadsheet. They also stated readings are generally good, but sometimes during high levels of precipitation the results are affected slightly.

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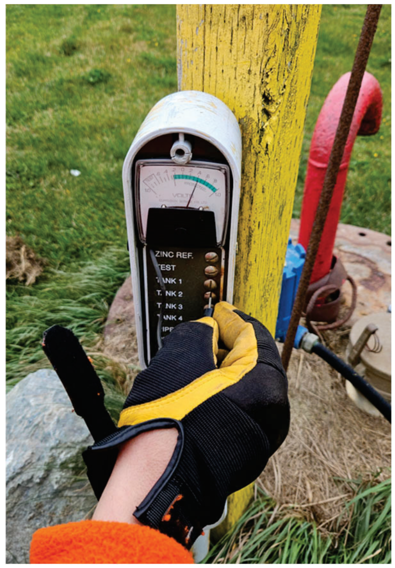


Photo 70: OWS No.2 Cathodic Protection Test

6.0 Recommendations

For each of the systems evaluated in previous sections, recommendations are presented below. For all those with no specific recommendations listed, regular monitoring and preventative maintenance as per manufacturer's recommendations is recommended.

6.1 Water Treatment Plant

6.1.1 Raw Water Pumps

These pumps are nearing the end of their expected service life, but no issues were noted during the site investigation. With the duplex pumping setup, the redundancy will allow for one failing pump to be repaired. However, if the pump cannot be repaired, purchasing a new pump and delivery to site could take months, and during that time the one running pump could fail. It is recommended that a new pump be purchased as a spare and if one of the existing pumps fails, it should be replaced with the spare immediately.

Recently, the pump in service stopped working and the standby pump did not start up automatically, and this would have been a serious issue with operations if no one was there to manually start the standby pump. Recommend replacing the instrument junction box and the motor control station to ensure reliable operation and operator safety.

6.1.2 Clarifier

The Clarifier does have several areas of concern as indicated in the inspection reports, but a full replacement of the tank would be very costly and disruptive to plant operations. The local repairs which were recommended and completed should extend the service life of the tank, but a refurbishment would be more permanent and would avoid full replacement.

The following are recommended for purchase:

- new spare Badgermeter flowmeter
- new spare recirculator

6.1.3 Sand Filters

The sand filters are all in poor condition and while temporary repairs have been implemented, the severe deterioration of portions of each of the three filters has led to the recommendation to replace all three filters. This will require substantial capital investment but when compared to the costs associated with refurbishment, the cost difference is not substantial (especially when considering the costs and disruptions to plant operations associated with a catastrophic failure of one of these tanks if the temporary repairs are not sufficient and led to rupture). This will require detailed scheduling and coordination, but the consequences of a failure would still lead to replacement anyway, as well as extended plant disruptions. A well planned and coordinated replacement would be ideal when compared to an unexpected tank rupture. Since there are three filters, one could be replaced at a time and interruption to operations would be minimized. Filter No. 3 replacement should be undertaken during a plant shutdown as the splitter box on filter #3 also serves filters #1 and #2 and if the plant in I operation then a temporary bypass would be required.

6.1.4 Clearwell

As with the sand filters, the Clearwell is recommended for replacement due to the poor condition of the tank. This initial capital cost for replacement versus refurbishment is similar and justified when considering the extra costs and process disruptions associated with a Clearwell tank failure. With no redundancy, an unscheduled failure would be detrimental to plant operations as the major reservoir for filtered water storage would be lost a new tank would have to be fabricated, delivered to site, installed, commissioned, etc. One option available to consider would be to rent a temporary tank which could be installed and connected to the system to minimize disruption to operations while the old tank is removed, and the new tank is being constructed. This work will require coordination with the sand filter replacements as well since four tanks are in the same general area. As stated previously, a well-planned replacement is recommended, especially when reviewing the potential consequences of an unexpected tank failure.

Replacement of the motor control station is also recommended to ensure reliable operation and operator safety.

6.1.5 Flocculent Tank & Pumps

The inspections and discussions with facility staff have confirmed that the existing PVC piping and valves are starting to fail, and exact matches for the original valves are not available. The piping and valves are recommended for replacement immediately to avoid issues associated with failure. Sections of the system can be isolated and replaced while maintaining operations.

There are two pumps which would allow for replacement of one at a time with no disruption to service. No issues were noted but replacement of at least one of the pumps should be considered to ensure continued service and reliability.

6.1.6 Coagulant Tank and Pumps

With no known issues noted, the system appears to be reliable and maintenance free so no recommendations for this tank or associated pumps. However, the tank and pumps should be inspected within the next 5 years to confirm they are suitable to remain in service up to 2030, and beyond if required.

6.1.7 Two (2) 50% Caustic Tanks and Two (2) Pumps

No known issues were noted for these caustic tanks or pumps from discussions with facility staff. The issues with nozzles which were presented in the Acuren reports are all assumed to be completed prior to returning the tanks to service. Therefore, the only recommendation for the north and south tanks and associated pumps is to schedule an inspection in the next 5 years to confirm there are no new issues.

6.1.8 Two (2) Acid Tanks (North and South) and Two (2) Pumps

The visual inspections of the north and south acid tanks and associated pumps did not reveal any issues, and no known issues were noted from facility staff. The Acuren inspection report indicated some issues with nozzles, but these were all completed prior to returning to service. It is recommended that an inspection be scheduled in the next 5 years to confirm there are no new issues which have developed.

The Acuren report did note issues with the piping with some wall section thicknesses showing measured as 10% less than nominal thickness. However, the remaining useful life (RUL) indicated for the piping is calculated to extend well beyond the scheduled 2030 shutdown.

6.1.9 Melting Tank and Two (2) Transfer Pumps

These tanks were also inspected in the 2021 Acuren inspections and issues were noted with the bottom welds and shell-to-bottom welds, and nozzles. All of these repairs were completed in 2021-2022, prior to returning the tank to service.

The pumps were not included in the Acuren inspection, and it was noted on site that some of the fittings were wrapped. It is recommended that these be monitored regularly, and if issues arise or appear to be worsening, the fittings should be replaced. There are two pumps so while one is shutdown to fix/replace fittings, the other can maintain operation.

As for the previous tanks and pumps, an inspection within the next 5 years is recommended to be completed.

6.1.10 Caustic Soda Storage Tank and Two (2) Transfer Pumps

Also inspected in 2021 by Acuren, the horizontal tank had indicated some nozzle issues, but these are assumed to have been completed prior to returning to service. The pumps were not noted by facility staff as having any known issues. An inspection is recommended within the next 5 years to confirm the tank and pumps are all suitable to remain in service.

6.1.11 Three (3) Cation Tanks (A, B and C)

Overall, the system is regarded as being reliable and working as designed. The system was installed in 1997, and facility personnel recommended the internal inspection of one cation, one anion and one mixed bed tank, and to replace the resin which has already surpassed the industry standards for replacement (cation resin 10-15 years; anion 4-7 years; and mixed bed 10 years). The rubber diaphragms should also be inspected and repaired as necessary (using Beldona® or other approved products) or replaced if the diaphragm is beyond repair. This is a good first step to keep the plant in operation, but once these inspections are complete and any necessary refurbishment or overhauls are complete, the next cation, anion, & mixed bed tank should be completed. Then finally, the last cation and anion tanks can both be inspected, resin replaced, and rubber diaphragms repaired or replaced as required.

6.1.12 Three (3) Anion Tanks (A, B and C)

As per the recommendations described in the cation tank section, the recommendation is to plan for internal inspection of one anion tank (along with one cation and one mixed bed tank). Replacement of resin and inspection of rubber diaphragms shall be completed to determine if repairs or replacement are required. Then the second anion, cation, and mixed bed tanks can be inspected, refurbishment completed, resin replaced, and rubber diaphragms repaired or replaced as required. Then the third anion and cation tanks can both be inspected, refurbished as needed, resin replaced, and diaphragms repaired/replaced.

6.1.13 Two (2) Mixed Bed Tanks

As above, each of the mixed bed, cation and anion tanks should be internally inspected. Since there are only two mixed bed tanks, these will be included in the first two rounds of inspections. The resin shall be replaced and diaphragms inspected with repairs or replacement to be completed as required. Once completed, the plant can operate at full capacity.

6.1.14 Demineralization Tank

The tank was constructed in 1969 and was disassembled in 2002 for inspection. Acuren completed their inspection and while it was deemed to be in “serviceable condition”, there was a concern with the welds in the tank shell only on the exterior side and not on both (i.e. Inside and out). Recommendations include:

- Complete an 'Engineering Fitness for Service" evaluation:
  - to confirm the single weld on the exterior is sufficient and meets applicable requirements.
  - to determine if the plumbness issue must be fixed.
  - Internal visual inspection of internal weld to determine if any signs of corrosion.

6.1.15 Caustic Regeneration Skid

The results of the latest inspection for the piping completed by Acuren on November 6, 2024, noted the worst erosive loss measured was 40.5%. However, the calculated remaining useful life (RUL) is 17.9 years, which will surpass the 2030 date, so no recommendations.

During the site visit, only one pump was running and the other was confirmed to be out of service for over a year. It is recommended that the pump be overhauled immediately, and new spare pump to be purchased in case the repaired pump, or second pump fails. As only one pump is required to maintain operations, the replacement could happen with no disruption. Even with the current redundancy, should one of the two pumps fail and require replacement, it could be a very lengthy delivery time (ie. months) and the remaining pump could have issues during that period and cause major disruptions to plant operations.

6.1.16 Acid Regeneration Skid

The latest Acuren inspection of the acid regeneration skid on November 6, 2024, did not reveal any critical issues and was rated as "suitable for continued service". With continued monitoring and preventative maintenance in accordance with manufacturer's recommendations, the system should meet the 2030 date. But if operation extends pass the 2030, date an inspection should be scheduled and completed.

6.1.17 Caustic Transfer Pumps

The pumps showed signs of previous leaks but were said to be reliable and no significant issues. However, as there are signs of previous problems, it is recommended to purchase a spare pump so if the leaks reappear and or the pump fails, the spare can be installed immediately and restore redundancy for the system.

6.1.18 Acid Transfer Pumps

The only issue noted for these pumps is that they have plastic heads, and one of these exploded in recent years. The person who witnessed this stated that if anyone was in the immediate area they could have been seriously injured. As this is a safety concern, it is recommended the existing pumps be replaced with new pumps of different construction. This is a safety concern and eliminating the hazard is the best option to ensure there is no concern.

6.1.19 Unit 1 Condensate Polishers

The polisher could not be inspected due to insulation. It is assumed they are nearing the end of their service life expectancy, and a Level 2 inspection, including internal inspection with wall thickness measurements, is recommended to ensure there are no critical issues.

Resin is approximately 10 years old and since this is the industry standard limit for replacement, it is recommended.

The supporting structure below the polishers is severely corroded and is recommended to be replaced (if polishers are removed for replacement based on the recommended Level 2 inspection) or the existing structure must be refurbished and reinforced.

The sampling station and meters are recommended for refurbishment.

The caustic and acid day tanks associated with the Unit 1 polishers were included in the recent Acuren inspections on November 6, 2024, and no issues. No recommendations for the tanks. However, if NL Hydro would like to clean and paint the tank exteriors it could reduce the propagation of corrosion for minimal cost and effort.

The two caustic and two acid transfer pumps appear to be in fair to poor condition but were noted to be reliable. There are two of each pump so if problems arise, one could be repaired or replaced and the other could maintain service. Purchasing one or two spare pumps for each to have at the plant which could be used on either of the three polishers is recommended. With pumps onsite, it would minimize downtime for replacement.

The MCC is antiquated and recommend a diligent inspection and IR program to identify hot spots and potential areas of failure. This would help prevent electrical hazards for personnel, and system downtime.

The control panel for the condensate polisher has reached the end of its lifespan as it is outdated and has several issues. Recommend replacing with new modern PLC panel or integrating with plant Foxboro DCS.

6.1.20 Unit 2 Condensate Polishers

The condition of the Unit 2 polishers is not known but it is assumed to be nearing the end of their service life expectancy, and a Level 2 inspection is recommended.

Resin is due for replacement (10 years old and this is an industry standard time for replacement), and is recommended.

The supporting structure below the polishers is severely corroded and is recommended to be replaced (if polishers are removed for replacement based on the recommended Level 2 inspection) or the existing structure must be refurbished and reinforced. This is critical for this unit as the unit is shifting and on section of piping appears to be separating at the flange (discussed in earlier section).

The sampling station and meters are recommended for refurbishment.

The caustic and acid tanks associated with the Unit 2 polishers were included in the recent Acuren inspections on November 6, 2024, and no issues. No recommendations for the tanks.

The two caustic and two acid transfer pumps appear to be in poor condition and one of the acid pumps has been repaired three times in recent years and is recommended for replacement. When this pump is purchased, an extra one should be purchased as a spare which could also be used on either of the other units as required.

The MCC is antiquated and recommend a diligent inspection and IR program to identify hot spots and potential areas of failure. This would help prevent electrical hazards for personnel, and system downtime.

The control panel for the condensate polisher has reached the end of its lifespan. Recommend replacing with new modern PLC panel or integrating with plant Foxboro DCS.

6.1.21 Unit 3 Condensate Polishers

Unit 3 polishers condition is not currently known but it is assumed to be nearing the end of their service life expectancy, and a Level 2 inspection is recommended

Resin is due for replacement and is recommended since the industry standard for replacement is 10 years, and the existing was installed about 10 years ago.

The supporting structure below the polishers is corroded and is recommended to be replaced (if polishers are removed for replacement based on the recommended Level 2 inspection) or the existing structure must be repaired and reinforced.

Due to the proximity of the unit to the exterior doors (which are frequently left open) the flow meters have frozen occasionally and leads to false readings. This also affects the operation of the large, actuated valves which open/close based on the feedback from the flow meters. Recommended that some additional localized heating be directed at the flow meters to eliminate the chances of freezing and sign should be posted to close the exterior doors when not in use (or possibly add a sensor to close the doors automatically after no activity near the door after a short time period).

The sampling station and meters are recommended for refurbishment.

The caustic and acid tanks associated with the Unit 2 polishers were included in the recent Acuren inspections on November 6, 2024, and no issues. No recommendations for the tanks.

The two caustic and two acid transfer pumps appear to be in fair to poor condition. Specific issues with these pumps were not noted and with redundancy one pump could be repaired/replaced while the other remains in service. When the recommended new pump for Unit 2 is purchased, an extra one should be purchased as a spare which could also be used on either of the other units as required. One caustic and one acid pumps should be purchased as a spare onsite which could be used on either of the three units.

The MCC is antiquated and recommend a diligent inspection and IR program to identify hot spots and potential areas of failure. This would help prevent electrical hazards for personnel, and system downtime.

The control panel for the condensate polisher has reached the end of its lifespan. Recommend replacing with new modern PLC panel or integrating with plant Foxboro DCS.

6.2 Wastewater Treatment Plant

6.2.1 Caustic Tank

The tank was inspected in 2021 by Acuren, and the issues noted for recommended action were completed at that time. The only recommendation for the caustic tank is to schedule an inspection within the next 5 years to confirm it is suitable for service beyond 2030.

6.2.2 Two (2) Caustic Pumps and Piping

These pumps appear to be original to the building and it was mentioned onsite that these pumps have not run for about 15 years. Since the site visit it was confirmed by a facility staff member (who has been working there for 25 years) that he had only witnessed the pumps in operation once, about 12 years ago. They tried again about 5 years ago and they appeared to be seized. The pumps were confirmed to be about 30 years old, and NL Hydro should determine if these require replacement/refurbishment or if they are even needed since they are used so infrequently.

The caustic piping was inspected on November 8, 2024, and was deemed suitable for continued service. No recommendation for this piping.

6.2.3 One (1) Polymer Pump

It is recommended that a new spare pump be purchased and stored onsite for immediate installation as required.

6.2.4 Two (2) Ferric Chloride Pumps

No recommendations for these pumps, just continued monitoring and preventative maintenance in accordance with manufacturer's recommendations.

6.2.5 Batch Reactor

The batch reactor was observed to be in good condition and proper operation was confirmed by facility staff. A full inspection was mentioned during the site visit to be tentatively scheduled for late 2024, but this was not completed. This is not scheduled under the upcoming project to be undertaken in 2026-2027 to ensure the system continues to operate without issues.

Accessibility to light fixtures was noted to be very limited, and maintenance is very difficult. This results in fixtures that no longer work. Light fixtures should be moved closer to walkways and maybe new directional light fixtures could be added as replacements.

6.2.6 Two (2) Sludge Pumps and Piping

No recommendations for these pumps, just continued monitoring and preventative maintenance as per manufacturer's recommendations.

As per the Acuren report completed on October 31, 2024, it is recommended that the coating on the pipe penetration through the concrete floor to be repaired as the piping is showing substantial corrosion.

6.2.7 Filter Press

No recommendations for the filter press, just continued monitoring and preventative maintenance in accordance with manufacturer's recommendations.

6.2.8 Recirculation/Discharge Pump

While this pump was noted as being reliable with minimal issues, it was noted that if the pump failed it would cause major issues to operations. For this reason, it is recommended that a second pump be purchased and installed in addition to the existing pump provide redundancy for this critical system.

6.2.9 Pumps 8A/8B

There are no apparent issues with these pumps, issues stem from the controls which have been prone to operator mistakes and a timer which are not operational. It is recommended that the timer on the car wash controller (pump 8A) be replaced to prevent the pump from continually running if the operator forgets to come in and turn the pump off. Alternatively, the car wash option could be removed and eliminate the issues.

6.2.10 WWTP HVAC Issues

The building has several issues with heating and cooling, but the major issue seems to be the cold temperatures inside during the winter months. It is recommended that a full detailed inspection and engineering assessment of the HVAC system be undertaken, including all equipment checked for proper operation, controls, and sequence of operation. An analysis / simulation of the building should also be completed to determine if the heating capacity of the installed equipment is sufficient to heat the building based on the simulation results.

Once the analysis is complete, more heaters can be added as required and new systems can be evaluated to improve the heat distribution and improve the cooling in summer and heating in winter. This could include improvements such as installing an HRV or ERV unit to return warm air from high in the space to the unit and mix with incoming cold air to transfer heat and increase the temperature of the supply air which can then be distributed down to the lower levels; addition of destratification fans to improve circulation throughout the building; (if confirmed necessary, replacement of louvres, exhaust fans, etc,; and ensuring the sequence of operation for control of motorized louvres, exhaust fans, and heaters is logical and promotes cooling in summer and heat distribution in the winter.

6.3 General

The local disconnect switches for majority of the pumps in both the Water Treatment and Wastewater Treatment Plant do not have arc flash labels and the labels on the three (3) MCCs for the condensate polishers as well as MCC 12 in the Wastewater Treatment Plant are outdated. Per CSA Z462: Workplace Electrical Safety, electrical equipment likely to require examination, adjustment, servicing, or maintenance while energized shall be marked with an arc flash label. The data shall be reviewed for accuracy at intervals not exceeding 5 years or when changes are made to the electrical system that can affect the information. An Arc Flash Hazard Review is recommended to be completed within the next 12 months. New AF labels should be installed on all equipment per CSA Z462 requirements.

There are a few areas where the lighting is poor and existing fixtures are blown or broken. Some fixtures are located where maintenance is difficult due to surrounding equipment. Recommend that light levels be measured, and a lighting study be undertaken to optimize number and location of fixtures. Areas of concern include above the clarifier tank, the area around the melting tank and caustic soda storage tank, the two (2) mixed bed tanks, and the unit #3 condensate polisher in the Water Treatment Plant and above the batch reactor in the Wastewater Treatment Plant.

6.4 Underground Wastewater Treatment System

6.4.1 Pumps 5A & 5B

There were no apparent issued noted from the visual inspection, and no known problems mentioned by facility staff. No recommendations for these pumps.

6.4.2 Oil Water Separators (OWS 1 & 2)

These OWS's are metal construction but all others on site, are plastic construction. If issues arise and the units require replacement, they should be replaced with plastic units. The weekly testing of the water samples is deemed adequate and should continue.

No issues were noted with the cathodic protection and the system serving OWS 2 was tested during the site visit.

While no known issues exist today, an internal inspection of the separators is recommended to check for cracks, areas of severe corrosion, etc. to ensure the units can remain in service until 2030.

6.5 NL Hydro Capital Plan Recommendations

Capital Upgrades that are recommended for the Water Treatment Plant, Wastewater Treatment Plant, Underground Wastewater Treatment System, and Oil Water Separators are as indicated below. Refer to Risk Review Table in Appendix A for risks, rankings and costs associated with each.

6.5.1 Water Treatment Plant

6.5.1.1 Raw Water Pumps

- Recommend purchasing a new pump as a spare to be ready for immediate installation if one of the existing pumps fail.
- Due to a recent issue with standby pump not starting automatically when the pump in service stopped working, it is recommended to replace the Instrument junction box and motor control station for the raw water pumps.
- Both of these recommendations should be implemented in 2025 to avoid delays as lead times for most equipment is lengthy.

6.5.1.2 Clarifier Tank

- The clarifier tank has several areas of concern and requires refurbishment. Recommended to be scheduled for 2026.

6.5.1.3 Sand Filters #1, #2, & #3

- All three sand filters are in poor condition and require replacement. Suggest replacing one filter at a time to minimize interruption to operations. This will likely be a multi-year project and will require detailed coordination and due to the condition of some of the filters, these replacements should be scheduled to begin in 2026.

6.5.1.4 Clearwell

- The clearwell tank is in very poor condition and requires replacement. This replacement will require coordination with the sand filter replacements since all four tanks are in the same general area, and this should also be scheduled for 2026. This will include the recommended replacement of the motor control station.

6.5.1.5 Flocculent Tank and Pumps

- Existing PVC piping and valves are starting to fail. Recommend replacing immediately (2025) to avoid issues associated with failure. Sections of the system can be isolated and replaced while maintaining operations.
- Replace (or at least purchase a spare) one of the flocculent pumps to ensure continued service and reliability (2025).

6.5.1.6 Coagulant Tank and Pumps

- The only recommendation for this system is to inspect the tank and pumps within the next 5 years (2030) to confirm the system is suitable to continue is service.

6.5.1.7 Caustic Tanks(2) and Pumps(2)

- The only recommendation for this system is to inspect the tanks and pumps within the next 5 years (2030) to confirm the system is suitable to continue is service.

6.5.1.8 Acid Tanks (North and South) and Pumps (2)

- The only recommendation for this system is to inspect the tanks and pumps within the next 5 years (2030) to confirm the system is suitable to continue is service.

6.5.1.9 Melting Tank and Transfer Pumps (2)

- As above, the only recommendation for this system is to inspect the tank and pumps within the next 5 years (2030).

6.5.1.10 Caustic Soda Storage Tank and Transfer Pumps(2)

- The tank and pumps should be inspected within the next 5 years (2030).

6.5.1.11 Cation Tanks, Anion Tanks, and Mixed Bed Tanks

- Full internal inspection (to API 653) of Cation Tank A, Anion Tank A, and Mixed Bed Tank A should be completed and any required refurbishments or overhauls completed. Resin to be replaced and rubber diaphragms to be inspected to confirm if they must be repaired or replaced. This first round of inspections and refurbishments should be scheduled for early 2026.
- Full internal inspection (to API 653) of Cation Tank B, Anion Tank B, and Mixed Bed Tank B, complete with necessary refurbishments, overhauls, resin replacement, and rubber diaphragm repairs/replacements (as required), should be completed after the 'A' tanks. This second inspection and refurbishment will likely be late 2026 or early 2027 (depending on the extent of refurbishment required with the first inspections).
- Remaining Cation Tank C and Anion Tank C to undergo full internal inspection (to API 653) and required refurbishments, overhauls, and resin replacement and rubber diaphragm repairs or replacement (as required) to be completed following the second tank inspections (late 2027).

6.5.1.12 Demineralization Tank

- Engineering Fitness for Service Evaluation to be completed. To be safe an ensure there are no critical issues with the inside weld, this should be scheduled for 2026.

6.5.1.13 Caustic Regeneration Skid

- Existing pump to be overhauled and a spare pump to be purchased (2025).

6.5.1.14 Acid Regeneration Skid

- Existing system is recommended to be inspected within the next 5 years (2030) to ensure suitability for continued operation is confirmed.

6.5.1.15 Caustic Transfer Pumps

- Due to the evidence of previous leaks, a spare pump is recommended for purchase and be available for immediate install should one of the existing pumps fail (2025).

6.5.1.16 Acid Transfer Pumps

- These pumps have failed in the past and pose a potential safety hazard to personnel working in the vicinity. Two new pumps of 'conventional' construction should be purchased, plastic pumps removed, and new pumps installed (2025).

6.5.1.17 Condensate Polishers

- Level 2 inspection, including internal inspection with wall thickness measurements to be competed on all three condensate polishers (2026-2027).
- Recommend replacing the resin in all three condensate polishers (2026-2027).
- Support structures under all three polishers to be replaced or refurbished and reinforced (2026-2027).
- Sampling Stations for all three polishers should be refurbished (2026-2027).
- Condensate Polisher #2 acid transfer pump to be replaced, additionally, one caustic transfer pump and one acid transfer pump to be purchased for spare (2025).
- The control panels for all condensate polishers should be replaced or integrated into existing Foxboro DCS (2026-2027).

6.5.2 Wastewater Treatment Plant

6.5.2.1 Caustic Tank

- No immediate recommendations for this tank as it was recently inspected in 2021 but should be inspected in 2030.

6.5.2.2 Caustic Pumps and Piping

- Since these pumps have only been used once in the past 25 years it does not seem as though these are important for plant operations. NL Hydro should determine if these are needed. At this time, these pumps do not seem to be needed.

6.5.2.3 Polymer Pump

- There is only one pump for this system so purchase of a spare pump is recommended (2025).

6.5.2.4 Ferric Chlroide Pumps(2)

- Continue with monitoring of pump operation and preventative maintenance in accordance with manufacturer's recommendations.

6.5.2.5 Batch Reactor

- Recommend a full inspection of the batch reactor in 2026.

6.5.2.6 Sludge Pumps(2) and Piping

- Continue with monitoring of pump operation and preventative maintenance in accordance with manufacturer's recommendations. Repair pipe penetration through floor due to corrosion (2025). This is not a major repair and should only require cleaning and coating the piping.

6.5.2.7 Filter Press

- Continue with maintenance as required and as per manufacturer's recommendations.

6.5.2.8 Recirculation/Discharge Pump

- Spare pump to be purchased and installed to introduce redundancy to the system (2025).

6.5.2.9 Pumps 8A/8B

- Recommended to either fix the timer for the car wash controller or eliminate the car wash to prevent operator error.

6.5.2.10 HVAC

- Recommend a study be completed to include a detailed inspection, engineering assessment, and analysis of the HVAC system in the wastewater treatment plant in 2025. Depending on the number of critical issues and recommendations, these should be incorporated into future work (possibly in the 2026-2027 project).

6.5.3 Underground Wastewater Treatment System

6.5.3.1 Pumps 5A/5B

- Pumps are working as designed and no known issues, no immediate recommendations for these pumps.

6.5.3.2 Oil Water Separators

- Recommend full internal inspection to check for cracks, areas of corrosion, etc. to ensure units can remain in service (2026-2027).

6.5.3.3 General

- Arc Flash Hazard review to be completed and arc flash labels to be installed on equipment as required per CSA Z462. Recommended for 2025.
- Lighting - recommend assessing lighting levels in indicated areas and installing new fixtures as required in more accessible places to better illuminate areas and allow for easier maintenance.

APPENDIX A

Recommendation		Estimate	Risk if not addressed	Likelihood	Operational Impact Score (Potential Consequence)							Risk Score	Risk Rating
					Safety	Environment	Financial	Operational	Compliance	People	Community		
Water Treatment Plant													
Raw Water Pumps	Recommend purchasing spare pump in the event one of the existing pumps fail.	$5,000	Lead time on a new pump could be months and due to the age of the existing pumps both could fail before a new pump is delivered	Possible	Very Low	Low	Very Low	High	Very Low	Very Low	Very Low	12	MEDIUM
Raw Water Pumps Instrument JB & Motor Control Station	Recommend replacing the Instrument Junction Box and Motor Control Station for the Raw Water Pumps.	$5,000	Equipment Failure, no pump control	Possible	Low	Very Low	Very Low	High	Very Low	Very Low	Very Low	12	MEDIUM
Clarifier Tank	Clarifier has several areas of concern, refurbishment is recommended as replacement would be costly and disruptive to plant operations.	$70,000	Catastrophic Tank Failure	Possible	Very Low	Low	Very Low	High	Very Low	Very Low	Low	12	MEDIUM
Badgermeter Flowmeter	The Badgemeter flowmeter behind the Clarifier is antiquated and may be difficult to find a replacement in the event of a failure, spare flowmeter to be purchased.	$10,000	Equipment Failure	Possible	Very Low	Very Low	Very Low	Low	Very Low	Very Low	Very Low	6	LOW
Clarifier Recirculator	Recommend purchasing spare recirculator for if the existing one fails and cannot be repaired.	$7,500	Settled solids will accumulate in the tank leading to disruptions in clarifier operation which is detrimental to generation	Low	Very Low	Very Low	Very Low	Moderate	Very Low	Very Low	Very Low	6	LOW
Sand Filter #1	Sand Filters are in poor condition with severe deterioration to portions of each filter. Recommend replacement.	$85,000	Catastrophic failure would cause major issues for the plant including worker safety, potential damage to other equipment, disruption to operations, etc	Possible	Very Low	Low	Very Low	Moderate	Very Low	Very Low	Low	9	MEDIUM
Sand Filter #2	Sand Filters are in poor condition with severe deterioration to portions of each filter. Recommend replacement.	$85,000	Catastrophic failure would cause major issues for the plant including worker safety, potential damage to other equipment, disruption to operations, etc	Possible	Very Low	Low	Very Low	Moderate	Very Low	Very Low	Low	9	MEDIUM
Sand Filter #3	Sand Filters are in poor condition with severe deterioration to portions of each filter. Recommend replacement.	$85,000	Catastrophic failure would cause major issues for the plant including worker safety, potential damage to other equipment, disruption to operations, etc	Possible	Very Low	Low	Very Low	High	Very Low	Very Low	Low	12	MEDIUM

Recommendation		Estimate	Risk if not addressed	Likelihood	Operational Impact Score (Potential Consequence)							Risk Score	Risk Rating
					Safety	Environment	Financial	Operational	Compliance	People	Community		
Clearwell Replacement	Clearwell tank is in poor condition and recommend replacement.	$85,000	Tank failure would be detrimental to plant operations as the major reservoir for filtered water storage would be lost and an unplanned tank replacement would be lengthy and costly	Possible	Very Low	Low	Very Low	High	Very Low	Very Low	Low	12	MEDIUM
Clearwell Pump Motor Control Station	Recommend replacing the Motor Control Station for the Clearwell Pumps.	$5,000	Equipment Failure, no pump control	Possible	Low	Very Low	Very Low	Low	Very Low	Very Low	Very Low	6	LOW
Flocculent Tank Piping and Valves	Existing PVC piping and valves are starting to fail and exact matches for the original valves are no longer available. System has redundant line, recommend replacing one line at a time so the system can remain in service with minimal impact to operations	$6,500	If sections of both lines fail the system may require to be taken out of service to repair. Since exact mathces for the original system is no longer available, sourcing replacements could be difficult.	Almost Certain	Very Low	Low	Very Low	Very Low	Very Low	Very Low	Very Low	10	MEDIUM
Flocculent Pumps	Purchase new pump as a spare or could be installed upon deliver to ensure continued service and reliability.	$5,000	Lead time on a new pump could be months so it should be purchased immediately in case there is a failure of both existing pumps (due to their age).	Possible	Very Low	Low	Very Low	Low	Very Low	Very Low	Very Low	6	LOW
Coagulant Tank and Pumps	Tank and pumps should be inspected within the next 5 years to ensure they can remain in service. Internal and external tank inspection as per API 653.	$5,000	Unexpected equipment failure	Low	Very Low	Low	Very Low	Low	Very Low	Very Low	Very Low	4	LOW
Caustic Tanks and Pumps	Tanks should be inspected to API 653 (internal and external) and pumps as well within the next 5 years to ensure they can remain in service.	$8,500	Unexpected equipment failure	Low	Very Low	Low	Very Low	Low	Very Low	Very Low	Very Low	4	LOW
Acid Tanks and Pumps	Tanks should be inspected to API 653 (internal and external) and pumps as well within the next 5 years to ensure they can remain in service.	$8,500	Unexpected equipment failure	Low	Very Low	Low	Very Low	Low	Very Low	Very Low	Very Low	4	LOW

Recommendation		Estimate	Risk if not addressed	Likelihood	Operational Impact Score (Potential Consequence)							Risk Score	Risk Rating
					Safety	Environment	Financial	Operational	Compliance	People	Community		
Melting Tank and Pumps	Tank should be inspected to API 653 (internal and external) and pumps as well within the next 5 years to ensure they can remain in service.	$8,500	Unexpected equipment failure	Low	Very Low	Low	Very Low	Low	Very Low	Very Low	Very Low	4	LOW
Melting Tank Transfer Pump fittings	Pump fittings could not be inspected due to them being wrapped, these should be monitored regularly and if issues arise, recommend replacement.	$3,500	Unexpected equipment failure	Possible	Very Low	Low	Very Low	Low	Very Low	Very Low	Very Low	6	LOW
Caustic Soda Storage Tanks and Pumps	Tanks should be inspected to API 653 (internal and external) and pumps as well within the next 5 years to ensure they can remain in service.	$8,500	Unexpected equipment failure	Low	Very Low	Low	Very Low	Low	Very Low	Very Low	Very Low	4	LOW
Cation Tank A & Anion Tank A	Recommend API 653 inspection of Cation Tank A and Anion Tank A. The resin to be replaced ($400/cu.ft, assumed 100cu.ft per tank) and rubber diaphragms should be repaired/replaced as required on the completion of the inspection.	$110,000	Unexpected equipment failure	Low	Very Low	Low	Very Low	Low	Very Low	Very Low	Very Low	4	LOW
Cation Tank B & Anion Tank B	Recommend API 653 inspection of Cation Tank B and Anion Tank B. The resin to be replaced ($400/cu.ft, assumed 100cu.ft per tank) and rubber diaphragms should be repaired/replaced as required on the completion of the inspection.	$110,000	Unexpected equipment failure	Low	Very Low	Low	Very Low	Low	Very Low	Very Low	Very Low	4	LOW
Cation Tank C & Anion Tank C	Recommend API 653 inspection of Cation Tank C and Anion Tank C. The resin to be replaced ($400/cu.ft, assumed 100cu.ft per tank) and rubber diaphragms should be repaired/replaced as required on the completion of the inspection.	$110,000	Unexpected equipment failure	Low	Very Low	Low	Very Low	Low	Very Low	Very Low	Very Low	4	LOW

Recommendation		Estimate	Risk if not addressed	Likelihood	Operational Impact Score (Potential Consequence)							Risk Score	Risk Rating
					Safety	Environment	Financial	Operational	Compliance	People	Community		
Mixed Bed Tanks A & B	Recommend API 653 inspection of Mixed Bed Tanks A and B. The resin to be replaced ($400/cu.ft, assumed 100cu.ft per tank) and rubber diaphragms should be repaired/replaced as required upon the completion of the inspection.	$110,000	Unexpected equipment failure	Low	Very Low	Low	Very Low	High	Very Low	Very Low	Very Low	8	MEDIUM
Demineralization Tank	It is recommended that a "Engineering Fitness for Service" evaluation be completed to confirm if the single weld on the tank exterior is sufficient and to determine if the plumbness issue should be fixed.	$7,500	Failure would cause major issues for the plant including worker safety, potential damage to other equipment, disruption to operations, etc	Low	Very Low	Low	Very Low	High	Very Low	Very Low	Very Low	8	MEDIUM
Caustic Regeneration Skid Pump	One of the two pumps on the skid has been out of service for over a year, it is recommended to overhaul the existing pump and also purchase a spare.	$5,000	Lead time on a new pump could be months and due to the age and condition of the existing pumps both could fail before a new pump is delivered	Likely	Very Low	Low	Very Low	Moderate	Very Low	Very Low	Very Low	12	MEDIUM
Caustic Transfer Pumps	Pumps show signs of previous leaks, recommend purchasing a spare	$5,000	Lead time on a new pump could be months and due to the age of the existing pumps both could fail before a new pump is delivered	Likely	Very Low	Low	Very Low	Low	Very Low	Very Low	Very Low	8	MEDIUM
Acid Transfer Pumps	Existing pumps have plastic heads, one of these has exploded in the past and could have caused harm if personnel were nearby. Recommend purchasing two new pumps of different construction to maintain redundancy.	$10,000	Plastic head of one of the existing pumps has exploded in the past which is a hazard and a safety concern	Likely	High	Low	Very Low	Low	Very Low	Very Low	Very Low	16	HIGH
Condensate Polisher #1	Recommend completing a Level 2 Inspection in accordance with API 653, including an internal inspection with wall thickness measurements.	$8,500	Failure would cause major issues for the plant including worker safety, potential damage to other equipment, disruption to operations, etc	Possible	Low	Moderate	Very Low	Moderate	Very Low	Very Low	Very Low	9	MEDIUM

Recommendation		Estimate	Risk if not addressed	Likelihood	Operational Impact Score (Potential Consequence)							Risk Score	Risk Rating
					Safety	Environment	Financial	Operational	Compliance	People	Community		
Condensate Polisher #1	Recommend replacing resin ($400/cubic foot, assumed 100cu.ft)	$40,000	Equipment failure and disruption to operations	Low	Very Low	Very Low	Very Low	Moderate	Very Low	Very Low	Very Low	6	LOW
Condensate Polisher #1 Support Structure	Support structure below Condensate Polisher #1 is severely corroded and should be replaced or refurbished and reinforced.	$10,000	Failure would cause major issues for the plant including worker safety, potential damage to other equipment, disruption to operations, etc	Likely	Low	Moderate	Very Low	Moderate	Very Low	Very Low	Very Low	12	MEDIUM
Condensate Polisher #1 Caustic and Acid Transfer Pumps	Purchase one spare caustic transfer pump and one spare acid transfer pump. These spares could be utilized on either of the three polishers.	$10,000	Lead time on a new pump could be months and due to the age of the existing pumps both could fail before a new pump is delivered	Low	Very Low	Low	Very Low	Moderate	Very Low	Very Low	Very Low	6	LOW
Condensate Polisher #1 Sampling Station	Sampling station is original condition, Beckman conductivity meters are not in use any longer and the sampling tubes and tube supports are corroded. Recommend refurbishment to ensure reliability.	$5,000	Sampling station may become unusable	Low	Low	Very Low	Very Low	Low	Very Low	Very Low	Very Low	4	LOW
Condensate Polisher #1 Control Panel	Recommend the control panels be replaced with new PLC panel or integrating with the plant Foxboro DCS.	$20,000	Equipment Failure, manual control is tedious and can lead to operator error	Likely	Low	Very Low	Very Low	Moderate	Very Low	Very Low	Very Low	12	MEDIUM
Condensate Polisher #2	Recommend completing a Level 2 Inspection in accordance with API 653, including an internal inspection with wall thickness measurements.	$8,500	Failure would cause major issues for the plant including worker safety, potential damage to other equipment, disruption to operations, etc	Possible	Low	Moderate	Very Low	Moderate	Very Low	Very Low	Very Low	9	MEDIUM
Condensate Polisher #2	Recommend replacing resin ($400/cubic foot, assumed 100cu.ft)	$40,000	Equipment failure and disruption to operations	Low	Very Low	Very Low	Very Low	Moderate	Very Low	Very Low	Very Low	6	LOW

Recommendation		Estimate	Risk if not addressed	Likelihood	Operational Impact Score (Potential Consequence)							Risk Score	Risk Rating
					Safety	Environment	Financial	Operational	Compliance	People	Community		
Condensate Polisher #2 Support Structure	Support structure below Condensate Polisher #2 is severely corroded and should be replaced or refurbished and reinforced.	$10,000	Failure would cause major issues for the plant including worker safety, potential damage to other equipment, disruption to operations, etc	Likely	Low	Moderate	Very Low	Moderate	Very Low	Very Low	Very Low	12	MEDIUM
Condensate Polisher #2 Caustic and Acid Transfer Pumps	One of the acid transfer pumps has been repaired three times in recent years. Recommend replacing the acid transfer pump that has issues.	$5,000	Lead time on a new pump could be months and due to the age of the existing pumps both could fail before a new pump is delivered	Likely	Very Low	Low	Very Low	Moderate	Very Low	Very Low	Very Low	12	MEDIUM
Condensate Polisher #2 Sampling Station	Sampling station is original condition, Beckman conductivity meters are not in use any longer and the sampling tubes and tube supports are corroded. Recommend refurbishment to ensure reliability.	$5,000	Sampling station may become unusable	Low	Low	Very Low	Very Low	Low	Very Low	Very Low	Very Low	4	LOW
Condensate Polisher #2 Control Panel	Recommend the control panels be replaced with new PLC panel or integrating with the plant Foxboro DCS.	$20,000	Equipment Failure and manual control is tedious and can lead to operator error	Likely	Low	Very Low	Very Low	Moderate	Very Low	Very Low	Very Low	12	MEDIUM
Condensate Polisher #3	Recommend completing a Level 2 Inspection in accordance with API 653, including an internal inspection with wall thickness measurements.	$8,500	Failure would cause major issues for the plant including worker safety, potential damage to other equipment, disruption to operations, etc	Possible	Low	Moderate	Very Low	Moderate	Very Low	Very Low	Very Low	9	MEDIUM
Condensate Polisher #3	Recommend replacing resin ($400/cubic foot, assumed 100cu.ft)	$40,000	Equipment failure and disruption to operations	Low	Very Low	Very Low	Very Low	Moderate	Very Low	Very Low	Very Low	6	LOW
Condensate Polisher #3 Support Structure	Support structure below Condensate Polisher #3 is severely corroded and should be replaced or refurbished and reinforced.	$10,000	Failure would cause major issues for the plant including worker safety, potential damage to other equipment, disruption to operations, etc	Likely	Low	Moderate	Very Low	Moderate	Very Low	Very Low	Very Low	12	MEDIUM

Recommendation		Estimate	Risk if not addressed	Likelihood	Operational Impact Score (Potential Consequence)							Risk Score	Risk Rating
					Safety	Environment	Financial	Operational	Compliance	People	Community		
Condensate Polisher #3 flowmeters	Flowmeters located close to the exterior door have occasionally frozen due to the door being left open, leading to false readings. Additional localized heating should be purchased and installed to be directed at the flowmeters.	$5,000	Equipment failure	Almost Certain	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low	5	LOW
Condensate Polisher #3 Sampling Station	Sampling station is original condition, Beckman conductivity meters are not in use any longer and the sampling tubes and tube supports are corroded. Recommend refurbishment to ensure reliability.	$5,000	Sampling station may become unusable	Low	Low	Very Low	Very Low	Low	Very Low	Very Low	Very Low	4	LOW
Condensate Polisher #3 Control Panel	Recommend the control panels be replaced with new PLC panel or integrating with the plant Foxboro DCS.	$20,000	Equipment Failure, manual control is tedious and can lead to operator error	Likely	Low	Very Low	Very Low	Moderate	Very Low	Very Low	Very Low	12	MEDIUM
Inspection & Infrared Thermography program for MCC's	All three Unit Condensate Polisher MCC's are antiquated. It is recommended that the inspection program be assessed as to its thoroughness and frequency to help mitigate failures.	$5,000	Hot spots on electrical equipment leading to failures and disruption to operations	Possible	Moderate	Very Low	Very Low	Low	Low	Very Low	Very Low	9	MEDIUM
Wastewater Treatment Plant													
Caustic Tank	Should be inspected in accordance with API 653 within the next 5 years to ensure they can remain in service	$6,500	Unexpected equipment failure	Low	Very Low	Low	Very Low	Low	Very Low	Very Low	Very Low	4	LOW
Caustic Pumps	These pumps have only been used once in the past 25 years and are not criritcal to operations. It is recommended to buy a new pump, if NL Hydro deems it as necessary (or NL Hydro may decide to remove the existing pumps as this system is not critical)	$5,000	Equipment Failure	Possible	Very Low	Low	Very Low	Low	Very Low	Very Low	Very Low	6	LOW
Polymer Pump	Purchase spare pump for immediate installation in the event that the pump fails	$5,000	Lead time on a new pump could be months and due to the age of the existing pump it could fail before a new pump is delivered, disrupting operations.	Possible	Very Low	Low	Very Low	Low	Very Low	Very Low	Very Low	6	LOW

Recommendation		Estimate	Risk if not addressed	Likelihood	Operational Impact Score (Potential Consequence)							Risk Score	Risk Rating
					Safety	Environment	Financial	Operational	Compliance	People	Community		
Batch Reactor	It is recommended that a full inspection (in accordance with API 653) of the batch reactor. Be completed.	$8,500	Unexpected equipment failure	Possible	Very Low	Low	Moderate	Moderate	Very Low	Very Low	Very Low	9	MEDIUM
Sludge Piping	Recommend that the coating on the sludge pipe penetration through the floor be repaired.	$750	Pipe failure and leaks	Low	Very Low	Low	Very Low	Low	Very Low	Very Low	Very Low	4	LOW
Recirculation/ Discharge Pump	Purchase spare pump for immediate installation in the event that the pump fails	$5,000	Pump failure would cause issues with operations and lead time on a new pump could be long	Possible	Very Low	Low	Very Low	Moderate	Very Low	Very Low	Very Low	9	MEDIUM
Pumps 8A & 8B	Replace the timer in the car wash circuit so there is no misoperation of the 8A & 8B pumps	$1,000	Misoperation of pump 8A & 8B	Likely	Very Low	Low	Very Low	Low	Very Low	Very Low	Very Low	8	MEDIUM
WWTP HVAC	Recommend a full detailed inspection, engineering assessment, and analysis of the HVAC system in the Wastewater treatment plant be completed	$15,000	Building is cold during winter months which can cause equipment malfunction. Improper ventilation can cause risks to personnel health due to vapours when added chemicals to the batch reactor, etc.	Almost Certain	Moderate	Very Low	Very Low	Moderate	Very Low	Very Low	Very Low	15	HIGH
Underground Wastewater Treatment System													
Oil Water Separators (OWS 1 & 2)	Internal inspection of the separators is recommended to check for cracks, areas of corrosion, etc. to ensure units can remain in service.	$8,500	Oil contamination	Possible	Very Low	Moderate	Very Low	Low	Low	Very Low	Very Low	9	MEDIUM
General													

Recommendation		Estimate	Risk if not addressed	Likelihood	Operational Impact Score (Potential Consequence)							Risk Score	Risk Rating
					Safety	Environment	Financial	Operational	Compliance	People	Community		
Arc Flash Labels	An Arc Flash Hazard Review is due for most of the equipment. New AF labels should be installed on all equipment per CSA Z462 requirements.	$30,000	Not code compliant and personnel risk of using correct PPE	Low	High	Very Low	Very Low	Low	Low	Very Low	Very Low	8	MEDIUM
Lighting	Measure lighting levels in indicated areas and install new fixtures as required in more accessible locations to better illuminate the area and allow for easier maintenance.	$5,000	Very low lighting levels leading to troubleshooting and maintenance impacts	Possible	Low	Very Low	Very Low	Low	Very Low	Very Low	Very Low	6	LOW

Upgrade Core IT Infrastructure

(2026–2027)

newfoundland labrador hydro

Contents

Upgrade Core IT Infrastructure (2026–2027)

Location: Various

Investment Classification: General Plant

Asset Category: Information Systems

Estimated Cost: $1,394,500

1.0 Introduction

This project will upgrade Information Technology (“IT”) Infrastructure components that enable employees to access software applications and data required for delivering efficient and effective service. This project is essential for ensuring reliable service by facilitating the upgrade of outdated IT infrastructure equipment critical to Newfoundland and Labrador Hydro’s (“Hydro”) business operations.

Historically, the administration of Information Systems (“IS”) sat within Nalcor Energy (“Nalcor”) and was charged to Hydro through an administration fee; however, post-amalgamation of Nalcor and Hydro, effective January 1, 2025, these assets are now owned by Hydro, a regulated utility, and not exempt from the *Public Utilities Act (“Act”)*. Therefore, any Information Systems expenditures for new IT assets, as well as sustaining capital on existing IT assets, will now be subject to application to the Board of Commissioners of Public Utilities (“Board”) for related expenditures pursuant to the *Act.*[1]

As such, the sustaining capital projects associated with core infrastructure upgrades of IT assets are now part of Hydro’s annual capital budget application. As a result, Hydro has created a separate project for the capital expenditures related to IT assets, recognizing the distinct nature and purpose of IT infrastructure as compared to Operational Technology (“OT”) infrastructure, used specifically for grid operations.[2]

[1] As noted in “Report on Amalgamation Activities,” Newfoundland and Labrador Hydro, rev. April 17, 2025 (originally filed April 15, 2025), Hydro intends to submit an existing IS assets application to the Board for the approval of the transfer of IS assets which were in service prior to January 1, 2025, into the regulated business segment, now anticipated in the third quarter of 2025.

[2] Capital expenditures related to OT are included in the Upgrade Core OT Infrastructure (2026) project.

2.0 Project Description and Justification

Hydro maintains server and storage equipment to ensure the availability and function of IT systems and services. This project proposes the upgrade of data center equipment, used to provide IT services for software applications and services.

For 2026, Hydro proposes to complete the following work as part of this project:

- Disaster Recovery ("DR")
  - Replace the Storage Area Network ("SAN").
- Microsoft Structured Query Language ("SQL")
  - Upgrade Microsoft SQL servers and databases to a current, supported version; and
  - Reconfigure and move existing databases to the new, supported SQL servers.

Completing this work will support the continued performance of the IT infrastructure used to run and operate Hydro's software applications and systems.

3.0 Asset Overview

3.1 Asset Background

Hydro utilizes many software systems and applications to support its business needs. These systems and applications house data and provide functionality to carry out important functions in Human Resources, Finance, Supply Chain, Asset Management, Customer Service, and other corporate activities. The availability and performance of these systems depend on Hydro's server infrastructure and network.

The core technologies included in the scope of this project are assets that other major systems rely on to function. If these technologies become outdated or impacted, it would result in a large-scale outage on our core applications, resulting in outages and performance issues with other hardware and software across the business.

Replacement criteria for these assets are based on performance, vendor support, and integration with other hardware and software. These assets may be replaced more frequently than in the past, as continuing technological advancements have led to an increase in cybersecurity threats, which limits the vendor's ability to support an asset deeper into its lifetime. Hydro's infrastructure is critical to the operation, testing, and disaster recovery of its corporate applications. Maintaining and upgrading the server infrastructure and network is crucial to ensuring the effective security, interoperability, supportability and performance of Hydro's core business applications.

Disaster Recovery

DR refers to the strategies and processes implemented to restore critical systems, data, and operations following a disruptive event, such as a natural disaster, cyberattack, or hardware failure. The goal is to minimize downtime and ensure business continuity.

An important component of Hydro's DR infrastructure is the SAN unit, which is used to recover and replicate the backup Storage Manager. The existing SAN unit was purchased and put into service in 2021. While the vendor can currently provide paid additional support for the existing unit, there are no updated features or fixes that will be available. As such, the SAN unit has reached its end of useful life and requires replacement in 2026.

Microsoft SQL

Microsoft SQL is a database management system used to store, manage and retrieve data for software systems and applications. Hydro currently has 22 SQL servers, which contain a total of 407 databases. Hydro uses SQL as the backend infrastructure for many applications, technology platforms, tools, and websites. The implementation of the current SQL environment began in 2020 and was completed in 2022. The vendor has stated the current unit will not be supported as of 2027. Without this support, Hydro will be unable to rely on the vendor to solve issues that arise with the infrastructure, nor will continued fixes and functionality support be available. Without support, upgrades, and patches from Microsoft, Hydro will be more susceptible to service interruptions, cybersecurity threats and problems with functionality. As such, Hydro's SQL environment and existing databases require transition to a vendor-supported version under this project in 2026 and 2027.

3.2 Historical Reliability

Hydro's experience with infrastructure and IT network components has shown that maintaining vendor support, mitigating security risks, and migrating to modern equipment reduces the risk of application failure and improves Hydro's response to a disaster event.

3.3 Asset Condition

IT infrastructure and network components managed under this program are in varying conditions. This program is driven by infrastructure that is approaching end-of-life.

4.0 Analysis

4.1 Evaluation of Alternatives

Annually, Hydro evaluates server infrastructure and network components. This evaluation focuses on identifying server components and equipment that fall into one of several categories: replacement due to age and risk of failure, upgrade eligibility to prolong service life, purchase as required to meet new computing needs, or enhancement for cybersecurity purposes. The assessment considers factors such as vendor support, product roadmaps, component performance, associated costs, and the importance of each component in operations, alongside the impact of potential failures. Non-essential upgrades are deferred to prioritize critical operational needs.

Hydro evaluated the following alternatives:[3]

- Deferral; and
- Like-for-like replacements.

4.1.1 Deferral

Under this alternative, infrastructure would be operated without any replacements, upgrades or enhancements, negatively impacting the efficiency and security of Hydro's operations. The timing and frequency of upgrades are controlled by the vendor, and interoperability will decrease as the existing equipment will no longer support new technologies required to interface with other servers, storage, and network technology. Running infrastructure past vendor support adds significant risk that the infrastructure will fail and interrupt day-to-day operations. As such, Hydro does not consider this a viable alternative.

[3] Upgrades to technological assets such as these are only available when supported by the vendor. Without vendor support, upgrades are unavailable, and therefore, Hydro's evaluation of alternatives did not include upgrade life extension.

4.1.2 Like-for-Like Replacements

Under this alternative, Hydro will replace the identified infrastructure network components with new, vendor-supported versions in 2026 and 2027.

Replacing infrastructure that is at the end of its life is critical to ensure reliability.

The assets proposed for replacement have reached end of life due to the upcoming lack of reliable and reasonable vendor support. Without this support, Hydro risks functionality, integration, and cybersecurity issues caused by a lack of fixes and updates, and the inability to ensure troubleshooting and repairs can be obtained when an unforeseen issue arises. Completing the identified work for this initiative will ensure a continued secure, reliable, and functional environment.

4.2 Least-Cost Evaluation

Hydro has not identified any viable alternatives to facilitate a least-cost evaluation.

4.3 Recommended Alternative

Hydro proposes replacing and upgrading the identified infrastructure in this project throughout 2026 and 2027. Not proceeding with these upgrades could lead to equipment failure, a lack of vendor support, cybersecurity vulnerabilities, or the inability to quickly respond to a DR event. Any of these issues will impact Hydro’s ability to deliver service and proceed with day-to-day operations.

4.3.1 Risk of Asset Stranding

There is minimal risk for asset stranding. The infrastructure proposed to be upgraded under this initiative is widely used to support software and systems used in multiple business and functional areas throughout the organization.

4.3.2 Risk Mitigation

Hydro assessed the pre- and post-implementation risk of the scope of work for the 2026 and 2027 projects in accordance with Hydro’s Capital Risk Assessment process, as outlined in Section 7.0 of Schedule 1. The outcome of this assessment is provided in Table 1.

Table 1: Risk Scoring Pre- and Post-Implementation

	Impact	Likelihood	Score
Pre-Implementation	4	5	**20**
Post-Implementation	4	1	**4**
		Risk Mitigated	**16**
		Risk Mitigated per $1 Million	**11.5**

5.0 Scope of Work

A preliminary analysis has identified the following infrastructure and network components to be upgraded as part of the 2026 and 2027 initiatives:

- Replace the SAN;
- Upgrade Microsoft SQL servers and databases to a current, supported version; and
- Reconfigure and move existing databases to the new, supported SQL servers.

The detailed program scope will be confirmed during the planning and design stages of the program.

5.1 Project Budget

The estimate for this project is shown in Table 2.

Table 2: Project Estimate ($000)[4]

Project Cost	2026	2027	Beyond	Total
Material Supply	240.0	0.0	0.0	**240.0**
Labour	62.9	28.6	0.0	**91.5**
Consultant	478.9	401.0	0.0	**879.9**
Contract Work	0.0	0.0	0.0	**0.0**
Other Direct Costs	0.0	0.0	0.0	**0.0**
Interest and Escalation	31.2	61.1	0.0	**92.3**
Contingency	58.6	32.2	0.0	**90.9**
Total	**871.6**	**522.9**	**0.0**	**1,394.5**

The project cost will be allocated using Hydro's Intercompany Transactions Guidelines under the Information Systems Administrative Fee and allocated based on users. Hydro will be responsible for

[4] Numbers may not add due to rounding.

approximately 57% of the total cost, the entities related to the Muskrat Falls Assets will be responsible for approximately 6% of the cost, and the remaining lines of business will accrue the remainder.

5.2 Project Schedule

The schedule for this project is shown in Table 3.

Table 3: Project Schedule

Activity	Start Date	End Date
Planning: Open project in JDE, review scope, develop schedule.	February 2026	March 2026
Design: Confirm requirements, complete detailed design.	April 2026	May 2026
Procurement: Award requests for proposals and secure resources.	April 2026	June 2026
Construction: Build solution, go live, conduct training, provide post-implementation support.	June 2026	August 2027
Closeout: Complete closeout activities.	September 2027	September 2027

6.0 Conclusion

Hydro must keep its IT infrastructure current to ensure the reliability of business applications and to prevent downtime that could impact operational efficiency. The core technologies included in the scope of this project are assets that other major systems rely on to function. If these technologies become outdated or impacted, it would result in a large-scale outage on our core applications, resulting in outages and performance issues with other hardware and software across the business.

Hydro recommends the upgrade of infrastructure components to ensure a reliable and secure environment to support continued operations and its ability to respond to a DR event.

Upgrade Distribution System

(2026-2027)

Wiltondale

Contents

Upgrade Distribution System (2026-2027)

Location: Wiltondale

Investment Classification: Access

Asset Category: Distribution

Estimated Cost: $1,361,400

1.0 Introduction

Newfoundland and Labrador Hydro ("Hydro") provides electric service to residents in select rural communities using electrical distribution systems. The distribution systems typically consist of wood pole distribution lines that direct power from a terminal station to customers throughout the community.

Hydro has received a request from Newfoundland Power Inc. ("Newfoundland Power") to establish a new delivery point on the Wiltondale distribution system. This request involves the transfer of a portion of Newfoundland Power's Distribution Feeder DLK-03 to this proposed delivery point. In order to support this initiative, upgrades to the Wiltondale distribution system will be required.

2.0 Project Description and Justification

A 16-kilometre (km) single-phase section of DLK-03 is overloaded. This section of the line extends northwest primarily along the Viking Trail Highway to serve customers in the Bonne Bay Big Pond area. Newfoundland Power has identified that the most cost-effective solution to address the overloading issue is to supply power to the affected customers through a new line extension connected to Hydro's Wiltondale Distribution Feeder 1 ("WDL-L1").[1]

Hydro has a statutory obligation to provide safe, reliable electricity service to its customers, which includes its Utility customer.[2] This project focuses on the necessary upgrades to the Wiltondale distribution system to ensure the continued supply of quality and reliable power to support the additional peak demand and energy requirements resulting from Newfoundland Power's request. According to load flow analysis, it has been determined that once the Newfoundland Power line is

[1] For more details, please refer to "2026 Capital Budget Application," Newfoundland Power Inc., June 27, 2025. rpt. 1.1.
[2] *Public Utilities Act* and *Electrical Power Control Act, 1994.*

connected, under peak conditions, the system will be subject to low voltages, which will violate Hydro's Planning Criteria and have the potential to result in customer service interruptions.[3] To mitigate this issue, voltage regulators will be installed. Further details are provided in Section 4.0 of this proposal.

The new delivery point will be connected to WDL-L1 by constructing a new, dedicated three-phase tap. The tap will include a three-phase recloser, a meter tank with a revenue meter, and a gang-operated switch. Additionally, a communication link will be installed from the voltage regulator, recloser, and revenue meter to the Wiltondale Terminal Station ("WDL TS"). A Supervisory Control and Data Acquisition ("SCADA") system will also be installed to allow for remote control and/or monitoring of the new assets from Hydro's Energy Control Centre.

This project is justified based on the operational need to fulfill Newfoundland Power's request for a new delivery point. Upgrades of the existing distribution system infrastructure are essential to enable the supply of the requested energy to Newfoundland Power.

3.0 Asset Overview

3.1 Asset Background

WDL-L1 is a three-phase, 12.5 kilovolt (kV) distribution feeder that originates from the WDL TS. It currently services approximately 35[4] customers. The location of the WDL-L1 feeder is shown in Figure 1 and Figure 2, respectively.

[3] Low voltage can cause appliances to malfunction, run less efficiently, or be damaged.
[4] As of May 2025.

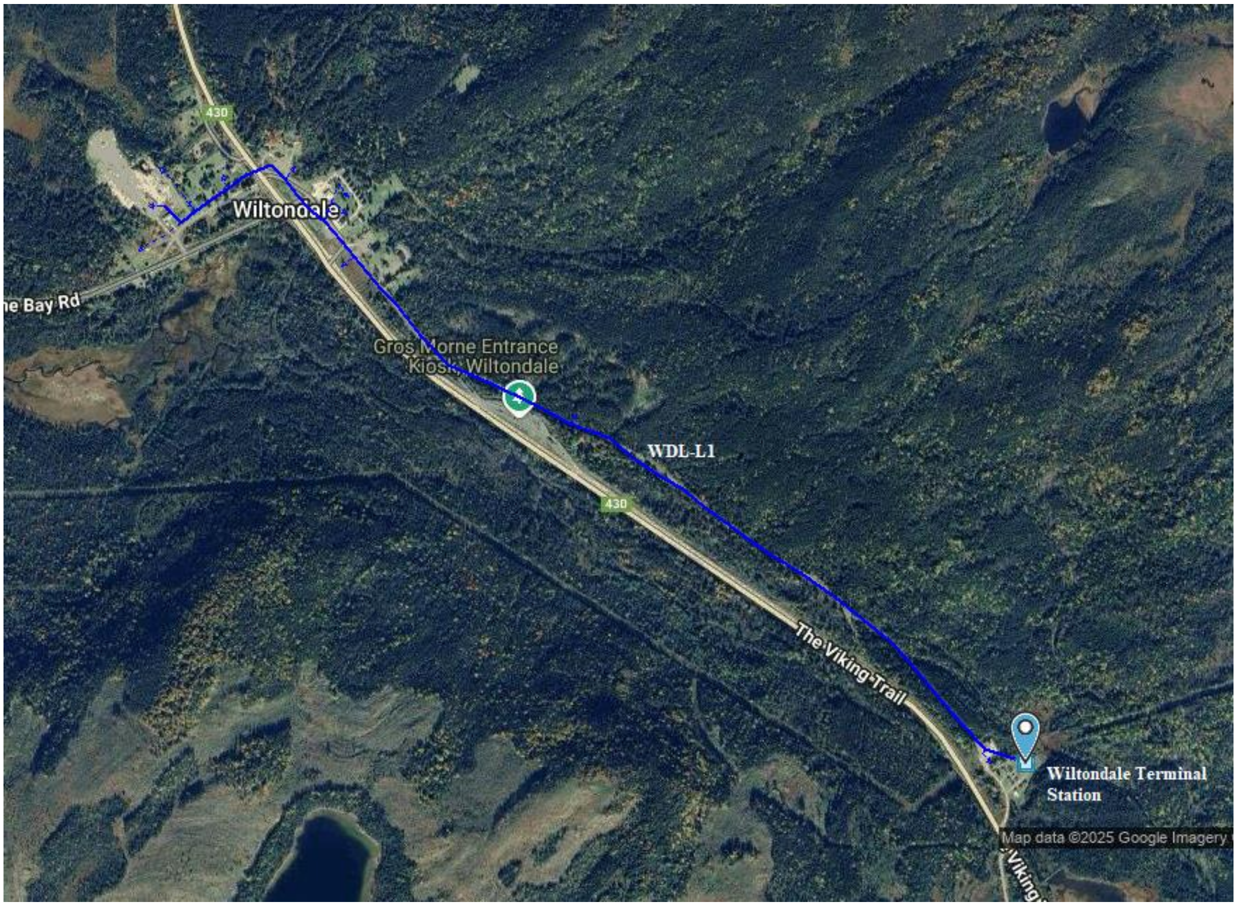


Figure 1: Layout of WDL-L1

1 WDL-L1 runs from the WDL TS for approximately 2.1 kms along the Viking Trail, Route 430, as a three-
2 phase overhead feeder which provides power to the community of Wiltondale. The primary conductor
3 of the WDL-L1 feeder is 1/0 AASC.[5]

[5] Aluminum Alloy Stranded Conductor ("AASC").

Figure 2: Location of WDL-L1

4.0 Analysis

Hydro has completed a load flow analysis of the Wiltondale distribution system to determine the impact of the new load requested by Newfoundland Power. The analysis has indicated that if a new load is added to the system, voltage levels at the start of WDL-L1 would fall below Hydro's normal low voltage planning criteria of 116 V, as shown in Figure 3.[6]

[6] The existing voltage at the start of WDL-L1 without the new load is 116.5 V.

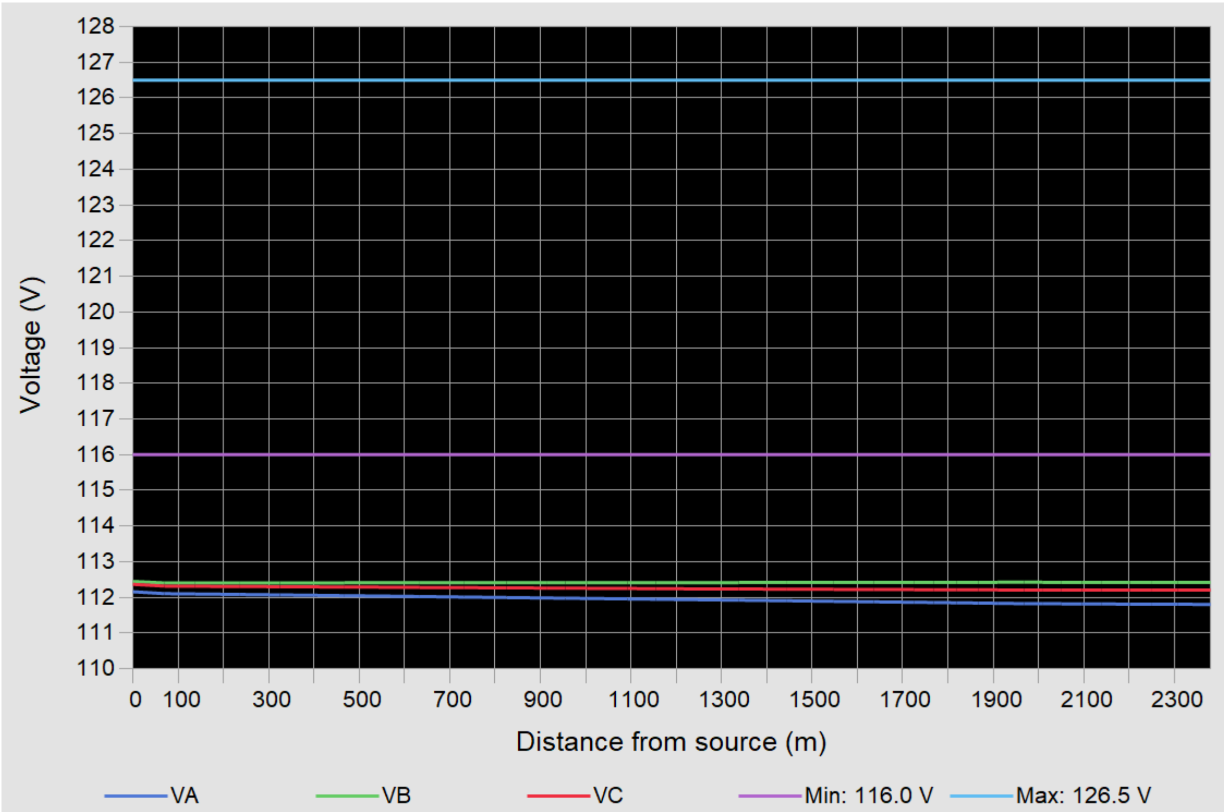


Figure 3: WDL-L1 Voltage Profile[7]

4.1 Evaluation of Alternatives

When distribution planning criteria violations are expected to occur on a distribution system, Hydro investigates various technical options to prevent the violations. The first course of action considered is operational changes, such as equipment setting adjustments and/or rebalancing the load on a feeder. If voltage levels cannot be brought to within the normal operating range through operational changes, a capital project is required involving equipment upgrades or a distribution reconfiguration. In the case of the Wiltondale distribution system low voltage violation, there are no options to adjust equipment settings or rebalance the distribution feeder. The other technical options considered by Hydro were:

- Load transfers;
- Single-phase to three-phase line conversion;
- Installation of voltage regulators;

[7] VA, VB, and VC represent the voltages of phases A, B, and C, respectively.

- Replacement of existing equipment with higher-rated equipment;
- Increase in conductor size (reconductor);
- Voltage conversion;
- Relocation of equipment; and
- Construction of a new distribution feeder.

As indicated in Section 4.0, the low voltage condition on the distribution occurs throughout the entire distribution system. This occurs because there is no voltage regulation (either a voltage regulator or an on-load tap changer) between the transmission system and distribution system. In most of Hydro's terminal stations that power distribution systems, voltage regulation is present. In Wiltondale, voltage regulation has not previously been required due to low load levels on the WDL TS. Given that the low voltage conditions are present from the start of the distribution system, the only technically feasible option to address the low voltage violation and ensure the provision of safe, reliable service to the customer is the installation of voltage regulators.

4.2 Least-Cost Evaluation

Hydro has not identified any viable alternatives to facilitate a least-cost evaluation.

4.3 Recommended Alternative

To address the low voltage issue, the installation of voltage regulators is required. This work involves the installation of a set of 100-amp (A) voltage regulators at the start of WDL-L1. Figure 4 illustrates the voltage profile of WDL-L1 following the installation of voltage regulators. As shown, the voltage levels remain above the minimum required threshold of 116 V.[8]

[8] Please note there are no customers within the first few meters of the distribution system before the proposed location of the voltage regulators, contributing to voltage values on the graph below Hydro's normal low-voltage planning criteria.

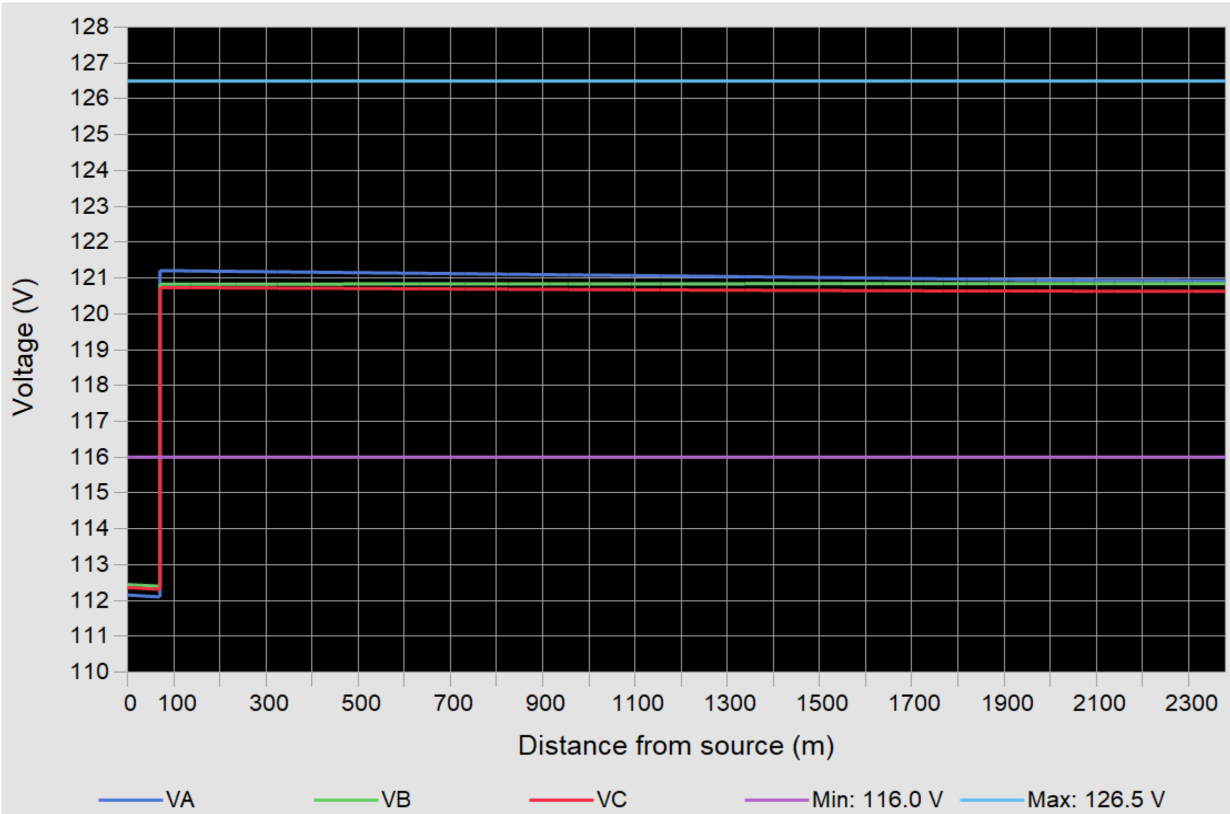


Figure 4: WDL-L1 Voltage Profile with Voltage Regulators

4.3.1 Risk of Asset Stranding

Hydro does not anticipate a change in service requirements in this area; therefore, the risk of asset stranding is low.

5.0 Scope of Work

An overview of the work to be completed under this project is as follows:

- Installation of a three-phase recloser, a meter tank with revenue meter and a gang-operated switch and associated support structures;
- Installation of a voltage regulator set (3 X 100 A voltage regulator) and associated support structure;
- Installation of a communication link from the voltage regulator, recloser, and revenue meter to the terminal station building; and
- Installation of a SCADA system to allow for remote control and/or monitoring of the new assets.

The point of interconnection is identified in the single-line diagram in Figure 5. The voltage regulators will be installed downstream of the existing recloser WD1-R1. This project will involve the construction of a three-phase tap downstream of the new voltage regulators to the interconnection point, incorporating a recloser, a metering tank and a gang-operated switch.

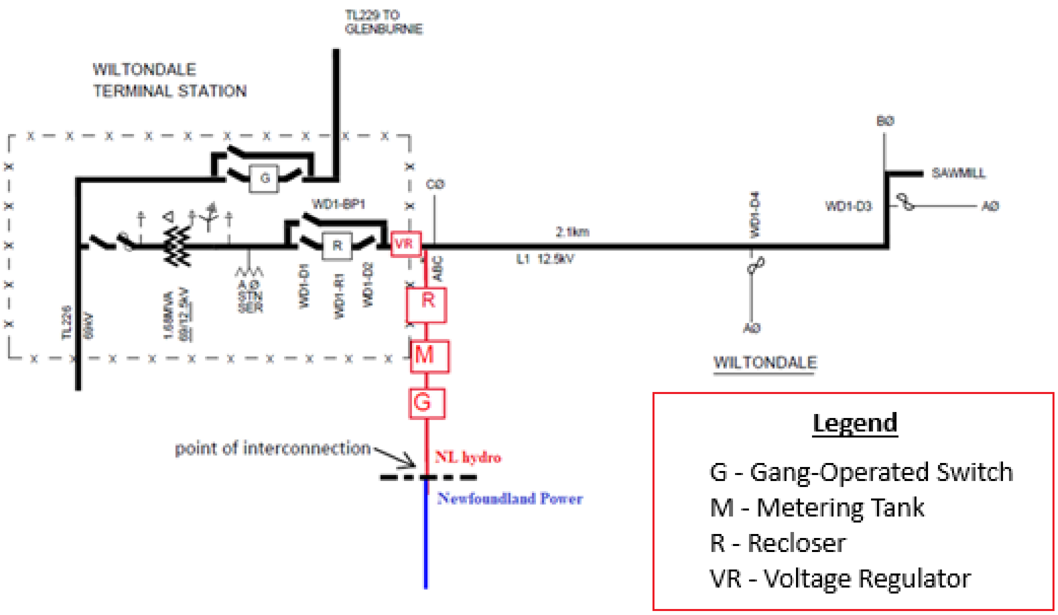


Figure 5: Single-Line Diagram with Point of Interconnection

5.1 Project Budget

The estimate for this project is shown in Table 1.

Table 1: Project Estimate ($000)

Project Cost	**2026**	**2027**	**Beyond**	**Total**
Material Supply	136.3	408.9	0.0	**545.2**
Labour	172.5	274.9	0.0	**447.4**
Consultant	0.0	4.0	0.0	**4.0**
Contract Work	5.0	25.5	0.0	**30.5**
Other Direct Costs	10.0	16.5	0.0	**26.5**
Interest and Escalation	23.0	96.3	0.0	**119.3**
Contingency	61.9	126.6	0.0	**188.5**
Total	**408.7**	**952.7**	0.0	**1361.4**

5.2 Project Schedule

The schedule for this project is shown in Table 2.

Table 2: Project Schedule

Activity	Start Date	End Date
Planning:		
Resource Planning.	January 2026	January 2027
Design:		
Conduct site visits and detailed design.	January 2026	May 2027
Procurement:		
Materials Order.	April 2026	May 2027
Construction:		
Construction.	July 2026	September 2027
Commissioning:		
Commissioning.	July 2026	September 2027
Closeout:		
Complete closeout documentation.	September 2027	December 2027

6.0 Conclusion

This project is critical to providing service to the proposed Newfoundland Power delivery point while ensuring continued compliance with Hydro's planning criteria. Hydro recommends proceeding with the proposed system upgrades to facilitate the reliable delivery of electricity to Newfoundland Power.

Upgrade Spherical Valve Controls

(2026–2029)

Bay d'Espoir

newfoundland labrador hydro

Contents

Upgrade Spherical Valve Controls (2026–2029)

Location: Bay d'Espoir

Investment Classification: Renewal

Asset Category: Hydraulic Plant

Estimated Cost: $1,353,100

1.0 Introduction

The Bay d'Espoir Hydroelectric Generating Station ("Bay d'Espoir") is composed of seven hydroelectric generating units, six located at Powerhouse 1 and one at Powerhouse 2. Units 1 – 6 are similar units and are located at Powerhouse 1, each with a capacity of 75 MW and having in-service dates between 1967 and 1970. Each unit has a spherical valve that functions as the main valve for controlling the flow of water to the turbine, and also as an emergency shut-off device.[1] In this way, the spherical valves serve as isolation and protection devices and are among the most critical equipment at Bay d'Espoir. They allow maintenance crews to safely perform work on individual units without dewatering the penstock, and in emergency situations, can be closed to limit damage to the units and penstocks. Spherical valves can be operated manually, but are normally operated via an automatic control system.

The existing automatic spherical valve control systems for Units 1–6 are obsolete and have reached the end of their useful service life. This project is proposed to replace the six automatic spherical valve control systems for Units 1–6 with modern control systems to ensure the continued safe and reliable operation of Bay d'Espoir, consistent with least cost and environmental responsibility.

This project is proposed to be completed over four years with an estimated budget of $1,353,100.

2.0 Project Description and Justification

Replacement of the spherical valve control systems for Bay d'Espoir Units 1–6 is required to address equipment obsolescence, cybersecurity risk and end of life. These control systems are now between 19 and 23 years old, and critical components were discontinued by the manufacturer in 2007. In addition, the software used to program the Programmable Logic Controller ("PLC") is obsolete. Although Newfoundland and Labrador Hydro ("Hydro") has some spare parts available, their viability is uncertain

[1] Note that there is no spherical valve for Unit 7.

since these electronic spares are now also between 19 and 23 years old. The expected useful life of the new spherical valve control systems is approximately 15 years.

Hydro recommends the replacement of the existing spherical valve control systems with modern control systems to ensure the continued safe and reliable operation of Bay d'Espoir. The spherical valves are mainly used for two purposes: isolation and protection. In terms of isolation, the spherical valves are used to close off penstock water from the generating units so that maintenance can be safely performed on the units without dewatering the penstock. The spherical valve will close each time the unit is not required for generation, and open when the unit is required for generation. In terms of protection, if an emergency situation is detected, such as a unit trip, the spherical valve will automatically close in order to limit potential extensive damage to the unit and shared penstock. During a unit protection event, such as a high bearing temperature, the spherical valve should automatically close. If not, the unit will continue to rotate, preventing the unit from safely going offline. This will result in increased bearing temperature, resulting in a greater probability of unit damage.

3.0 Asset Overview

3.1 Asset Background

There are four penstocks at Bay d'Espoir: three for Powerhouse 1 and one for Powerhouse 2. At Powerhouse 1, each penstock feeds two units. Each unit has its own spherical valve that functions as the main valve for controlling the flow of water into the turbine, and also as an emergency shut-off device. Each spherical valve can be manually operated, but is normally operated via an automatic control system. Under normal operation, the control system is used to open and close the spherical valves any time a unit starts or stops, as well as to isolate a unit during maintenance. Under emergency situations, the control system is operated automatically to close the spherical valve in order to prevent damage to the unit and penstock.

The current spherical valve control systems for Bay d'Espoir Units 1–6 were installed between 2002 and 2006. Each spherical valve control system is identical, consisting of a display panel with LED[2] status lights, as well as open/close switches on the panel exterior. The panel interior contains power supplies, a PLC, Input/Output ("I/O") modules, relays, and associated wiring used in the automatic control of the

[2] Light-Emitting Diode ("LED").

spherical valve auxiliary field devices. Figure 1 and Figure 2 show the exterior and interior of the spherical valve control panel, respectively.

Figure 1: Spherical Valve Control Panel Exterior

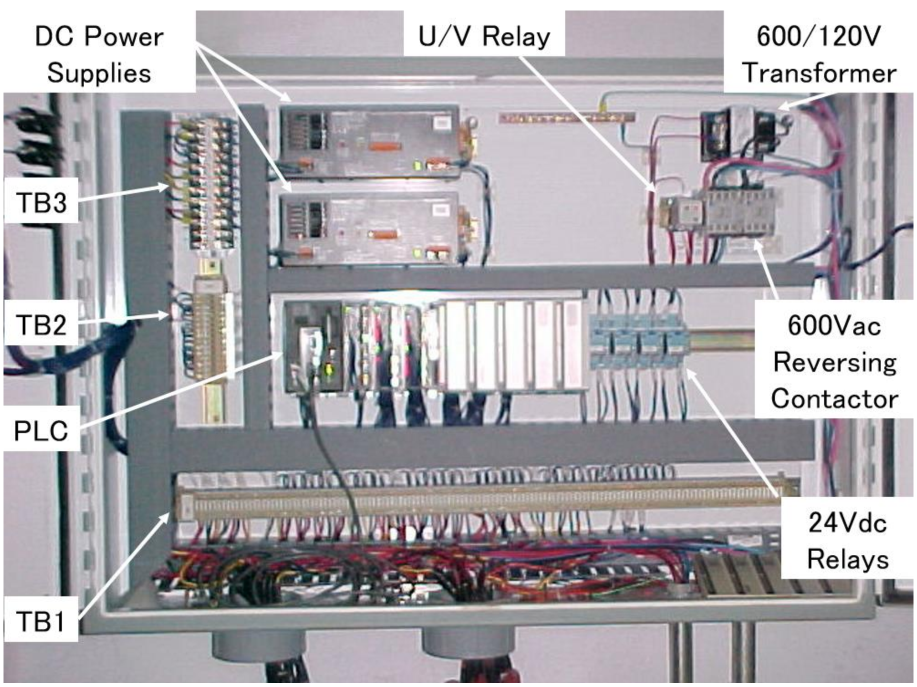


Figure 2: Spherical Valve Control Panel Interior

Hydro maintenance crews complete annual maintenance activities on the spherical valve systems, including the controls, in advance of unit outages. There have been no refurbishments or upgrades required for the controls since these systems were installed.

The PLC, I/O modules, and programming software are obsolete, present a cybersecurity risk and are at the end of their useful service life. For these reasons, Hydro recommends replacement of the spherical valve controls with modern control systems.

3.2 Historical Reliability

To date, the current spherical valve control systems for Bay d'Espoir Units 1–6 have not experienced any reliability concerns. However, given the age, obsolescence, and criticality of these controls, the planned replacement of the systems is required to ensure the continued safe and reliable operation of Bay d'Espoir.

3.3 Asset Condition

The spherical valve controls for Bay d'Espoir Units 1–6 are currently functioning as intended with no known hardware issues; however, the control systems and programming software are obsolete and at the end of their useful service life. For these reasons, replacement of the spherical valve controls is proposed in alignment with Hydro's asset management strategy for hydraulic generation assets. Replacement has been identified by Hydro as work required to minimize the disruption of service, and to avoid unsafe working conditions should the spherical valve controls fail.

4.0 Analysis

4.1 Evaluation of Alternatives

Hydro evaluated the following alternatives:

- Deferral;
- Upgrade life extension; and
- Like-for-like replacement.

4.1.1 Deferral

Under this option, the existing spherical valve controls for Bay d'Espoir Units 1–6 would remain in service. This poses a risk to the reliable and safe operation of Bay d'Espoir since the existing spherical valve control systems are obsolete and at the end of their useful service life. Available spare parts are of the same vintage as the existing control systems (i.e., over 20 years old). The failure of the existing control system could result in the following events:

- A single unit outage (75 MW) due to a spherical valve not opening when required, resulting in loss of generation and an extended outage; or
- An outage of two units (150 MW) on the same penstock, potentially resulting in damage to the unit and/or the penstock if the automatic control fails to close the spherical valve in an emergency situation, forcing head gate closure and an extended outage.

In the case of failure of a spherical valve control system, it would take at least six months to design, procure, install and commission a replacement system. Depending on the time of year when an outage occurs, replacement capacity and energy, if available, would have to be obtained through increased generation elsewhere in the province. Given the significance of the Bay d'Espoir generating capacity to the overall system, it is unacceptable to maintain the status quo and the associated risk of loss of generation.

4.1.2 Upgrade Life Extension

An upgrade life extension is not a viable option as the current spherical valve control systems for Bay d'Espoir Units 1–6 are obsolete, and spare electronic components, which are approximately twenty years old, are not considered to be a viable alternative.

4.1.3 Like-for-Like Replacement

Under this option, the existing spherical valve control systems for Bay d'Espoir Units 1–6 would be replaced with modern control systems. The six existing obsolete control panels and contents, including PLCs and displays, would be removed, and six new control systems, complete with new Human Machine Interfaces ("HMI") and programming software, would be installed. The new control systems would provide a service life of approximately 15 years.

4.2 Least-Cost Evaluation

Hydro has not identified any viable alternatives to facilitate a least-cost evaluation.

4.3 Recommended Alternative

Hydro recommends replacement of the obsolete spherical valve controls for Bay d'Espoir Units 1–6 with modern control systems to ensure the safe and reliable operation of these critical control systems, consistent with least-cost and environmental responsibility.

4.3.1 Risk of Asset Stranding

The spherical valve controls are an integral component of the Bay d'Espoir hydroelectric protection and control system, and will be required as long as the six associated units at Powerhouse 1 in Bay d'Espoir are in service. As there are no plans to retire these units, the risk of asset stranding is negligible.

4.3.2 Risk Mitigation

Hydro assessed the pre- and post-implementation risk of the scope of work for the 2026–2029 project in accordance with Hydro's Capital Risk Assessment process, as outlined in Section 7.0 of Schedule 1. The outcome of this assessment is provided in Table 1.

Table 1: Risk Scoring Pre- and Post-Implementation

	Impact	Likelihood	Score
Pre-Implementation	5	3	**15**
Post-Implementation	5	1	**5**
		Risk Mitigated	**10**
		Risk Mitigated per $1 Million	**7.4**

5.0 Scope of Work

The scope of work includes the following for Bay d'Espoir Units 1–6:

- Removal of the existing spherical valve control systems for each unit;
- Procurement of new PLC components and HMIs for new spherical valve control systems for each unit;
- PLC and HMI design for new spherical valve control systems, including in-office testing for each unit; and
- Installation and commissioning of new PLCs and HMIs, with one unit completed in 2027, two units in 2028, and three units in 2029.

5.1 Project Budget

The estimate for this project is shown in Table 2. Error! Reference source not found.**Table 2: Project Estimate ($000)**[3]

Project Cost	2026	2027	Beyond	Total
Material Supply	130.2	1.5	118.4	250.1
Labour	148.9	176.9	510.5	836.3
Consultant	0.0	0.0	0.0	0.0
Contract Work	0.0	0.0	0.0	0.0
Other Direct Costs	0.7	2.5	11.4	14.6
Interest and Escalation	14.6	29.5	140.3	184.4
Contingency	20.5	9.2	38.1	67.8
Total	**314.9**	**219.6**	**818.6**	**1,353.1**

5.2 Project Schedule

The schedule for this project is shown in Table 3. This is a four-year project starting in 2026 and ending in 2029.

Table 3: Project Schedule

Activity	Start Date	End Date
Planning:		
Project kickoff and schedule development.	January 2026	April 2026
Design:		
Detailed design – first unit.	March 2026	March 2027
Detailed design – next two units.	March 2027	November 2027
Detailed design – final three units.	May 2028	December 2028
Procurement:		
Procurement for all six units.	September 2026	December 2026
Construction & Commissioning:		
First unit.	April 2027	May 2027
Next two units.	April 2028	July 2028
Final three units.	April 2029	July 2029
Closeout:		
Project close-out.	December 2029	December 2029

[3] Numbers may not add due to rounding.

6.0 Conclusion

The spherical valve control systems for Bay d’Espoir Units 1–6 are among the most critical equipment at Bay d’Espoir. They act as isolation and protection devices, allowing workers to safely work on a single unit without dewatering the shared penstock, and protecting the unit and penstock from damage during an emergency situation. The current spherical valve control systems are approximately twenty years old and thus at the end of their useful service life, and are obsolete. Hydro recommends the replacement of all six spherical valve control systems over a four-year period from 2026–2029. Failure to complete this project could result in an extended outage and lost generation to one or more of the units at Bay d’Espoir.

Install Intelligent Electronic Devices Management Software

(2026–2028)

Contents

Install Intelligent Electronic Devices Management Software (2026–2028)

Location: Various

Investment Classification: Service Enhancement

Asset Category: Telecontrol

Estimated Cost: $1,270,200

1.0 Introduction

Newfoundland and Labrador Hydro's ("Hydro") operational sites contain hundreds of microprocessor-controlled devices that are used to control and monitor critical electrical infrastructure. These Intelligent Electronic Devices ("IED") respond to manual operator controls, and/or contain logic to make decisions such as whether to trip breakers, shut down generators, and start and stop auxiliary systems, among others. There are typically dozens of IEDs at each of Hydro's operational sites. Management of these devices is currently a manual process whereby Hydro technologists are required to visit the operational sites in order to access the devices for the purposes of viewing and/or changing settings. This manual process limits the amount of cybersecurity management that can be applied to the devices. This increases Hydro's cybersecurity vulnerability at a time when cyberattacks on electrical grid infrastructure are continually increasing in complexity and impact. This manual process also introduces operational inefficiencies due to the requirement to travel to a site in order to perform all interactions with devices, from basic tasks such as ascertaining the current device settings, to more advanced tasks such as retrieving event records during abnormal system events and maintaining device passwords.

IED management solutions provide remote, secure, and centralized access to IEDs located in the field in order to provide immediate access to device settings and configurations, and to allow the scalable application of cybersecurity policies. Hydro recommends the installation of an IED management solution for its hundreds of IEDs in order to implement current and emerging cybersecurity best practices and standards, which require increasing station-level security management. This initial project will connect at least four of Hydro's most critical terminal stations based on internal guidance on asset criticality, with future projects connecting the remainder of Hydro's terminal stations and generating facilities.

2.0 Project Description and Justification

This project will see the installation of an enterprise-level IED management system at Hydro Place that will connect to microprocessor-controlled devices at Hydro's operational sites. This will enable remote access and allow for the implementation of current and emerging cybersecurity best practices and standards, which require increasing station-level security management. This project is required in order to allow Hydro to increase its cybersecurity program for operational devices in response to the current and ever-increasing risk of cyberattacks on critical infrastructure.

This project is dependent on a secure path for communications between operational devices and the centralized IED management software. To that end, this project has been made possible by the 2025 completion of a project by Hydro to increase the capacity of its secure Operational Technology ("OT")/Supervisory Control and Data Acquisition ("SCADA") network.[1] The increased bandwidth of the OT/SCADA network allows for the addition of new traffic associated with advanced applications such as IED management.

It will take several years for Hydro to incorporate its hundreds of IEDs into the proposed IED management system. It is necessary for Hydro to complete this initial project at this time in order to begin the process of strengthening its cybersecurity posture for operational devices. Future projects will connect additional terminal stations and generating facilities in an order of priority based on internal guidance on asset criticality, which aligns well with criteria established within major international standards related to station cybersecurity asset criticality, such as NERC-CIP.[2]

The useful life of the IED management system will be determined by the length of vendor support of the software application. To this end, part of the system evaluation will include rating potential vendors based on the maturity of their organization and their product.

3.0 Asset Overview

3.1 Asset Background

Each of Hydro's operational sites contains dozens of IEDs, with the exact quantity dictated by factors such as the voltage level and the number of generators, or the number of transmission lines entering

[1] As outlined in the Upgrade SCADA Network (2024) project, which was approved as part of Hydro's 2024 Capital Budget Application ("CBA") in Board of Commissioners of Public Utilities Order No. P.U. 35(2023).
[2] North American Electric Reliability Corporation, Critical Infrastructure Protection ("NERC-CIP").

and leaving. The types of IEDs at these sites include microprocessor-based protection relays, remote terminal units, programmable logic controllers, human machine interfaces, smart meters, and more.

Existing electromechanical devices do not have communications interfaces or internal logic and are thus not considered to be IEDs and are outside the scope of this project. Hydro has capital programs in place to replace electromechanical devices with microprocessor-based devices, which will be connected to the IED management system upon installation. Additionally, any new terminal stations or generating facilities in future will also be connected to the IED management system from the outset.

3.2 Historical Reliability

The implementation of an IED management system will improve reliability. Whereas currently it is usually necessary for field staff to travel to the site to determine the cause of an IED operation (i.e., a relay trip), the IED management solution will enable this to be done immediately remotely, saving travel time. This will allow faster analysis of system events and contribute to faster outage restoration times.

4.0 Analysis

4.1 Evaluation of Alternatives

Hydro has evaluated the following alternatives:

- Deferral; and
- Install IED management software.

4.1.1 Deferral

This project was deferred from inclusion in the 2025 CBA to allow for time to review multiple vendor solutions and thus, prepare a more comprehensive scope. In consideration of increasing cybersecurity concerns for critical infrastructure, Hydro believes it would be imprudent to further delay this project. It will take several years to connect all of Hydro's IEDs into this system, so a multi-year approach is required. This initial project will include a small number of sites in order to solidify the technical aspects of the IED connections. Future projects will proceed at a more rapid pace to ensure incorporation of all IEDs in the shortest time possible so that current and emerging utility cybersecurity best practices can be widely implemented.

4.1.2 Install Intelligent Electronic Device Management Software

This project will see the installation of an enterprise-level IED management system, which will enable remote access and allow for the implementation of current and emerging cybersecurity best practices and standards, which require increasing station-level security management.

4.2 Least-Cost Evaluation

Hydro has not identified any viable alternatives to facilitate a least-cost evaluation.

4.3 Recommended Alternative

Hydro recommends proceeding with the proposed project in order to address current and emerging utility cybersecurity risks associated with its IEDs.

4.3.1 Risk of Asset Stranding

This project proposes to install a system which will interface with a significant percentage of Hydro's operational sites; thus, the risk of asset stranding due to a lack of available sites is low. The risk of asset stranding due to issues with the software is also low; software solutions have been available in the marketplace for many years and have already been successfully implemented by other utilities.

4.3.2 Risk Mitigation

Hydro assessed the pre- and post-implementation cybersecurity risk of the scope of work for the 2026–2028 project in accordance with Hydro's Capital Risk Assessment process, as outlined in Section 7.0 of Schedule 1. The outcome of this assessment is provided in Table 1.

Table 1: Risk Scoring Pre- and Post-Implementation

	Impact	Likelihood	Score
Pre-Implementation	5	4	**20**
Post-Implementation	4	3	**12**
		Risk Mitigated	**8**
		Risk Mitigated per $1 Million	**6.3**

5.0 Scope of Work

The scope of work includes the following:

- Procurement and installation of IED management enterprise system at Hydro Place to communicate with IEDs at Hydro's operational sites;
- Upgrades to the networking infrastructure at four of Hydro's operational sites to securely connect IEDs at those sites to the IED management software at Hydro Place; and
- Commissioning activities to establish communication and cybersecurity management activities between Hydro Place and IEDs at four of Hydro's operational sites.

The tentative sites to be included in this project are Stony Brook Terminal Station, Massey Drive Terminal Station, Deer Lake Terminal Station, and Hardwoods Terminal Station. This is subject to change based on identified synergies with other work or field resource availability.

5.1 Project Budget

The estimate for this project is shown in Table 2.

Table 2: Project Estimate ($000)[3]

Project Cost	2026	2027	Beyond	Total
Material Supply	29.9	34.9	17.4	**82.3**
Labour	221.6	253.6	179.0	**654.1**
Consultant	0.0	0.0	0.0	**0.0**
Contract Work	0.0	271.1	10.5	**281.5**
Other Direct Costs	6.7	2.5	2.1	**11.4**
Interest and Escalation	13.0	57.1	67.7	**137.9**
Contingency	25.8	56.2	20.9	**102.9**
Total	**297.2**	**675.4**	**297.6**	**1,270.2**

[3] Numbers may not add due to rounding.

5.2 Project Schedule

This project will start in 2026 and conclude in 2028. The schedule for this project is shown in Table 3.

Table 3: Project Schedule

Activity	Start Date	End Date
Planning:		
Initial planning and scheduling.	January 2026	March 2026
Design:		
Design network infrastructure upgrades.	February 2026	January 2028
Procurement:		
Tender, evaluate, and award a software solution.	September 2026	August 2026
Order network infrastructure.	October 2026	January 2028
Construction:		
Configure and install the software solution.	September 2026	February 2027
Install network infrastructure upgrades.	February 2027	November 2028
Commissioning:		
Commission software and connections to operating sites.	February 2027	November 2028
Closeout:		
Close out project finances and complete as-built documentation.	November 2028	December 2028

6.0 Conclusion

Hydro's current manual approach to managing its IEDs is an obstacle to the implementation of a scalable operational cybersecurity program. The current state requires field technologists to visit operational sites to access IEDs, view settings, and make changes. This also leads to operational inefficiencies, especially for remote sites and during inclement weather. Hydro recommends the implementation of a centralized IED management system to allow immediate, secure access to its hundreds of IEDs located across Newfoundland and Labrador. This will make it possible for Hydro to implement best-practice-based, utility-specific cybersecurity programs that will reduce Hydro's vulnerability to cyberattacks on its critical infrastructure. As part of this initial project, Hydro will connect to four terminal stations, with future projects connecting the remainder of Hydro's terminal stations and generating facilities.

Replace Radio Link to Hydraulic Control Structure

(2026–2027)

Ebbegunbaeg

Contents

Replace Radio Link to Hydraulic Control Structure (2026–2027)

Location: Ebbegunbaeg

Investment Classification: General Plant

Asset Category: Telecontrol

Estimated Cost: $1,227,300

1.0 Introduction

Reliable communications infrastructure is essential for the safe and efficient operation of Newfoundland and Labrador Hydro's ("Hydro") remote hydraulic control structures. At the Ebbegunbaeg Control Structure, Hydro uses a radio link from the Godaleich Hill Microwave Radio Repeater Site ("Godaleich Hill Site") to transmit operational data and enable remote system control. However, the existing radio link has reached the end of its useful service life, has limited bandwidth, and is no longer supported by the manufacturer. As a result, this radio system poses increasing risks to operational reliability. It is necessary to replace this radio link to maintain secure, efficient, and uninterrupted communication to the critical site.

2.0 Project Description and Justification

Hydro operates an Ultra High Frequency ("UHF") radio link from the Godaleich Hill Site to the Ebbegunbaeg Control Structure. This link provides 768 kbps of bandwidth and carries Supervisory Control and Data Acquisition ("SCADA") data, which allows for remote control and monitoring of the control structure from Hydro's Energy Control Center ("ECC"). The radio link also carries one analog telephone line.

The current radio link has reached the end of its useful service life. It has been discontinued by the manufacturer, and spare parts are no longer readily available.

A failure of the radio link would cause a loss of SCADA visibility and remote operation from the ECC for the Ebbegunbaeg Control Structure. Depending on reservoir conditions, this could create an emergency situation, requiring personnel to be immediately dispatched to the site via vehicle or helicopter to operate the gates. A new communications link is required to ensure reliable and safe remote operation of the Ebbegunbaeg Control Structure.

Hydro proposes replacing the UHF radio link from the Godaleich Hill Site to the Ebbegunbaeg Control Structure with a fibre-optic link, installed on the existing electrical distribution line to the structure. This would ensure the continuity of secure, reliable SCADA communication to the site, and also provide sufficient bandwidth to expand site services to meet modern technology requirements, including corporate network connectivity, Internet Protocol ("IP") phones, and physical security. The increased bandwidth would also allow for remote access and management of operational devices at the site, which has become standard practice for Hydro's remote sites.

3.0 Asset Overview

3.1 Asset Background

The Ebbegunbaeg Control Structure provides critical water control on the Bay d'Espoir system, and consists of three remotely-operated gates. These gates control water from the Meelpaeg Reservoir and discharge into Crooked Lake, and eventually through the Upper Salmon and Bay d'Espoir powerhouses. Remote control and monitoring of the gates occur through a UHF radio communications link between the Ebbegunbaeg Control Structure and the Godaleich Hill Site.

The current UHF radio communications link was installed in 2009. Various corrective maintenance activities, as well as bi-annual preventative maintenance every two years, have been conducted; however, no major maintenance or refurbishment activities have been carried out on these assets since their installation.

3.2 Historical Reliability

The current UHF radio system has generally performed reliably throughout its lifetime.

3.3 Asset Condition

The current UHF radio link between the Godaleich Hill Site and the Ebbegunbaeg Control Structure has reached the end of its useful service life, is no longer supported by the manufacturer, and spare parts are no longer available.

The bandwidth available on the existing UHF radio link between the Godaleich Hill Site and the Ebbegunbaeg Control Structure is not adequate to service Hydro's technology requirements, including corporate network connectivity, IP phones, physical security, and remote access and management of operational devices.

4.0 Analysis

4.1 Evaluation of Alternatives

Hydro evaluated the following alternatives for replacement of the UHF radio link between Godaleich Hill Site and the Ebbegunbaeg Control Structure:

- Deferral;
- Upgrade life extension;
- Like-for-like replacement; and
- Alternative strategies.

4.1.1 Deferral

Under this alternative, Hydro would continue operating the existing UHF radio system for remote control and monitoring of the Ebbegunbaeg Control Structure. This poses a risk to the continued reliable operation of the control structure, as this radio system is no longer supported by the manufacturer. As spare parts are no longer available, a failure of the system would cause a loss of remote monitoring and control of the hydraulic control structure. The Ebbegunbaeg Control Structure plays a vital role in managing water flow within the Bay d'Espoir system. It features three remotely operated gates that regulate water released from the Meelpaeg Reservoir into Crooked Lake, ultimately supplying the Upper Salmon and Bay d'Espoir powerhouses. If the gates are not operated correctly, it could impact power generation at the Bay d'Espoir Hydroelectric Generating Station. Depending on reservoir conditions, this could be an emergency situation requiring personnel to be immediately dispatched to the site to operate the gates. This is a remote site, so the resources need to be transported there by helicopter if available; otherwise, they need to go there by vehicle, which would take approximately three to six hours from the Bishop's Falls office.

4.1.2 Upgrade Life Extension

Hydro has not identified any upgrade life extension options for this project, as the asset has reached the end of its useful service life.

4.1.3 Like-for-Like Replacement

Under this alternative, Hydro would replace the current obsolete UHF system with a new, vendor-supported UHF system. This is not a viable option since UHF links do not provide adequate bandwidth to support Hydro's technology requirements for remote sites.

4.1.4 Alternative Strategies

Hydro identified two viable alternatives for the replacement of the UHF radio link between Godaleich Hill Site and Ebbegunbaeg Control Structure: (i) installation of a fibre-optic link; and (ii) installation of a microwave radio link.

Installation of a Fibre-Optic Link

This alternative would install a new fibre-optic link between the Godaleich Hill Site and the Ebbegunbaeg Control Structure by installing fibre-optic cable on an existing electrical distribution line between the two sites. Upgrades to make the poles ready for fibre attachment would be completed based on the results of an engineering survey.

Installation of a Microwave Radio Link

This alternative would install a new microwave radio link between the Godaleich Hill Site and the Ebbegunbaeg Control Structure, utilizing the existing microwave radio tower at Godaleich Hill Site. Hydro would install a new 60-meter microwave radio tower at the Ebbegunbaeg Control Structure, as the line of sight required is not clear enough utilizing the existing, lower tower at Ebbegunbaeg. New microwave radio equipment, including microwave antennas and waveguides, would be installed on these towers.

4.2 Least-Cost Evaluation

Hydro performed a least-cost evaluation to determine the least-cost option for this project. The viable alternatives for this project that were considered in a least-cost evaluation included:

- Installation of a fibre-optic link; and

- Installation of a microwave radio link.

Assumptions to complete the evaluation included that both alternatives would have the same useful life and that the microwave antenna can be installed on the existing UHF antenna location at the Godaleich Hill Site tower.

A summary of the least-cost evaluation is presented in Table 1. The lowest-cost option is the installation of a fibre-optic link.

Table 1: Least-Cost Evaluation Summary ($)

Alternatives	CPW[1]	CPW Difference between Alternative and the Least-Cost Alternative
Installation of a Fibre-Optic Link	1,094,790	-
Installation of a Microwave Radio Link	1,297,759	202,969

4.3 Recommended Alternative

Based on the least-cost evaluation, it is recommended to proceed with the installation of a fibre-optic link as a replacement for the existing UHF link between Godaleich Hill Site and Ebbegunbaeg Control Structure.

4.3.1 Risk of Asset Stranding

This project is required for the continued reliable operation of the Ebbegunbaeg Control Structure, which is an essential component of the Bay d'Espoir Hydroelectric Generating Station. As this control structure will be required for the lifetime of the Bay d'Espoir Hydroelectric Generating Station, and communication abilities will be required for its operation, the risk of asset stranding is low.

4.3.2 Risk Mitigation

Hydro assessed the pre- and post-implementation risk of the scope of work for the 2026-2027 project in accordance with Hydro's Capital Risk Assessment process, as outlined in Section 7.0 of Schedule 1. The outcome of this assessment is provided in Table 2.

[1] Cumulative Present Worth ("CPW").

Table 2: Risk Scoring Pre- and Post-Implementation

	Impact	Likelihood	Score
Pre-Implementation	4	4	**16**
Post-Implementation	4	2	**8**
		Risk Mitigated	**8**
		Risk Mitigated per $1 Million	**6.5**

5.0 Scope of Work

The scope of this project includes:

Year One (2026)

- Completion of engineering survey to assess readiness of existing distribution pole line between Godaleich Hill Site and Ebbegunbaeg Control Structure for fibre-optic cable installation;
- Necessary upgrades to the existing distribution system pole line to make it ready for fibre-optic cable installation; and
- Preparation and awarding of tender for supply and installation of fibre-optic cable between Godaleich Hill Site and Ebbegunbaeg Control Structure.

Year Two (2027)

- Development of network configuration design;
- Installation of fibre-optic cable between Godaleich Hill Site and Ebbegunbaeg Control Structure; and
- Installation and commissioning of networking equipment and commissioning of the fiber-optic link between Godaleich Hill Site and Ebbegunbaeg Control Structure.

5.1 Project Budget

The estimate for this project is shown in Table 3.

Table 3: Project Estimate ($000)[2]

Project Cost	2026	2027	Beyond	Total
Material Supply	0.0	48.0	0.0	48.0
Labour	381.9	79.3	0.0	461.2
Consultant	24.0	63.3	0.0	87.4
Contract Work	0.0	434.2	0.0	434.2
Other Direct Costs	2.3	4.5	0.0	6.8
Interest and Escalation	21.5	64.5	0.0	86.1
Contingency	40.8	62.9	0.0	103.8
Total	**470.5**	**756.8**	**0.0**	**1,227.3**

5.2 Project Schedule

The schedule for this project is shown in Table 4.

Table 4: Project Schedule

Activity	Start Date	End Date
Planning:		
Kick off project, prepare schedule.	January 2026	March 2026
Design:		
Complete pole line survey.	February 2026	May 2026
Complete fibre-optic design.	August 2026	May 2027
Procurement:		
Prepare and award the fibre-optic cable tender.	September 2026	November 2026
Procure networking equipment.	November 2026	February 2027
Construction:		
Make poles ready for fibre installation.	May 2026	August 2026
Install fibre-optic cable.	August 2027	September 2027
Install networking equipment.	August 2027	September 2027
Commissioning:		
Test and commission the fibre-optic link.	September 2027	September 2027
Closeout:		
Closeout project.	December 2027	December 2027

[2] Numbers may not add due to rounding.

6.0 Conclusion

Hydro currently uses a UHF radio link to provide communications to the Ebbegunbaeg Control Structure from the Godaleich Hill Site. This link is used for remote control and monitoring of the control structure. It has reached the end of its useful service life, has limited bandwidth, and is no longer supported by the manufacturer. As a result, the system poses increasing risks to operational reliability. Hydro proposes to replace this radio link with a fibre-optic link to maintain secure, efficient, and uninterrupted communication to the critical site. This new fibre-optic link will ensure reliable SCADA communication to the Ebbegunbaeg Control Structure as well as support current and emerging technology requirements.

Replace Fuel Storage Tank

(2026)

McCallum

Contents

List of Attachments

Replace Fuel Storage Tank (2026)

Location: McCallum

Investment Classification: Renewal

Asset Category: Generation

Estimated Cost: $1,008,400

1.0 Introduction

McCallum is located on the south coast of Newfoundland and is one of the 21 communities that comprise Newfoundland and Labrador Hydro's ("Hydro") Isolated Diesel Generation System. The existing bulk fuel storage tank was placed in its current location in 1998. This tank is placed on top of a fabricated steel support structure that is anchored to bedrock.

An inspection of the tank's support system, completed in 2022, noted that the support structure has deteriorated to the point at which it can no longer adequately support the fuel tank.[1] Subsequently, the current fuel storage volume has been limited to 50% of the tank's design capacity. While the reduced fuel storage capacity can adequately address fuel storage requirements, the support structures' condition continues to deteriorate, and if left unattended, is at risk of collapse.

The issues with the fuel tank are compounded by the recent condemnation of the adjacent wharf, which was owned and operated by the Government of Newfoundland and Labrador.[2] The wharf, which served as a staging area for fuel deliveries and material storage, is no longer receiving maintenance or repairs and can no longer be utilized to support the diesel plant operations.

To ensure the continued delivery of safe, reliable electricity to the community of McCallum, consistent with environmental responsibility, Hydro is proposing the replacement of the bulk fuel storage tank. Hydro will execute the proposed refurbishment work as a single-year project, with detailed engineering, fuel storage tank procurement and installation completed in 2026. Removal and disposal of the original tank will be completed in 2027 as part of an operating project.

[1] The Tank Support System Inspection report is provided as Attachment 1.
[2] For further details, please refer to Attachment 2.

The total project estimate is $1,008,400.

2.0 Project Description and Justification

This project proposes to replace the existing bulk fuel storage tank at Hydro’s diesel generating station in McCallum. This project includes the procurement and installation of two new, double-walled, horizontal fuel storage tanks. Based on Hydro’s assessment of the fuel storage criteria for McCallum, Hydro’s proposal provides for reduced fuel storage with two tanks that are smaller in footprint and better suited for the site location.

The support structure for the existing fuel storage tank is compromised and requires refurbishment. The issues with the fuel storage tank are compounded because of the condemnation of the adjacent wharf. The diesel plant is situated on a bedrock shoreline, surrounded by private property and sloping, rugged landscape, as shown in Figure 1.

Figure 1: McCallum Diesel Plant Location

The provincial wharf, which has historically been utilized to accept fuel deliveries and serve as a laydown area for material transport, has been condemned and can no longer be utilized for this purpose. Given the unavailability of a suitable alternative space, significant logistical issues have arisen for Hydro's diesel generation operations in the community. As there are no plans to restore the wharf and it is no longer deemed capable of supporting any service loads, the continued operation of the existing vertical fuel storage tank will be inhibited. Future fuel storage tank inspections will also be complicated due to the inability to place the temporary tanks required to execute this work atop the wharf deck.

The inability to utilize the wharf as a laydown for temporary fuel storage further inhibits the completion of the necessary tank support structure refurbishments. Completion of the tank refurbishments will require that the tank be removed from service, and without an adequate fuel supply, the diesel plant will be unable to generate. As the sole source of generation in the community, such a plant outage would result in an extended disruption to customer service.

Hydro must ensure that the fuel storage tank in McCallum is maintained in sound operating condition to provide continuity of fuel supply for the diesel generating units. Given the logistical challenges presented by the unique setup in McCallum, the proposed installation of new fuel storage tanks is required. The proposed project will ensure an adequate fuel supply for the community for the next 25–30 years.

3.0 Asset Overview

3.1 Asset Background

The existing bulk fuel storage tank is a 90,800-litre vertical double wall tank installed in 1998. This tank is supported by a fabricated steel support structure that is anchored to the bedrock shoreline, adjacent to the diesel plant.

Traditionally, fuel deliveries to the plant were performed by shipping 1,000-litre fuel totes by the provincial ferry and offloading on the deck of the provincial wharf. Fuel was then pumped from the totes to the adjacent tanks. As the wharf is condemned and no longer able to support any loading, the current refuelling procedure requires time consuming, manual transport by operations personnel of 45-gallon fuel drums from the nearby Department of Fisheries and Oceans ("DFO") wharf to the diesel plant, where the fuel is then transferred to the bulk storage tank.

3.2 Historical Reliability

The existing bulk fuel storage tank has provided adequate fuel supply for the McCallum Diesel Generating Station throughout its service life. Repairs were completed on the structure to enable its continued operation at a reduced capacity; however, these repairs are temporary in nature, and further refurbishment is required to ensure the continued operation of the tank.

3.3 Asset Condition

The existing bulk fuel storage tank's steel support structure has deteriorated to the point at which its structural integrity has been compromised, as further evidenced in Attachment 1. The support beams show signs of corrosion and wear, and members have experienced significant section loss, as can be seen in Figure 2 and Figure 3.

Given the reduced capacity of the support structure, temporary repairs were required to enable the fuel tank to be filled to half of its design capacity. These repairs, completed in 2022, were recommended by Hydro's external consultant and deemed to be temporary in nature, with the completion of long-term refurbishment required within five years.

Figure 2: Corrosion through Stiffener on Main Support Beam

Figure 3: Corrosion of Beams and Connections

3.4 Condition-Based Remaining Life

The fuel storage tank's support structure has deteriorated to the point at which it is no longer capable of supporting its original design loads. Repairs to enable the tank to be filled to 50% of its storage capacity are temporary in nature, and will reach their five-year recommended replacement window in 2027.

4.0 Analysis

4.1 Evaluation of Alternatives

Hydro evaluated the following alternatives:

- Deferral;
- Upgrade life extension; and
- Alternative strategies.

4.1.1 Deferral

The existing fuel storage tank is supported by an independent steel support structure. A 2022 condition assessment, provided as Attachment 1, highlighted concerns with the condition of the support structure, noting that its members had deteriorated to the point at which their structural integrity had been compromised. Repairs were completed to reinforce the structure; however, they were deemed to be temporary in nature, and it was recommended that a complete refurbishment be completed within five years.

Given its exposure to a corrosive marine environment, the tank support structure will continue to deteriorate. If left unattended, the support structure is at risk of failure. The impacts of any such failure would be devastating, resulting in an environmental catastrophe given the proximity of the tank to the ocean, and an extended plant outage. Deferral of remedial measures to address concerns pertaining to the condition of the tank's support structure is not an option.

4.1.2 Upgrade Life Extension

While the fuel storage tank itself is noted to be in acceptable condition, the support structure on which it rests is severely deteriorated. Refurbishment of the support structure is required to ensure the continued safe, reliable operation of the fuel tank. To replace the tank support structure and reinstate the existing fuel storage tank, the following scope items would be required:

- Temporary removal of the existing vertical tank utilizing a combination of cranes and barges, with reinforcement of the tank necessary to complete the lift;

- Temporary fuel storage through the provision of one horizontal fuel storage tank;[3]
- Demolish the existing storage shed, located adjacent to the diesel plant, to create a laydown for the temporary fuel storage;[4]
- Drain, clean and inspect the existing tank before lifting to a barge for storage to enable the refurbishment of the tank support structure;[5]
- Replace the tank support structure;
- Lift the fuel storage tank back in place and inspect the floor, shell, and welds again, including extensive ultrasonic thickness testing, to ensure the integrity of the tank is not compromised following the high-risk transfer. Any identified deficiencies would require repair prior to returning the tank to service; and
- Install a fuel pipeline from the tank to the DFO wharf.[6]

The tank lift required for this alternative is extremely logistically challenging and poses considerable risk to the reliability of the diesel generating station by inducing significant stresses and strains, which could jeopardize the integrity of the tank. Depending upon the nature of the repairs required after the lift, the tank could remain out of service for an extended period of time, and ultimately result in the requirement to add additional temporary fuel storage to address customer load. Given its enhanced risk and the absence of any notable benefits, Hydro does not consider this to be a viable alternative.

4.1.3 Alternative Strategies

To alleviate the concerns stemming from the deteriorated tank support system, while considering the issues presented by the deteriorated wharf and the decreasing fuel consumption requirements in McCallum, Hydro considered the alternative strategy for the Installation of Reduced Fuel Tank Storage.

[3] Temporary fuel storage is required to fuel the generating units and maintain service to the community while the existing vertical tank is removed from service.
[4] Hydro considered completing upgrades to utilize the provincial wharf for temporary fuel storage; however, this was determined to be cost-prohibitive, with the completion of temporary repairs required to improve the deck loading capacity estimated at $477,000. Cost estimates are based on those provided in Attachment 2, escalated to 2026. For further details, please refer to Attachment 2.
[5] In the absence of temporary upgrades to provide for vessel berthing at the wharf, estimated at $1,227,000, reliance on a barge would continue to be required.
[6] Installation of a fuel pipeline will enable the tank to be filled directly from fuel totes and eliminate the requirement for manual fuel transfers, as is the current practice.

Installation of Reduced Fuel Tank Storage

To replace the tank support structure and fuel storage tank, the following scope items would be required:

- Demolish the existing storage shed, located adjacent to the diesel plant;
- Procure and install two appropriately-sized, shop-fabricated, horizontal fuel storage tanks adjacent to the plant;[7] and
- Install a fuel pipeline from the tank to the DFO wharf.

Hydro has adopted a six-week fuel storage criteria for McCallum due to the remote location and logistical challenges associated with wharf limitations. Based on Hydro's Spring 2024 Fuel Requirements Forecast, the six-week fuel storage requirement dictates that McCallum requires at least 14,089 litres of usable fuel storage, or 15,324 litres of total storage volume.[8]

4.2 Least-Cost Evaluation

The installation of a reduced fuel tank storage alternative has the same scope requirements as that of upgrade life extension, aside from the purchase of a second horizontal fuel storage tank, which is estimated at $20,000. Within the upgrade life extension alternative, the cost of transferring the tank to and from the barge, re-inspection and testing the tank floor, shell, and welds, in addition to the cost of any repairs required, would cost significantly more than the $20,000, and presents significantly higher risk. Depending on the nature of the repairs required, the tank could remain out of service for an extended period of time, and ultimately result in the need to add additional temporary fuel storage to address customer load.

Additionally, the future operating costs for the upgrade life extension alternative would be substantially greater, given the costs associated with the implementation of temporary fuel storage tanks via barge and crane to facilitate this work. Under the Installation of Reduced Fuel Storage alternative, future inspections would be completed by staggering the inspections to ensure that one tank remains available to maintain the fuel supply. Reliance on a single tank poses a risk to reliable fuel supply and the delivery

[7] As these tanks are smaller in footprint, they are better suited for the site location as they require less space to install. Following the installation of the horizontal fuel storage tanks the vertical tank will be removed and disposed through an operating project.
[8] Assuming a usable fuel volume of 92% of total tank capacity.

of safe, reliable power, with the McCallum Diesel Generating Station serving as the sole source of electricity for the isolated coastal community.

Given the enhanced risk and the absence of any notable benefits, Hydro does not consider the upgrade life extension alternative to be a viable alternative. As such, Hydro has not identified any viable alternatives to facilitate a least-cost evaluation.

4.3 Recommended Alternative

To address the issues with the fuel storage tank in McCallum, Hydro is recommending the installation of reduced-capacity fuel storage. This option would replace the existing bulk fuel storage tank with two appropriately-sized fuel tanks and eliminate dependencies on the condemned provincial wharf.

4.3.1 Risk of Asset Stranding

The McCallum Diesel Generating Station is the sole source of electricity for the isolated coastal community. These stations are required to meet firm capacity, and, currently, the load profile for McCallum is expected to remain stable. Should a change in the load forecast result in a requirement to replace/modify the bulk fuel storage system, these horizontal tanks can be repurposed elsewhere within Hydro's operations; therefore, the risk of asset stranding is low.

4.3.2 Risk Mitigation

Hydro assessed the pre- and post-implementation risk of the scope of work for the 2026 project in accordance with Hydro's Capital Risk Assessment process, as outlined in Section 7.0 of Schedule 1. The outcome of this assessment is provided in Table 1.

Table 1: Risk Scoring Pre- and Post-Implementation

	Impact	Likelihood	Score
Pre-Implementation	5	4	**20**
Post-Implementation	3	2	**6**
		Risk Mitigated	**14**
		Risk Mitigated per $1 Million	**13.9**

5.0 Scope of Work

This project will replace the fuel storage tank at Hydro's Diesel Generating Station in McCallum and includes the following scopes of work:

- Procurement of new bulk fuel storage tank (2 x 12,000 litre horizontal fuel storage tanks);
- Mechanical engineering design for a new fuel pipeline between the fuel tanks and the DFO wharf;
- Demolition, removal and disposal of the existing storage shed for the location of new fuel storage tanks;
- Acquisition of land as required;
- Installation of two new horizontal bulk fuel storage tanks; and
- Installation of all associated pipes.

5.1 Project Budget

The McCallum fuel tank replacement will be executed as a single-year project. The estimate for this project is shown in Table 2.

Table 2: Project Estimate ($000)

Project Cost	2026	2027	Beyond	Total
Material Supply	70.0	0.0	0.0	**70.0**
Labour	91.8	0.0	0.0	**91.8**
Consultant	108.8	0.0	0.0	**108.8**
Contract Work	529.9	0.0	0.0	**529.9**
Other Direct Costs	2.1	0.0	0.0	**2.1**
Interest and Escalation	42.9	0.0	0.0	**42.9**
Contingency	162.9	0.0	0.0	**162.9**
Total	**1,008.4**	**0.0**	**0.0**	**1,008.4**

5.2 Project Schedule

Replacement of the existing bulk fuel storage tank will be completed over one year. This project is projected to start in February 2026 and be completed in December 2026.

The schedule for this project is shown in Table 3.

Table 3: Project Schedule

Activity	Start Date	End Date
Planning:		
Project planning.	February 2026	March 2026
Design:		
Design for new tanks.	February 2026	June 2026
Design for mechanical piping.	February 2026	June 2026
Procurement:		
Procurement of new fuel tanks.	April 2026	July 2026
Construction:		
Install new fuel tank.	September 2026	November 2026
Commissioning:		
Commission new fuel tank system.	October 2026	November 2026
Closeout:		
Project closeout.	November 2026	December 2026

6.0 Conclusion

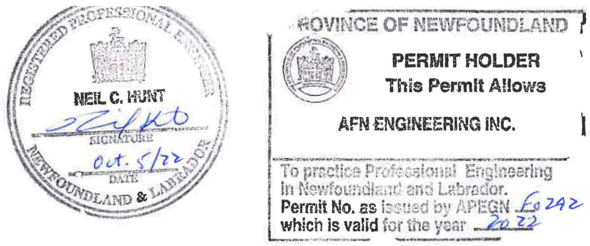
The steel support structure for the existing bulk fuel storage tank has deteriorated and requires refurbishment. The issues with the fuel tank are compounded by the recent condemnation of the adjacent wharf; this structure has historically served as a staging area for fuel deliveries and material storage, and its inability to further support Hydro's operations presents numerous challenges.

Hydro must ensure that the fuel storage tank in McCallum is maintained in sound operating condition to provide continuity of fuel supply for its diesel generating units. The proposed replacement of the existing fuel storage tank with reduced fuel storage alleviates the concerns surrounding the wharf's condition and ensures the reliable operation of the plant for the next 25 to 30 years.

Attachment 1

Tank Support System Inspection

AFN Engineering Inc.



AFN ENGINEERING INC.

Tank Support System Inspection

McCallum, NL

October 2022 – 22-4912

Table of Contents

Tables

Appendices

1.0 Introduction

In September 2022, AFN Engineering Inc. (AFN)/Dillon Consulting (Dillon) was engaged by Hydro to complete a visual and ultrasonic testing (UT) inspection of the existing structure supporting the fuel tank located in McCallum, NL. The existing fuel tank supplies fuel to the entire community and can contain approximately 90,000 litres of fuel.

Photo 1: View of existing tank located behind the wharf

1.1 Background

The existing tank is currently supported on a steel platform located behind the provincial pile wharf. The columns of the platform are supported on concrete piers that have been poured onto the exposed bedrock. During high tides the steel columns and concrete piers become partially submerged under water.

The original tank support structure was originally built in 1998. Currently, there are areas along the supporting beams that show signs of significant corrosion and wear. Since there is no record of repairs or maintenance completed to the structure since it was originally built, there are concerns about the structure having a reduced capacity.

and W150x22 beams which are supported on W360x33 cross beams. The cross beams are supported on W360x45 girders which are then supported on HSS 203x203x6.4 columns with HSS 76x76x4.8 bracing members spanning between the columns to provide lateral support. The total platform measures approximately 6.1 m by 6.1 m.

Detailed drawings of the original tank support construction are included in **Appendix A.**

3.0 Inspection Results

The inspection of the platform was completed on September 4, 2022. The inspection included a visual assessment of the existing tank support and UT readings along various beams. Site Photographs are located in **Appendix B**.

3.1 Ultrasonic Testing (UT) Readings

UT readings were taken on the main support members. Readings were taken at the mid points of the W360x33 girders and W360x45 beams, and four readings were taken along each of the HSS columns (one each at the north, south, east, and west sides). Readings were also taken along the support beams and channels spanning between the W360x33 beams and along the cross bracing members.

The UT readings were limited to the web of the beams and could not be taken on the flanges of the members due to the amount of corrosion present. Due to the variability in the UT readings and the limits on where the readings could be taken throughout the members, assumptions of the approximate thickness loss was assumed to determine the current capacity of the support structure. Given the total amount of corrosion present, a total of 2 mm total thickness loss around the cross section of each member was assumed in order to determine the current capacity of the structure.

4.0 Results and Recommendations

4.1 Design Assumptions

The analysis of the structure included determining the original strengths of each member and their reduced strengths according to a number of assumptions as follows:

1. Since the UT measurements were not consistent and could not be obtained for any of the flanges of the members, for the purpose of the analysis it was assumed that there is a minimum of 2 mm section loss on all members.
2. Environmental loads from the National Building Code (NBCC 2015) were used for Grand Bank as a representative location closest to McCallum.
3. An importance factor of 0.8 was used on all environmental loads.
4. Due to the amount of rusting throughout the members and their connections, it was assumed that all connections were pinned when in fact there may be still some fixity remaining.

4.2 Analysis and Results

A structural analysis of the support structure was completed using the STAAD Pro modeling software. Models of the structure were completed and included the total weight of the tank and support structure, environmental loading and considered the weight of fuel assuming the tank was 100% full (90,000L), 50% full (45,000L) and 25% full (22,500L). Results of the original member capacities and reduced member capacities due to the 2 mm thickness loss are shown in the tables below. Additionally, the corresponding loads on each member are shown for a full tank, half tank and one quarter tank load.

4.2.1 Main Beams

Original and reduced capacities of the main beams compared to a full, half, and one quarter tank load are summarized in the table below.

Table 1: Beam Capacities and Loads

Member	Original Member Capacities		2mm Thickness Loss		Tank Full		Tank ½ Full		Tank ¼ Full	
	M_r (kN*m)	V_r (kN)	M_r (kN*m)	V_r (kN)	M_f (kN*m)	V_f (kN)	M_f (kN*m)	V_f (kN)	M_f (kN*m)	V_f (kN)
C150x12	19.0	138.0	8.6	29.0	14.4	37.8	7.4	19.4	3.9	10.3
W150x22	42.9	155.1	16.4	46.9	19.2	43.7	16.4	28.3	15.0	20.8
W200x27	67.2	210.9	32.7	64.2	37.8	19.5	29.5	19.4	28.8	19.4
W360x33	127.7	339.4	59.1	104.1	70.7	114.6	48.2	59.6	38.6	32.2
W360x45	186.6	362.6	102.3	150.7	140.1	220.0	74.2	129.0	41.5	84.2

Notes:
1. Values in red have exceeded the reduced member capacities.
2. Values in yellow are close to the reduced member capacities.

4.2.2 Columns

Original and reduced capacities of the columns compared to a full, half, and one quarter tank load are summarized in the table below.

Table 2: HSS 203x203x6.4 Column Capacities and Loads

Member	Original Member Capacities	2mm Thickness Loss	Tank Full	Tank ½ Full	Tank ¼ Full
	C_r (kN)	C_r (kN)	C_f (kN)	C_f (kN)	C_f (kN)
1	1274.0	481.1	368.0	218.5	144.0
2	1303.4	492.2	375.2	221.0	145.0
3	1318.1	497.6	357.5	212.9	140.0
4	1323.0	573.6	351.1	211.7	142.1

4.2.3 Bracing Members

Original and reduced capacities of the bracing members compared to a full, half, and one quarter tank load are summarized in the table below:

Table 3: HSS 76x76x4.8 Bracing Capacities and Loads

Member	Original Member Capacities		2mm Thickness Loss		Tank Full		Tank ½ Full		Tank ¼ Full	
	C_r (kN)	T_r (kN)	C_r (kN)	T_r (kN)	C_f (kN)	T_f (kN)	C_f (kN)	T_f (kN)	C_f (kN)	T_f (kN)
1	336.7	353.7	57.5	60.1	0.19	N/A	0.15	N/A	0.13	N/A
2	331.4	353.7	56.6	60.1	0.32	N/A	0.22	N/A	0.17	N/A
3	271.2	353.7	46.6	60.1	40.7	19.0	16.4	13.9	8.3	13.9
4	288.2	353.7	49.0	60.1	0.19	N/A	0.21	N/A	0.22	N/A
5	279.0	353.7	47.5	60.1	0.87	N/A	0.73	N/A	0.66	N/A
6	339.3	353.7	57.7	60.1	5.5	4.9	6.9	0.94	7.5	N/A
7	331.4	353.7	56.6	60.1	30.2	3.2	15.4	3.2	8.1	3.19

4.2.4 Deflection of Main Beams

Deflection from the fuel loading was also looked at for each for the main supporting members. A summary of the deflection for the full, half, and one quarter tank loads are compared to the allowable deflection for each member in the table below.

Table 4: Beam Deflection Checks

Member	Member Length (mm)	Deflection Allowable L/300 (L/180 for cantilever) (mm)	Deflection 2mm Section Loss - Tank Full (mm)	Deflection 2mm Section Loss - Tank ½ Full (mm)	Deflection 2mm Section Loss Tank ¼ Full (mm)
C150x12	1524	5.08	9.74	4.86	2.43
W150x22	1524	5.08	10.25	5.11	2.56
W200x27	3048	10.16	4.55	2.27	1.14
W360x33 (center Span)	3048	10.16	8.09	4.09	2.04
W360x33 (cantilever end)	1524	8.47	8.99	4.44	2.24
W360x45 (center Span)	3048	10.16	13.64	6.79	3.40
W360x45 (cantilever end)	1524	8.47	5.10	2.52	1.28

Notes:
1. Values in red have exceeded the allowable deflection.
2. Values in yellow are close to the allowable deflection.

4.2.5 Beam Stiffeners

In addition the member capacity checks, crippling of the web of the main support beams were also checked. From site observations it was noticed that the stiffeners are in very poor condition and severely deteriorated to the point where no value can be assumed. A summary of the web crippling checks under the full, half, and one quarter tank loads are summarized in the table below.

Table 5: Stiffener Capacities and loadings – W360x33 Beam

Location	Max Original Web Capacity (kN)	Max Reduced Web Capacity (kN)	Tank Full (kN)	Tank ½ Full (kN)	Tank ¼ Full (kN)	Tank Empty (kN)
1	302.3	29.1	183.20	102.20	61.70	38.50
2	302.3	29.1	271.70	151.10	90.65	42.5
3	302.3	29.1	183.20	102.20	61.70	38.50

Table 6: Stiffener Capacities and loadings – W360x45 Beam

Location	Max Original Web Capacity (kN)	Max Reduced Web Capacity (kN)	Tank Full (kN)	Tank ½ Full (kN)	Tank ¼ Full (kN)	Tank Empty (kN)
1	427.8	75.6	183.20	102.20	61.70	38.50
2	427.8	75.6	271.70	151.10	90.65	42.5
3	427.8	75.6	183.20	102.20	61.70	38.50

Notes:
1. Values in red have exceeded the allowable deflection.

As can be seen from the tables above, the main support beams would experience web crippling under a full, half, and one quarter tank loads. Additionally, in certain cases the beam would experience web crippling even if the tank was empty. This is due to the dead load of the tank and environmental loadings on the tank.

4.3 Recommendations

The tank support system in its existing state has undergone significant section loss which has resulted in members having capacities of less than half of the original values. Minimizing/delaying future losses is a requirement, therefore the following recommendations are to be implemented:

1. The support structure shall be sandblasted and repainted to delay future corrosion. Losses of another 1 mm on members would reduce some capacities to less than a quarter of their original values and the structure would be in danger of supporting the dead load of the tank and environmental loads without any fuel in the tank.

2. The stiffeners in the beams are to be replaced to support any fuel in the tank. The current support system is assumed to have no value from the stiffeners which cause issues to the current beams as they would experience web crippling. Under the current conditions, the beams are currently at or over their limits to support existing dead loads and environmental loads.
3. If the above two conditions are met, it is recommended that the tank can be filled to one third of the volume of the tank (30,000L) as indicated in the summary tables below.

Table 7: Loadings for 1/3 Full Tank – Beam Capacities

Member	Original Member Capacities		2mm Thickness Loss		⅓ Full Tank	
	M_r (kN*m)	V_r (kN)	M_r (kN*m)	V_r (kN)	M_f (kN*m)	V_f (kN)
C150x12	19.0	138.0	8.6	29.0	5.08	13.3
W152x22	42.9	155.1	16.4	46.9	15.4	23.2
W200x27	67.2	210.9	32.7	64.2	28.8	19.4
W360x33	127.7	339.4	59.1	104.1	41.1	49.6
W360x45	186.6	362.6	102.3	150.7	52.62	98.9

Table 8: Loadings for 1/3 Full Tank – Beam Capacities

Member	Member Length (mm)	Deflection Allowable L/300 (L/180 for cantilever) (mm)	Deflection 2mm Section Loss Tank ⅓ Full (mm)
C150x12	1524	5.08	3.24
W152x22	1524	5.08	3.42
W200x27	3048	10.16	1.52
W360x33(center Span)	3048	10.16	2.70
W360x33 (cantilever end)	1524	8.47	2.94
W360x45(center Span)	3048	10.16	4.55
W360x45 (cantilever end)	1524	8.47	1.71

Table 9: Stiffener Capacities and loadings

Location	Max Original Web Capacity (kN)		Max Reduced Web Capacity (kN)		⅓ Full Tank
	W360x33	W360x45	W360x33	W360x45	
1	302.3	427.8	29.1	75.6	74.9
2	302.3	427.8	29.1	75.6	111.0
3	302.3	427.8	29.1	75.6	74.9

Notes:
1. Values in red have exceeded the allowable deflection.
2. Values in yellow are close to the allowable deflection.

If it is decided to not complete repairs on the support structure, it would be difficult to predict how long the structure can safety support the empty tank. Over time, the corrosion throughout the members will continue to reduce in capacities further limiting the amount of fuel that can be placed in the tank.

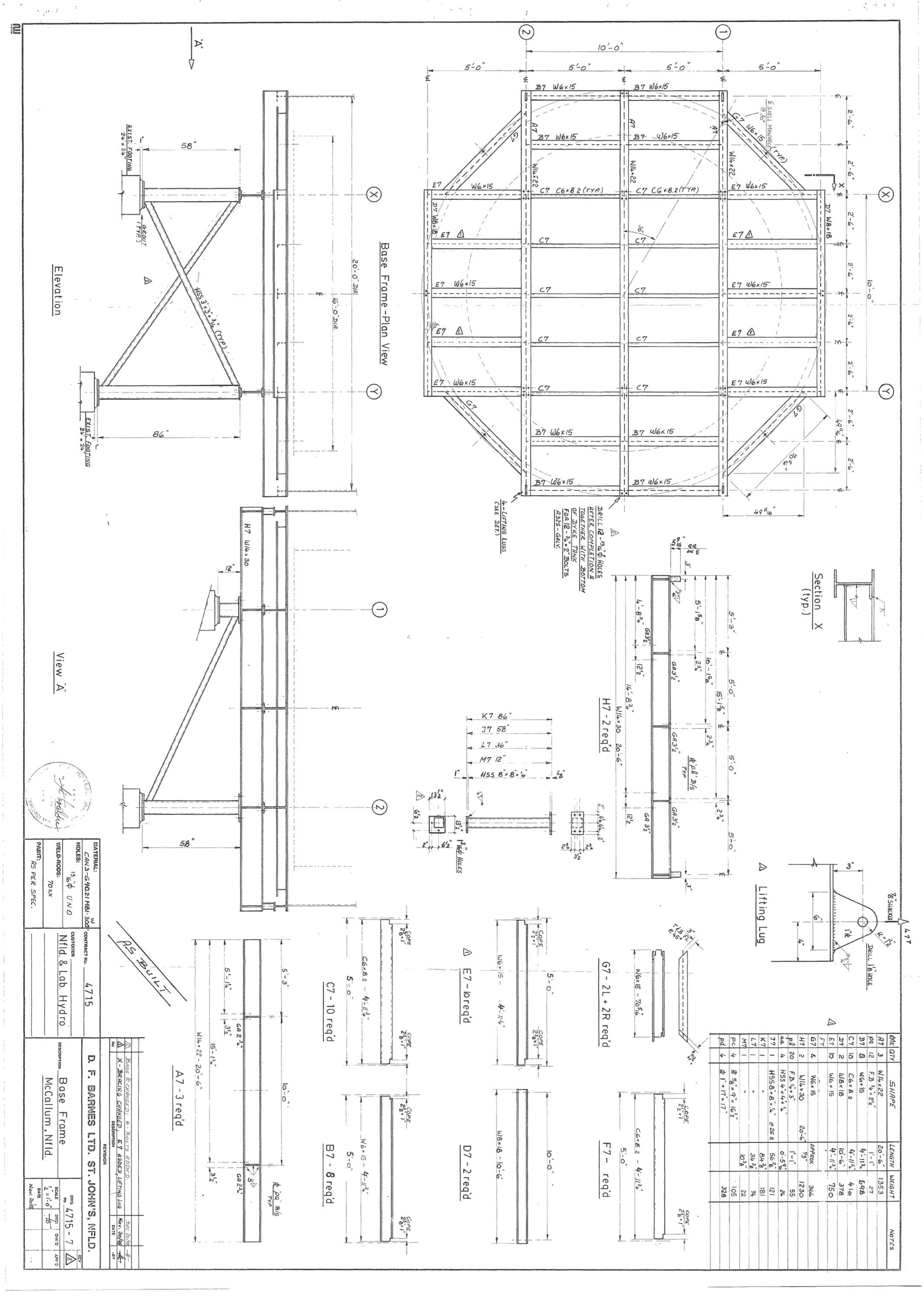
4.4 Tank Repairs to Accommodate ½ Fuel Load Capacity

An analysis was completed to determine the required repairs to the tank support structure that would allow for the tank to be filled to half of the tank capacity, 45,000 litres. Repair drawings are shown in **Appendix C**. The repairs include replacing all stiffeners located throughout the structure and installing new C150x12 channels to support the loads. Additionally, new W150x22 beams will be required to support the cantilevered beams along the north and south sides of the tank support.

It must be noted that the repairs outlined in the drawings in **Appendix C** provide a temporary solution to allow the existing tank support structure to provide adequate capacity to support 45,000 litres of fuel along with the accompanying dead and live loads. The repairs are assumed to extend the original life of the structure to a maximum of five years. It is recommended that a detailed investigation of the tank support structure be completed immediately following completion of sandblasting of the existing members. Should it be discovered that there is more section loss throughout the members than the 2 mm that was originally estimated, an additional analysis will take place to determine the immediate corrective actions to take place and the allowable load that the tank support structure can safely support. Should the section loss be no more than the 2 mm that was originally estimated, it is recommended that an investigation take place once every two years to verify the maximum capacity the tank support structure can safely support. Investigations will take place up to a maximum of five years upon which full replacement of the structure should be considered.

Appendix A

Existing Tank Drawings


Base Frame-Plan View
Elevation
View "A"
Section X (typ.)
Lifting Lug
H7 - 2req'd
A7 - 3 req'd
C7 - 10 req'd
E7 - 10req'd
G7 - 2L + 2R req'd
B7 - 8 req'd
D7 - 2 req'd
F7 - req'd
AS BUILT
Nfld & Lab. Hydro
4715
D. F. BARNES LTD. ST. JOHN'S, NFLD.
Base Frame
McCallum, Nfld.
4715 - 7

Appendix B

Photographs

Photo 1: View of existing tank located behind the wharf

Photo 2: View of main support beam

Photo 3: View along main support beam/corrosion through stiffener

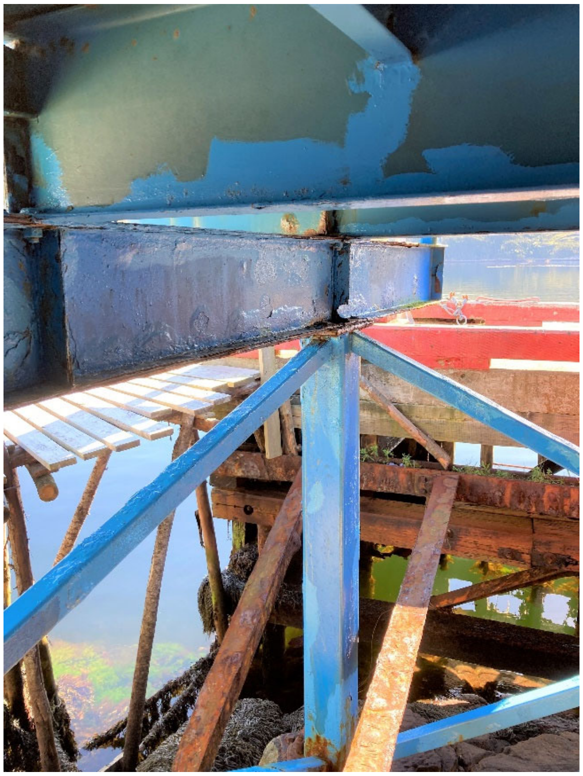


Photo 4: View at underside of tank – existing beams, column, and bracing members

Photo 5: Corrosion along flange of beam

Photo 6: Corrosion beams and connections

Photo 7: Corrosion at underside of beam

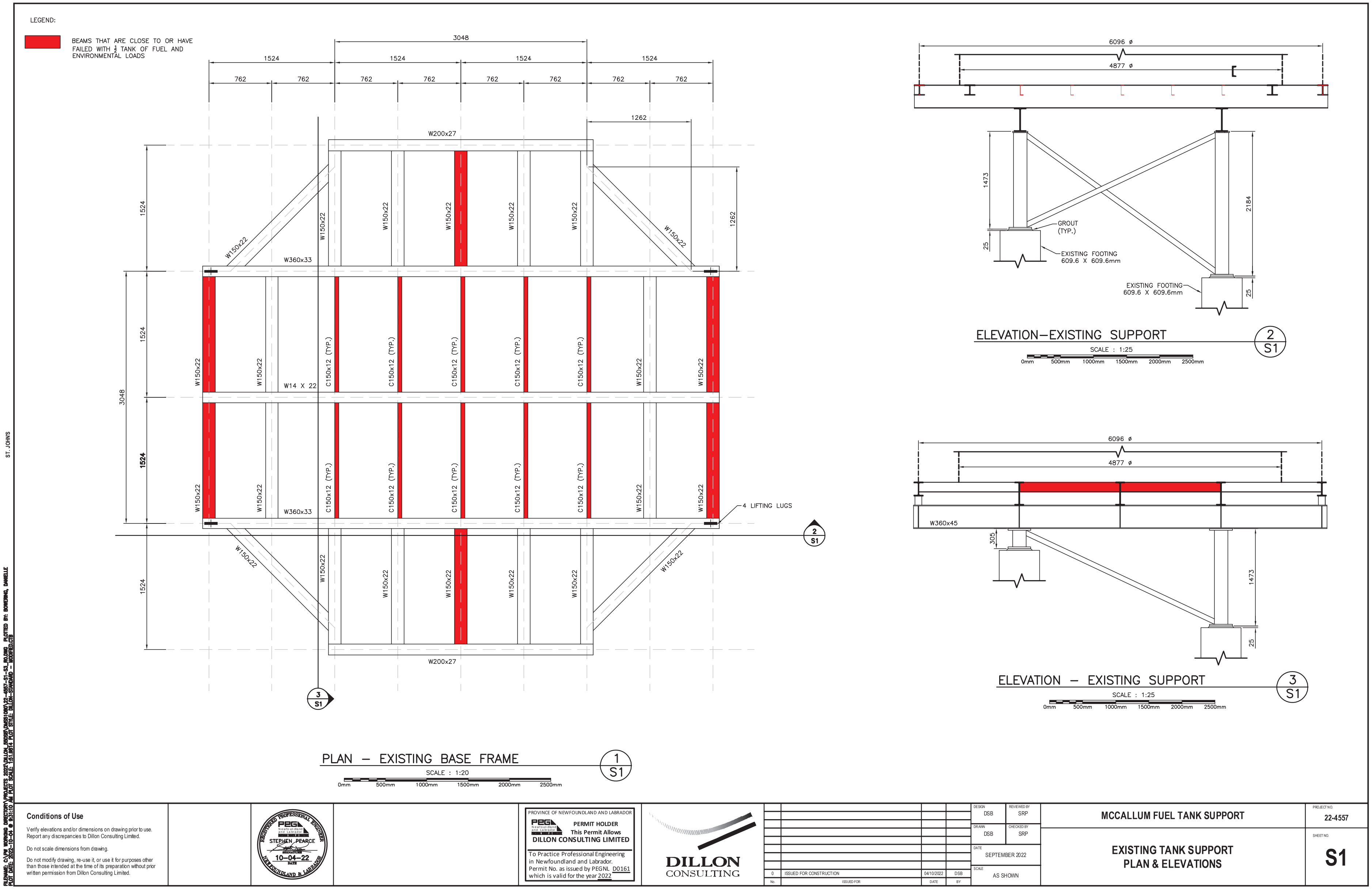
Photo 8: Loss in stiffener above column connection

Photo 9: Corrosion at beam/column connection

Photo 10: View of beams, columns, and bracing members for the support structure

Appendix C

Repair Drawings


LEGEND:
BEAMS THAT ARE CLOSE TO OR HAVE FAILED WITH ½ TANK OF FUEL AND ENVIRONMENTAL LOADS
3048
1524
762
1262
W200x27
W150x22
W360x33
W14 X 22
C150x12 (TYP.)
4 LIFTING LUGS
PLAN – EXISTING BASE FRAME
SCALE : 1:20
1
S1
6096 ø
4877 ø
1473
2184
25
GROUT (TYP.)
EXISTING FOOTING 609.6 X 609.6mm
ELEVATION–EXISTING SUPPORT
SCALE : 1:25
2
S1
W360x45
305
ELEVATION – EXISTING SUPPORT
3
S1
0mm 500mm 1000mm 1500mm 2000mm 2500mm
ST. JOHN'S
Conditions of Use
Verify elevations and/or dimensions on drawing prior to use. Report any discrepancies to Dillon Consulting Limited.
Do not scale dimensions from drawing.
Do not modify drawing, re-use it, or use it for purposes other than those intended at the time of its preparation without prior written permission from Dillon Consulting Limited.
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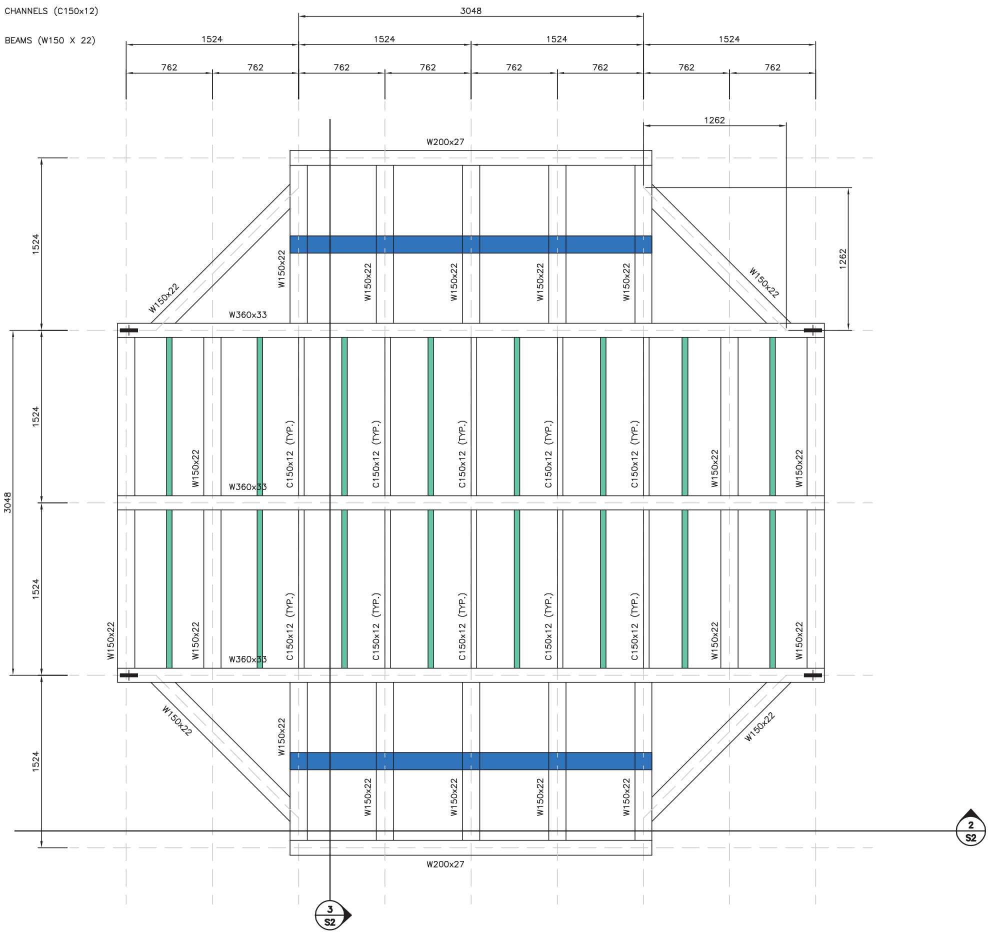
DILLON CONSULTING
0 ISSUED FOR CONSTRUCTION 04/10/2022 DSB
DESIGN DSB
REVIEWED BY SRP
DRAWN DSB
CHECKED BY SRP
DATE SEPTEMBER 2022
SCALE AS SHOWN
MCCALLUM FUEL TANK SUPPORT
EXISTING TANK SUPPORT
PLAN & ELEVATIONS
PROJECT NO. 22-4557
SHEET NO. S1

LEGEND:

- NEW CHANNELS (C150x12)
- NEW BEAMS (W150 X 22)



NOTES:
1. ALL CONNECTIONS SHALL BE SURFACE PREPARED TO BARE STEEL FOR WELDING PURPOSES, FIELD TOUCH UP ALL WELDING AS REQUIRED.

PLAN – BASE FRAME (1/S2)

SCALE : 1:20

0mm 500mm 1000mm 1500mm 2000mm 2500mm

GENERAL NOTES

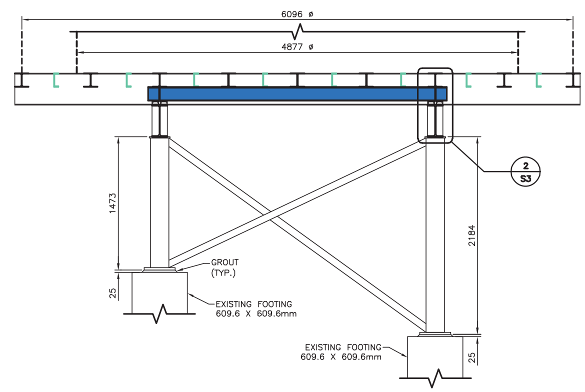
1. ALL WORK AND MATERIALS SHALL CONFORM TO THE REQUIREMENTS OF THE NATIONAL BUILDING CODE OF CANADA 2015.
2. ALL WORK TO BE CARRIED OUT IN ACCORDANCE WITH OCCUPATIONAL HEALTH AND SAFETY ACT OF NEWFOUNDLAND.
3. NO ALTERATIONS TO STRUCTURAL DETAILS SHALL BE MADE WITHOUT WRITTEN PERMISSION OF THE STRUCTURAL ENGINEER.
4. ALL DIMENSIONS SHOWN ARE APPROXIMATE ONLY. EXISTING CONDITIONS MAY VARY. CONTRACTOR SHALL VERIFY AND CHECK ALL DIMENSIONS ON DRAWINGS PRIOR TO COMMENCING WORK. NOTIFY THE ENGINEER IMMEDIATELY OF ANY DISCREPANCIES.
5. SAFEGUARD AND PROTECT ALL EXISTING STRUCTURES, SERVICES AND UTILITIES WHICH MAY BE AFFECTED BY THE WORK.
6. DRAWINGS ARE NOT TO BE SCALED.

STRUCTURAL STEEL NOTES

1. STEEL DESIGN, FABRICATION AND ERECTION SHALL CONFORM TO CAN–S16.1. LATEST EDITION.
2. ALL STRUCTURAL STEEL TO MEET CAN/CSA–G40.21 SPECIFICATIONS AS FOLLOWS:
   – PLATES – GRADE 300W
3. STEEL FABRICATOR SHALL BE CERTIFIED TO DIVISION 1 OR 2.1 MINIMUM, BY THE CANADIAN WELDING BUREAU.

WELD NOTES:

1. MINIMUM WELD SIZE = 5mm.
2. WELD TYPE = FILLET WELD (UNLESS NOTED OTHERWISE)
3. ALL WELDING TO MEET CSA W59. COMPANIES TO BE CERTIFIED UNDER W47.1.
4. WELDING ELECTRODES TO BE E49XX.



NOTES:
1. ALL CONNECTIONS SHALL BE SURFACE PREPARED TO BARE STEEL FOR WELDING PURPOSES, FIELD TOUCH UP ALL WELDING AS REQUIRED.

ELEVATION – TANK SUPPORT REPAIRS (2/S2)

SCALE : 1:25

0mm 500mm 1000mm 1500mm 2000mm 2500mm

Conditions of Use

Verify elevations and/or dimensions on drawing prior to use. Report any discrepancies to Dillon Consulting Limited.

Do not scale dimensions from drawing.

Do not modify drawing, re-use it, or use it for purposes other than those intended at the time of its preparation without prior written permission from Dillon Consulting Limited.

REGISTERED PROFESSIONAL ENGINEER – PEGNL – STEPHEN PEARCE – 10–04–22 – NEWFOUNDLAND & LABRADOR

PROVINCE OF NEWFOUNDLAND AND LABRADOR
PERMIT HOLDER
This Permit Allows
DILLON CONSULTING LIMITED
To Practice Professional Engineering in Newfoundland and Labrador.
Permit No. as issued by PEGNL D0161 which is valid for the year 2022

DILLON CONSULTING

No.	ISSUED FOR	DATE	BY
0	ISSUED FOR CONSTRUCTION	04/10/2022	DSB

DESIGN	REVIEWED BY
DSB	SRP
DRAWN: DSB	CHECKED BY: SRP
DATE: SEPTEMBER 2022	
SCALE: AS SHOWN	

MCCALLUM TANK SUPPORT

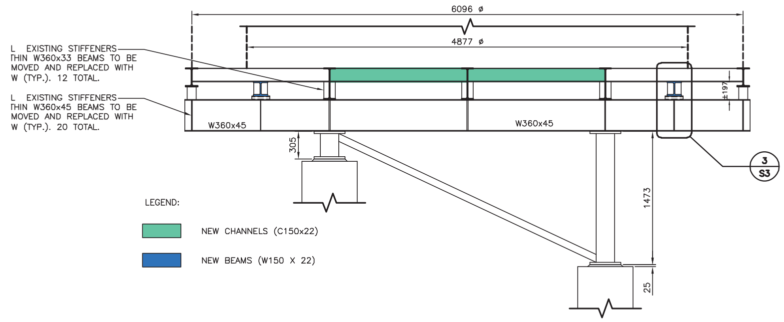
TANK SUPPORT REPAIRS
PLAN AND ELEVATION

PROJECT NO. 22-4557

SHEET NO. S2

ST. JOHN'S

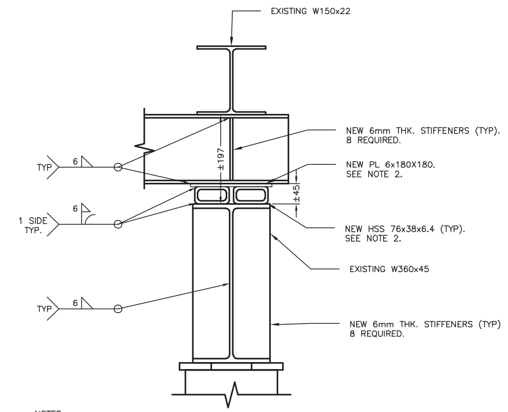
FILENAME: C:\PW WORKING DIRECTORY\PROJECTS 2022\DILLON_B5DSB\DMS51080\22-4557-S1-S3_R0.DWG PLOTTED BY: BOWERING, DANIELLE
PLOT DATE: 2022-10-04 @ 9:31:32 AM PLOT SCALE: 1:51.9814 PLOT STYLE: DILLON-STANDARD – MODIFIED.CTB



NOTES:
1. ALL CONNECTIONS SHALL BE SURFACE PREPARED TO BARE STEEL FOR WELDING PURPOSES, FIELD TOUCH UP ALL WELDING AS REQUIRED.

ELEVATION – TANK SUPPORT REPAIRS (1/S3)

SCALE : 1:25



NOTES:
1. ALL CONNECTIONS SHALL BE SURFACE PREPARED TO BARE STEEL FOR WELDING PURPOSES, FIELD TOUCH UP ALL WELDING AS REQUIRED.
2. OPTIONAL SUPPORT FOR NEW BEAM. CONTRACTOR MAY PROPOSE ALTERNATE DETAIL TO MAKE UP ±45mm GAP. MINIMUM BEARING AREA = 160mm x 200mm.

DETAIL – W150x22 BEAM CONNECTION (2/S3)

SCALE : 1:5

GENERAL NOTES

1. ALL WORK AND MATERIALS SHALL CONFORM TO THE REQUIREMENTS OF THE NATIONAL BUILDING CODE OF CANADA 2015.
2. ALL WORK TO BE CARRIED OUT IN ACCORDANCE WITH OCCUPATIONAL HEALTH AND SAFETY ACT OF NEWFOUNDLAND.
3. NO ALTERATIONS TO STRUCTURAL DETAILS SHALL BE MADE WITHOUT WRITTEN PERMISSION OF THE STRUCTURAL ENGINEER.
4. ALL DIMENSIONS SHOWN ARE APPROXIMATE ONLY. EXISTING CONDITIONS MAY VARY. CONTRACTOR SHALL VERIFY AND CHECK ALL DIMENSIONS ON DRAWINGS PRIOR TO COMMENCING WORK. NOTIFY THE ENGINEER IMMEDIATELY OF ANY DISCREPANCIES.
5. SAFEGUARD AND PROTECT ALL EXISTING STRUCTURES, SERVICES AND UTILITIES WHICH MAY BE AFFECTED BY THE WORK.
6. DRAWINGS ARE NOT TO BE SCALED.

STRUCTURAL STEEL NOTES

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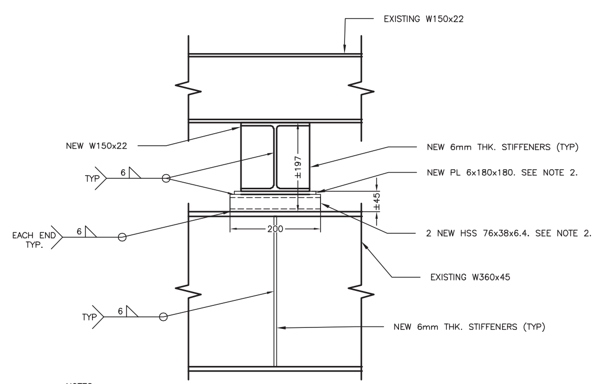
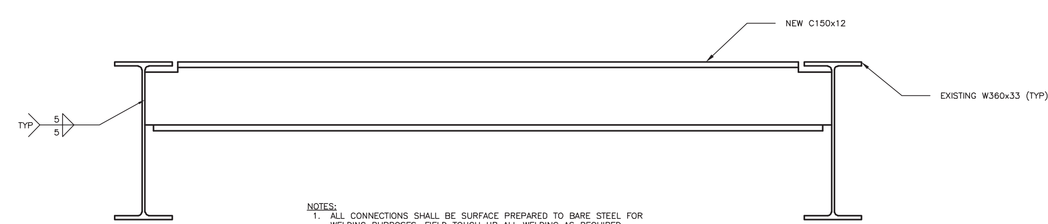


NOTES:
1. ALL CONNECTIONS SHALL BE SURFACE PREPARED TO BARE STEEL FOR WELDING PURPOSES, FIELD TOUCH UP ALL WELDING AS REQUIRED.
2. OPTIONAL SUPPORT FOR NEW BEAM. CONTRACTOR MAY PROPOSE ALTERNATE DETAIL TO MAKE UP ±45mm GAP. MINIMUM BEARING AREA = 160mm x 200mm.

DETAIL – W150x22 BEAM CONNECTION (3/S3)

SCALE : 1:5



NOTES:
1. ALL CONNECTIONS SHALL BE SURFACE PREPARED TO BARE STEEL FOR WELDING PURPOSES, FIELD TOUCH UP ALL WELDING AS REQUIRED.

DETAIL – C150x12 CHANNEL CONNECTION (4/S3)

SCALE : 1:5

ST. JOHN'S

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STEPHEN PEARCE — 10-04-22

PROVINCE OF NEWFOUNDLAND AND LABRADOR
PEGNL PERMIT HOLDER
This Permit Allows
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Permit No. as issued by PEGNL D0161 which is valid for the year 2022

DILLON CONSULTING

No.	ISSUED FOR	DATE	BY
0	ISSUED FOR CONSTRUCTION	04/10/2022	DSB

DESIGN: DSB | REVIEWED BY: SRP
DRAWN: DSB | CHECKED BY: SRP
DATE: SEPTEMBER 2022
SCALE: AS SHOWN

MCCALLUM TANK SUPPORT

TANK SUPPORT REPAIRS
ELEVATION AND DETAILS

PROJECT NO. 22-4557
SHEET NO. S3

Attachment 2

Condition Inspection, Provincial Ferry Wharf, McCallum, NL

AFN Engineering Inc.

ENGINEERING INC.

CONDITION REPORT

Title: CONDITION INSPECTION, PROVINCIAL FERRY WHARF, MCCALLUM, NL			*Corporate Stamp:* PROVINCE OF NEWFOUNDLAND PERMIT HOLDER This Permit Allows AFN ENGINEERING INC. To practice Professional Engineering in Newfoundland and Labrador. Permit No. as issued by APEGNL F0292 which is valid for the year 2022
Client: NEWFOUNDLAND AND LABRADOR HYDRO			
Facility: PROVINCIAL FERRY WHARF, MCCALLUM, NL			*Professional Stamp:* REGISTERED PROFESSIONAL ENGINEER NEIL C. HUNT SIGNATURE 30/07/22 DATE NEWFOUNDLAND & LABRADOR
Client Project Reference: PO6274	*Client Document Reference.:* N/A	*Client Revision:* N/A	
AFN Project Reference: 6-327	*AFN Document No.:* 6-327.002	*Revision:* D0	

AFN ENGINEERING INC.
29 Brad Gushue Crescent
St. John's, NL, A1H 0A3
709-748-7175 (p), 709-368-6377 (f)
nhunt@afnengineering.ca

REVISION HISTORY							
N/A	D0	30-Jul-22	Issued for Use	N. Hunt	P. Hunt	N. Hunt	NH
N/A	A0	10-Jul-22	Issued for Client Review	N. Hunt	P. Hunt	N. Hunt	
Client Revision	*AFN Revision*	*Date*	*Reason for Issue*	*Originator*	*Checked by*	*Approved by*	*Initial*

TABLE OF CONTENTS

Revision Log

Revision.	Description of Changes
D0	Issued for Use
A0	Initial Revision

ABBREVIATIONS

Abbreviation.	Description
Hydro	Newfoundland and Labrador Hydro
AFN	AFN Engineering Inc.
MDI	MDI Contracting
Dillon	Dillon Consulting Limited
DFO	Department of Fisheries and Oceans Canada
LNT	Low Normal Tide
SWLL	Safe Working Load Limit
UT	Ultrasonic thickness

1.0 INTRODUCTION

AFN Engineering Inc. (AFN) was contracted by Newfoundland and Labrador Hydro (Hydro) to conduct a condition inspection of the Provincial ferry wharf located in McCallum, NL. The Provincial ferry wharf fronts the diesel generating station owned and operated by Hydro.

The underwater investigation was carried out by MDI Contracting (MDI) on June 27, 2022. The subsequent inspection above low normal tide (LNT) was carried out by AFN personnel on July 4, 2022.

A general view of the site is included as Figure 1.

Figure 1: General site view

1.1 BACKGROUND

In January 2022, Hydro was notified that the Provincial wharf was in need of repairs, and would no longer be used for docking. Docking services were subsequently moved to the adjacent Department of Fisheries and Oceans Canada (DFO) wharf for all offloading of passengers and freight. On May 4, 2022 signs were erected on the Provincial ferry wharf by the provincial government, informing the public to "Use at Own Risk".

Due to the location of Hydro's generating station, it is not possible to enter the plant by foot or transfer materials to the building without crossing the Provincial wharf. Without the access to the Provincial wharf, Hydro would be prevented from performing the following tasks:

- Critical planned and corrective maintenance activities including offloading engines, generators or full gensets on the wharf using the ferry crane.
- Refilling of the plants fuel tank. Hydro can no longer offload 1000L fuel totes (approximately 2200lbs per tote) onto the wharf for fuel delivery using the ferry crane. Typically, 7-10 totes are offloaded to the wharf in a single delivery. Tote dimensions are approximately 1m x 1m x 1m.
- Condition assessment of the tank. The next internal tank inspection is due to be performed in 2025. Tank inspection requires a temporary 9000L fuel tank (empty) to be placed on the wharf until it is rolled off and placed next to the existing fuel tank. The empty tank weight is unknown.
- Helicopter delivery of material due to safety/environmental risk. Previously, Hydro would lower material on the wharf, safely away from the fuel tank.

1.2 SCOPE

The scope of work defined in Hydro's Terms of Reference for this project included:

- Review of historical documentation. A copy of the latest Government of Newfoundland and Labrador wharf inspection report was provided to AFN and will be referenced in this report.
- Completion of an on-site inspection of the provincial wharf including an above water visual inspection and an underwater diving inspection.
- Completion of a condition assessment report detailing the following (sealed by a Professional Engineer registered in the Province of NL):

  - Inspection findings and overall condition of the wharf.

- Recommendations for required upgrades and repairs to the existing wharf to meet provincial ferry docking requirements.

- Establish safe working load limit (SWLL) for the wharf in its current capacity.

- Recommendations for required upgrades and repairs for traversing wharf, complete with cost estimates.

- Recommendations to increase the SWLL of the wharf, complete with cost estimates.

2.0 EXISTING CONDITIONS

The ferry wharf was built in 1977 under federal infrastructure funds administered by the Department of Public Works Canada (now Public Services and Procurement Canada). The original construction consisted of 200mm diameter pipe piles (concrete filled) with a total of 18 pipe piles forming the support foundation. All piles are bearing piles. There are no batter piles.

Piles are laid out in three (3) rows, labelled as Row “A”, “B” and “C” in this report. Row “A” is along the outside berthing face and Row “C” is along the back of the wharf. Row spacing is 3.05m. There are: (i) seven (7) piles along Row “A”; (ii) seven (7) piles along Row “B; and (iii) four (4) piles along Row “C”. Pile bent spacing is 4.5m. For reference, Bent 1 is located on the east end of the wharf. The elevated hydro tank sits behind Row “B” on the east end of the wharf (not on the wharf itself). The total length of the wharf along the outside berthing face is 26.6m. The total width of the wharf on the west end is 6.1m.

Reference Pile rows/bents are shown in Figure 2.

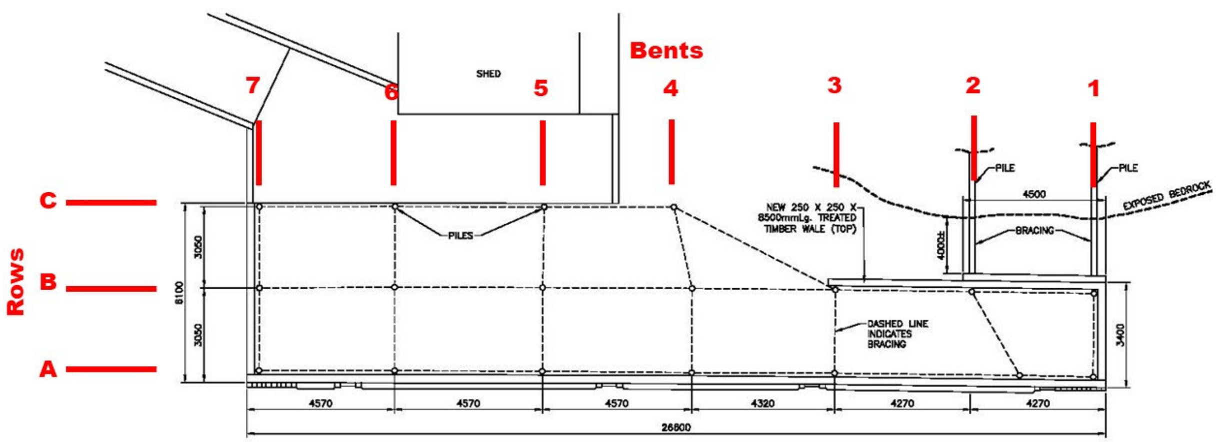


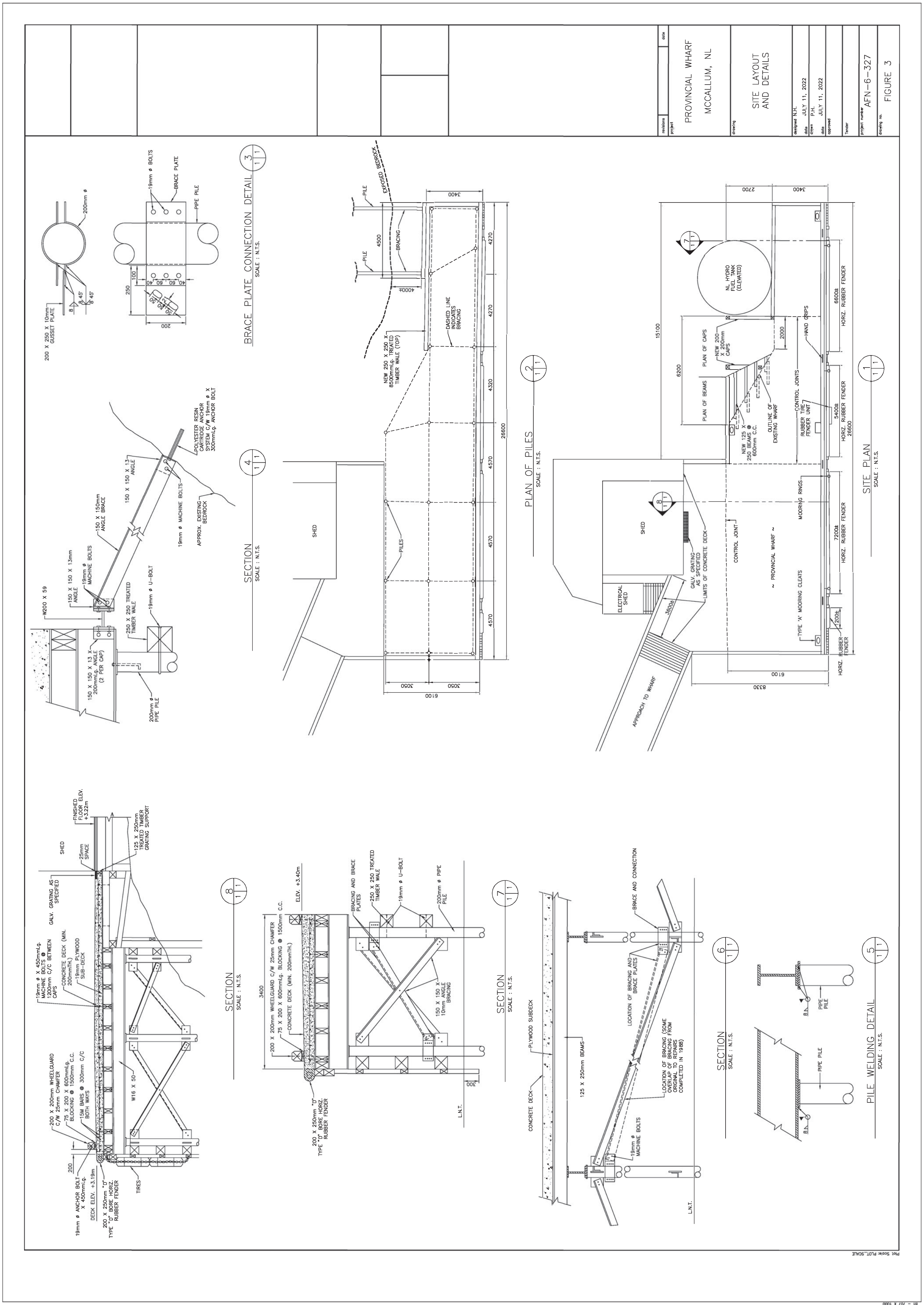
Figure 2: Pile Rows/Bents

Pile caps consists of W16 X 50 wide flange beams. The original deck consisted of 125mm X 250mm timber beams at 600mm spacing atop the wide flange beams, with a 75mm thick plank deck. In 1988, the timber plank deck was removed and a 200mm thick reinforced concrete deck, with plywood subdeck, was placed over the timber deck beams. Reinforcing details of the concrete deck consist of 15M bars at 300mm spacing each way. Transverse and longitudinal bracing consists of 150mm X 150mm X 9.6mm L-bracing. The bracing is attached to a 250mm X 200mm X 25mm brace plate which is welded to the pile. Behind piles 1B and 2B, there is angled tie-back bracing (150mm X 150mm X 10mm) which is welded to the pile cap and extends down to the bedrock. The bracing is attached to the bedrock with drilled resin cartridge anchors.

The deck elevation of the wharf is approximately 3.2m with respect to LNT. As-built information suggests that all piles are advanced 5m into the harbour bottom, although the presence of bedrock outcrops may have reduced this penetration depth, particularly along Row "C". Ancillary components consist of:

- Treated timber wheeguard (200mm X 200mm).
- Type A mooring cleats on dedicated concrete cleat blocks.
- Fendering consisting of treated timber wales (250mm X 250mm), untreated fenders/chocks a top rubber D-bore horizontal fender, hung tire fenders and corner blasting mats. Untreated fenders are 100mm X 150mm and there are four (4) rows of chocks. Ladders consist of untreated timber uprights with steel rungs.
- The approach/walkway infrastructure on the west side consists of timber crib/span and timber post construction, complete with a timber deck.

Detail drawings of the original construction features, including the existing site plan and pile layout, is indicated in Figure 3.


PROVINCIAL WHARF
MCCALLUM, NL
SITE LAYOUT AND DETAILS
JULY 11, 2022
AFN-6-327
FIGURE 3
SITE PLAN
SCALE : N.T.S.
PLAN OF PILES
SCALE : N.T.S.
BRACE PLATE CONNECTION DETAIL
SCALE : N.T.S.
SECTION
SCALE : N.T.S.
PILE WELDING DETAIL
SCALE : N.T.S.
NL HYDRO FUEL TANK (ELEVATED)
SHED
ELECTRICAL SHED
APPROACH TO WHARF
~ PROVINCIAL WHARF ~
HORIZ. RUBBER FENDER
MOORING RINGS
CONTROL JOINT
EXPOSED BEDROCK
PILES
BRACING
PIPE PILE
CONCRETE DECK
PLYWOOD SUBDECK
125 X 250mm BEAMS
TIRES
L.N.T.

3.0 INSPECTION FINDINGS

3.1 GENERAL COMMENTS

Comments related to the current condition of the wharf are noted below:

- The concrete deck surface was noted to be in fair condition, although several transverse cracks were noted across the full width of the wharf. There was no significant areas of spalling or deck deterioration noted.

- The Type A cleats were noted to be in fair condition, although paint was flaking/peeling from the surface of the cleat and typical corrosion of the cleat was evident. The concrete cleat base itself was noted to be in fair condition with no significant concrete crumbling noted.

- Three (3) of the four (4) ladders were in a state of disrepair (deteriorated uprights/missing rungs and are considered unsafe in their current state. One (1) ladder was in fair condition visually but rotting of the upright is likely, given the condition of the other ladders.

- The wooden fendering system components (chocks, vertical fenders) is in poor condition with rotted/cracked/missing timbers noted throughout. The overall timber components of the fendering system is considered to be in a state of disrepair.

- The corner blasting mats are in fair condition and remain serviceable. However, the blasting mat on the east end has a fair amount of rubber tire pieces missing and is hanging low.

- The three (3) rubber tire fenders present, and associated chains/hardware were in fair condition and remain serviceable. However, historically there have been as many as eight (8) rubber tire fenders on the south berthing face, so it is assumed five (5) are now lying on the harbour bottom.

- The top rubber horizontal fender was missing and/or damaged throughout.

- The wheelguard remains serviceable/functional but rotting/splitting of timbers was noted throughout so it has likely reached the end of its useful life. The top handgrips attached to the wheelguard at ladder locations was bent/damaged at each ladder location.

- The wales along the outside berthing face, which support the fendering system appeared in poor to fair condition. Visually, there were no significant cracks in the timber, but rotting/softening of these timbers is expected.

- Visually, the steel pipe piles were in fair condition. Refer to Section 3.2 with respect to UT measurements and corrosion rates of the steel.

- The angled transverse and longitudinal bracing was in an overall state of disrepair. In practically all locations, the angle braces were severely corroded and let go from the pile itself.
- The steel pile caps were in poor condition, with heavy corrosion at beam ends.
- The timber beams atop the steel caps were in poor condition, with cracking of timber noted.
- The angled bracing behind bents 1B and 2B which is connected to the bedrock was in poor condition, with significant corrosion noted.
- The timber decking, crib support timbers and timber piling along the approach walkway was in fair condition and remains serviceable as a pedestrian walkway.
- Debris was observed on the harbour bottom along the south berthing face, including timbers, metal and fendering.

3.2 ULTRASONIC THICKNESS MEASUREMENTS

A visual survey was conducted at each pile location and a series of ultrasonic thickness (UT) measurements were taken by divers from MDI. The UT measurements were taken at three different elevations on every pile. Each elevation was then divided into quadrants. Quadrants were located on the pile being Q1 (12 o'clock) the front face of the wharf, then following around in a clockwise fashion until getting to Q4 (9 o'clock) ending facing North. All measurements are included in MDI's report attached as Appendix C and summarized below. Note that for comparison purposes, data from a May 2019 inspection by Harbourside Engineering Consultants (Project No. 181197, prepared on behalf of the Provincial Transportation and Works), is also included in Table 1 for comparison purposes.

Table 1: UT Measurements

MDI (June 2022)						Harbourside (May 2019)
Location	**UT at top of pile (mm)**	**UT at mid-point of pile (mm)**	**UT at bottom of pile (mm)**	**UT - average (mm)**	**% reduction from original thickness (assumed original thickness of 12.7mm)**	**% reduction from original thickness (assumed original thickness of 12.7mm)**
Pile 1A	12.20	9.60	7.40	10.13	20.21 %	16.7
Pile 1B	11.80	11.65	7.80	10.42	17.98 %	16.3
Pile 2A	11.55	11.13	7.38	10.02	21.13 %	24.2
Pile 2B	n/a	10.90	7.80	9.35	26.38 %	15.5
Pile 3A	8.65	8.53	7.45	8.21	35.37 %	30.7
Pile 3B	11.38	11.48	7.83	10.23	19.49 %	14.8
Pile 3C	n/a	n/a	n/a	n/a	n/a	n/a
Pile 4A	9.58	8.20	7.48	8.42	33.73 %	14.8
Pile 4B	n/a	11.13	8.33	9.73	23.43 %	26.8
Pile 4C	11.33	11.18	10.95	11.15	12.2 %	19.3
Pile 5A	9.83	7.68	7.53	8.34	34.32 %	15.0
Pile 5B	11.70	11.13	7.30	10.04	20.93 %	16.5
Pile 5C	n/a	11.90	11.68	11.79	7.19 %	1.5
Pile 6A	11.23	9.58	6.88	9.23	27.36 %	23.7
Pile 6B	n/a	11.80	6.80	9.30	26.77 %	21.5
Pile 6C	n/a	12.25	11.93	12.09	4.82 %	17.0
Pile 7A	11.05	10.05	7.75	9.62	24.28 %	18.0
Pile 7B	n/a	n/a	n/a	n/a	n/a	20.5
Pile 7C	n/a	12.13	11.98	12.05	5.12 %	8.3

As noted in Table 1, corrosion rates at each pile location varied from 5.12% (at pile 7C), to 35.37% (at pile 3A). The measurements are comparable to those obtained in the previous Harbourside report, with only a few anomalies (as identified "in red" in Table 1). Anomalies in UT field testing can be expected due to the nature of the non-destructive field testing.

The highest rate of corrosion was noted at pile 3A where a 35.37% average reduction in the steel was noted in comparison to the assumed original design thickness of 12.7mm. This represents an average corrosion rate of 0.1mm per year. If corrosion rates continued at that rate, the average thickness of the steel would be reduced to 50% in approximately 18 years.

It is noted that the worst reading was taken at the bottom of pile 6B which showed a remaining steel thickness of 6.80mm. At this location, the corrosion rate is 0.13mm/year and the estimated timeframe for the steel to be reduced to 50% is less than 4 years.

While there were no documented areas of exposed concrete for the pilings, observations were somewhat limited due to the presence of marine growth. It is expected that pinholes could be present near the harbour bottom, where corrosion rates are the highest.

It is noted that no UT measurements were taken on the pile caps, however corrosion rates of the pile caps are expected to be similar to those rates documented at the top of the piling. The worst case being 32% at the top of pile 3A. No holes were noted in the web of the pile caps, but significant corrosion was noted on the pile cap ends.

4.0 CAPACITIES

The capacity calculations for each structural member was completed by Dillon Consulting Limited (Dillon) under subconsultant agreement with AFN. A summary of the calculations are provided in Appendix B and are summarized below for two cases; i.e. (i) load case with no transverse/longitudinal bracing between piles; and (ii) load case with bracing added between piles.

Current Capacities (no bracing)

- Current deck live load remaining capacities between bents 4-7 are calculated as 3.5 kPa. Slightly higher remaining capacities were calculated between bents 1-2 and bents 3-4, with a significantly lower deck live load remaining capacity calculated between bents 2 to 3, where the span along the outside edge of Row A was approximately 5.69m.

- The W16 x 50 transverse beam remaining capacities (in their current state without bracing) would be able to accommodate a uniform deck live significantly higher than the above noted deck capacities.

- Pile capacities were calculated assuming no bracing (given the fact that the bracing is in a state of disrepair for the entire structure). The capacities were calculated based on the capacity of the steel itself, with no allowance for the piles being filled with concrete. Remaining deck live load capacities were calculated to range from 0 kPa up to a maximum of 4.08 kPa. Based on these findings, the piles in the current state are the critical members limiting the allowable live loads permitted on the deck in specified areas.

Capacities (bracing added)

- The addition of bracing increases the capacity of the piles allowing them to be capable of sustaining higher deck live loads. The addition of bracing does not add to the capacity of the transverse beams or deck, therefore with the addition of bracing the deck now becomes the critical member limiting the allowable live load to be placed on this wharf structure. Adding bracing provides a pin connection for the piles above LNT and reduces the unsupported length of the piles.

5.0 CONCLUSIONS AND COST ESTIMATES

The Provincial wharf is considered to be in poor condition overall and docking/berthing of the Provincial ferry at this site is not recommended. In the absence of repairs to the pile bracing, no safe working load shall be applied to the site between Bents 1 to 4 and in this regard, the site should be restricted from additional vertical live (or moving/movable) loads. However, the exception to this would be pedestrian traffic, which would be permitted over bents 4-7 only (which allows for personnel to make their way over the wharf and through the gate to access the plant).

Calculations provided in this report are considered conservative in nature and are based on the capacity of the steel pile itself with no allowance for the pile being concrete filled. While pedestrian use is considered appropriate in the wharf's current condition between bents 1 to 4, movement should be restricted to at least 3m from the waters edge given the fact that the ladders on the wharf are not safe for use.

Should upgrades to the facility be considered, the minimum requirement would be: (i) replacement of the transverse and longitudinal bracing throughout; and (ii) an additional pile/cap between Bents 2-3 along Row A to reduce the span along this outer edge. Tote loads are in the 10-12 kPa range, therefore not recommended to be placed anywhere on the deck. Placing the totes after the noted refurbishments are completed, should be restricted to above a pile location to allow transfer of loads to the underlying piles. In addition, pumping from the totes would be recommended in lieu of the use of forklifts at the site.

Recommendations are provided below for two (2) options: (i) upgrades to meet provincial ferry docking requirements; and (ii) upgrades for allowing additional vertical load to the wharf (without allowing docking).

<u>Upgrades to meet provincial ferry docking requirements</u>

- Replace all the transverse and longitudinal steel bracing.
- Replace the complete fendering system. This includes wales, the top rubber fender, vertical hardwood fenders and chocks. The existing corner blasting mats remain serviceable and can be re-used. Three of the existing hung rubber tire fenders can be re-used, but an additional five (5) are required for full coverage along the berthing face.
- Replace the ladders, perimeter wheelguard, wheelguard blocking and top handgrips at ladder locations.
- Seal cracks in the concrete deck, re-paint cleats and seal cleat anchor bolt holes.
- With respect to the steel piles, corrosion rates are expected to continue particularly at the harbour bottom where corrosion rates are the highest at this site. In this regard, upgrades to the facility may only be a short term solution (less than 5 years) after which a full replacement

of the facility pile foundation may be required. As a minimum to increase the structures ability to resist docking and berthing loads for the ferry, additional batter piles or socketed piles should be provided at each bent (or alternative tie-back strong arms could be provided behind the back row of piles).

Table 2 indicates the estimated constriction costs associated with upgrading the facility to meet provincial ferry docking requirements.

Table 2: Cost Estimate – Facility Upgrades to Meet Provincial Ferry Docking Requirements

Item	**Description**	**Estimated Construction Cost**
Piles and Pile Caps	Monitor corrosion rates. Consider full replacement of pilings and pile caps once reduction of steel components has reached 50% of its original thickness (which may be in less than 5 years).	Not applicable unless a long term replacement option is considered. Cost estimates provided in this table are based on short term solutions only (less than 5 years). See Note 1.
Batter piles or socketed piles	Add batter piles, socketed piles or tie-back strong arms to each bent, to provide lateral resistance to berthing and docking loads.	$500,000
Bracing	Replace all longitudinal and transverse bracing.	$195,000
Fendering	Replace the entire fendering system (wales, chocks, vertical hardwood fenders, top rubber horizontal fender, grader tires).	$150,000
Ladders	Replace all ladders.	$15,000
Wheelguard	Replace wheelguard, wheelguard blocking and top ladder handgrips.	$10,000
Cleats	Repaint cleats and seal anchor bolt holes.	$5,000
Deck	Seal cracks in deck.	$5,000
Harbour debris	Retrieve all harbour debris, particularly along the south berthing face, using divers.	$20,000

	Subtotal:	**$900,000**
	Contingency (15%):	**$135,000**
	Engineering (10%):	**$103,500**
	TOTAL:	**$1,138,500**

Note 1: A full facility reconstruction is expected to cost in the range of $2.5M-$3.0M

Upgrades for allowing additional vertical load on the wharf

- Replace all the transverse and longitudinal steel bracing.
- Replace the ladders, perimeter wheelguard, wheelguard blocking and top handgrips at ladder locations.
- Add an additional pile/cap between Bents 2-3 along Row A to reduce the span along this outer edge.

Table 3: Cost Estimate – Facility Upgrades for Additional Vertical Loading to the Wharf

Item	**Description**	**Estimated Construction Cost**
Piles and Pile Caps	Monitor corrosion rates. Consider full replacement of pilings and pile caps once reduction of steel components has reached 50% of its original thickness (which may be in less than 5 years).	Not applicable unless a long term replacement option is considered. Cost estimates provided in this table are based on short term solutions only (less than 5 years).
Bracing	Replace all longitudinal and transverse bracing.	$195,000
New pile/cap on Bent 2-3 (Row A)	Reduce the span along the outer edge between Bents 2-3 on Row A by adding an additional pile/cap.	$140,000
Ladders	Replace all ladders.	$15,000
	Subtotal:	**$350,000**
	Contingency (15%):	**$52,500**
	Engineering (10%):	**$40,250**
	TOTAL:	**$442,750**

6.0 CLOSURE

This report has been prepared for the sole benefit of Hydro. The report may not be relied upon by any other person or entity without the express written consent of Hydro, AFN and Dillon. Any use which a third party makes of this report, or any reliance on decisions made based on it, are the responsibility of such third parties. The report was not intended to be a detailed structural report and no intrusive work was completed.

APPENDIX A

PICTURES

General view showing berthing face

General view showing approach walkway

General view showing west end of wharf

General view showing east end of wharf

Elevated tank on east end behind Row “B” of wharf

Tie-back angled bracing behind piles 1B and 2B

Piles, bracing and pile cap (typical)

Piles, bracing and pile cap (typical)

Pile cap (typical)

Typical underside showing timber deck beams

Typical underside

Typical underside

Poor condition of bracing

Caps with timber blocking on either side of web

Horizontal rubber fender, chocks and chains for rubber tire fenders

Poor condition of ladder, chocks and top rubber fender

Corner blasting mat and poor condition of ladder

Typical cleat

Concrete deck surface

Transverse deck crack

Concrete deck surface

Concrete deck surface

Concrete edge showing aggregate

Western walkway approach

Wheelguard and top ladder handgrips on wheelguard

APPENDIX B

STRUCTURAL ANALYSIS

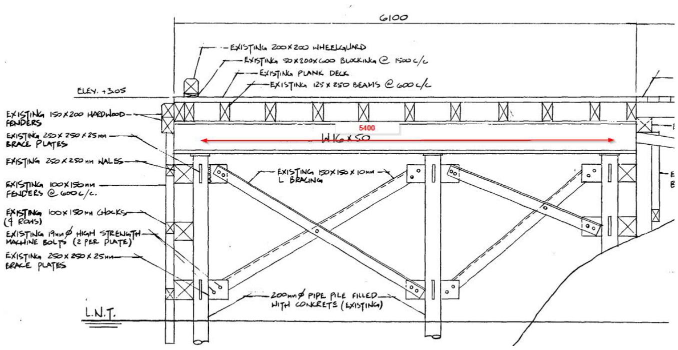
DILLON CONSULTING

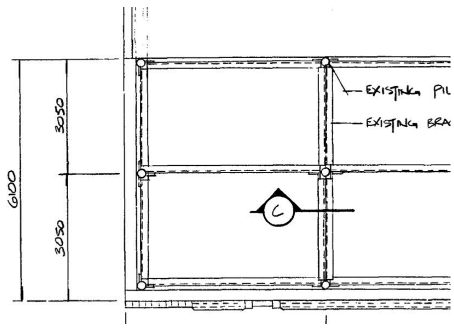
Project: McCallum - Report Check | **Project No.:** TBD |
Item: Structural Calculations | **Notes by:** DSB | **Date:** 15-July-2022
Subject: | **Check by:** | **Date:**

Background Info:

$d_{piles} := 200\ mm$ — Diameter of existing piles.

$t_{pile} := 12.7\ mm$ — Assumed pipe thickness.





**Assumed that piles are at equal spacing.

Pile Properties:

$d_{piles} = 200\ mm$ | $I_{pile} := 40.3 \cdot 10^6\ mm^4$ | $r_{pile} := 73.5\ mm$

$t_{pile} := 12.7\ mm$ | $S_{pile} := 368 \cdot 10^3\ mm^3$ | $F_y := 300\ MPa$ (Assumed)

$A_{pile} := 7460\ mm^2$ | $Z_{pile} := 493 \cdot 10^3\ mm^3$ | $d_i := d_{piles} - 2 \cdot t_{pile} = 174.6\ mm$

Inner diameter of piles.

$$\frac{d_{piles}}{t_{pile}} = 15.748 \qquad \frac{13000}{\sqrt{\dfrac{F_y}{1\ MPa}}} = 750.555$$

Pile is Class 1.

Beam Properties:

W16x50 (W410x74) beam:

$d_{beam} := 413\ mm$

$I_{x\_beam} := 275 \cdot 10^6\ mm^4$

$b_{beam} := 180\ mm$

$A := 9480\ mm^2$

$t_{beam} := 16.0\ mm$

$S_{x\_beam} := 1330 \cdot 10^3\ mm^3$

$w_{beam} := 9.7\ mm$

$Z_{x\_beam} := 1510 \cdot 10^3\ mm^3$

$S_{piles} := \frac{5400\ mm}{2} = 2700\ mm$ Approximate spacing of piles.

$L_{beam} := 6100\ mm$ Max length of beam.

Beam classification:

$b_{el} := \frac{b_{beam}}{2} = 90\ mm$

$\frac{b_{el}}{t_{beam}} = 5.625$ $\frac{145}{\sqrt{\frac{F_y}{1\ MPa}}} = 8.372$

$h := d_{beam} - 2 \cdot t_{beam} = 381\ mm$

$\frac{h}{w_{beam}} = 39.278$ $\frac{1100}{\sqrt{\frac{F_y}{1\ MPa}}} = 63.509$

Section is Class 1

$M_{r\_beam} := 0.9 \cdot Z_{x\_beam} \cdot F_y = 407.7\ kN \cdot m$ Beam Capacity.

$S_{w\_beam} := 0.735\ \frac{kN}{m}$ Beam Self Weight.

Reduced Beam Capacities:

Due to the amount of corrosion on the existing beams, it is assumed that there is reduction in thickness of 3mm all around the beam cross section.

$$d_{beam} := d_{beam} - 2 \cdot 3\ mm = 407\ mm$$

$$b_{beam} := b_{beam} - 2 \cdot 3\ mm = 174\ mm$$

$$w_{beam} := 5\ mm$$

$$t_{beam} := t_{beam} - 2 \cdot 3\ mm = 10\ mm$$

$$I_{new} := \frac{1}{12} \cdot b_{beam} \cdot t_{beam}^{3} \cdot 2 + \frac{1}{12} \cdot \left(d_{beam} - 2 \cdot t_{beam}\right)^{3} \cdot w_{beam} + 2 \cdot \left(b_{beam} \cdot t_{beam}\right)\left(\frac{d_{beam}}{2} - \frac{t_{beam}}{2}\right)^{2} = \left(161.299 \cdot 10^{6}\right)\ mm^{4}$$

$$S_{new} := \frac{I_{new}}{\left(\frac{d_{beam}}{2}\right)} = 792624.478\ mm^{3}$$

$$M_{r\_beam} := 0.9 \cdot S_{new} \cdot F_{y} = 214.01\ kN \cdot m$$

Reduced capacity of the beam.

Deck Elevation:

$Top := 3.05\ m$

$LNT := 0\ m$

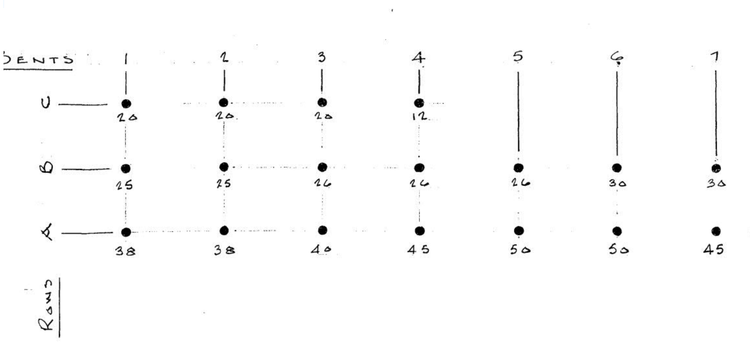
$b_{top} := 250\ mm$ Existing top beam depth.

$b_{plank\_deck} := 75\ mm$ Existing plank deck depth.

$t_{plate} := 1\ in$ Cover plate on top of pile.

$L_{pile\_above\_LNT} := 10\ ft - 3\ in - 10\ in - d_{beam} - t_{plate} = 2.285\ m$ Approximate length of pile above LNT.

Approximate Pile Lengths:



$L_{pile\_C1} := 20\ ft = 6.1\ m$ $L_{pile\_B1} := 25\ ft = 7.62\ m$ $L_{pile\_A1} := 38\ ft = 11.58\ m$

$L_{pile\_C2} := 20\ ft = 6.1\ m$ $L_{pile\_B2} := 25\ ft = 7.62\ m$ $L_{pile\_A2} := 38\ ft = 11.58\ m$

$L_{pile\_C3} := 20\ ft = 6.1\ m$ $L_{pile\_B3} := 26\ ft = 7.92\ m$ $L_{pile\_A3} := 40\ ft = 12.19\ m$

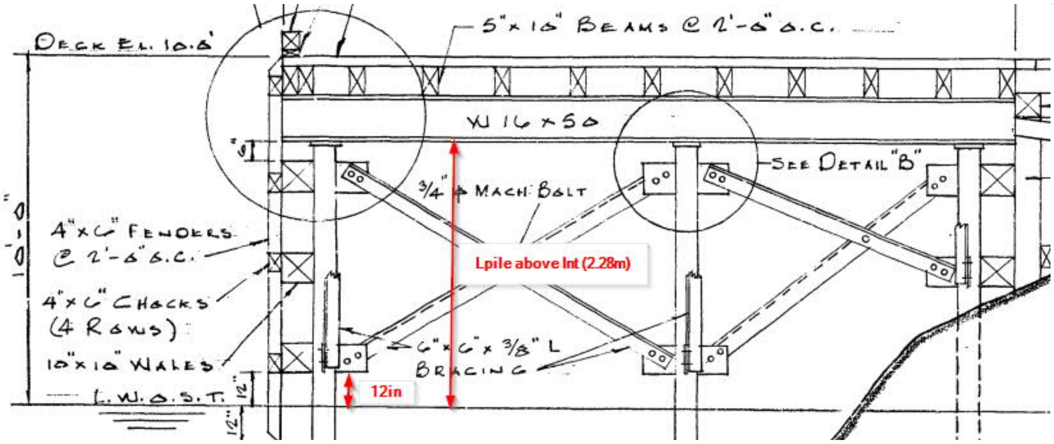
$L_{pile\_C4} := 12\ ft = 3.66\ m$ $L_{pile\_B4} := 26\ ft = 7.92\ m$ $L_{pile\_A4} := 45\ ft = 13.72\ m$

$L_{pile\_B5} := 26\ ft = 7.92\ m$ $L_{pile\_A5} := 50\ ft = 15.24\ m$

$L_{pile\_B6} := 30\ ft = 9.14\ m$ $L_{pile\_A6} := 50\ ft = 15.24\ m$

$L_{pile\_B7} := 30\ ft = 9.14\ m$ $L_{pile\_A7} := 45\ ft = 13.72\ m$

$L_{brace\_LNT} := 12\ in = 304.8\ mm$ Approximate distance to bracing above LNT.



$L_{brace} := L_{pile\_above\_LNT} - L_{brace\_LNT} = 1.981\ m$ Length of braced segment.

$L_{pile\_max\_A6} := L_{pile\_A6} - L_{brace} = 13.259\ m$ Max unbraced length of pile.

$k_{braced} := 1.0$ This is for pinned-pinned condition (assuming all bracing is in place).

$k_{unbraced} := 2.0$ Assuming pinned-free condition (if no bracing is in place).

Original Pile capacity:

$n := 1.34$

$E := 200000\ MPa$

$\phi_s := 0.9$

$$slenderness := \frac{k_{braced} \cdot L_{pile\_max\_A6}}{r_{pile}} = 180.4$$

$$F_e := \frac{\pi^2 \cdot E}{slenderness^2} = 60.65\ MPa$$

$$\lambda := \sqrt{\frac{F_y}{F_e}} = 2.224$$

$$C_r := \frac{\phi_s \cdot A_{pile} \cdot F_y}{\left(1 + \lambda^{2 \cdot n}\right)^{\frac{1}{n}}} = 374.852\ kN$$

****See Spreadsheet for Remaining Original Pile Capacities.**

2022 Pile Capacity:

Using pile A6:

$t_{avg} := 10.02\ mm$ Average 2022 thickness.

$d_i = 174.6\ mm$

$d_o := d_i + 2 \cdot t_{avg} = 194.64\ mm$ Inner diameter of piles.

$$I_{new} := \frac{\pi \cdot \left(d_o^{\,4} - d_i^{\,4}\right)}{64} = \left(2.483 \cdot 10^{7}\right)\ mm^4$$

$$A_{new} := \frac{\pi \cdot \left(d_o^{\,2} - d_i^{\,2}\right)}{4} = 5811.61\ mm^2$$

$$r_{new} := \sqrt{\frac{I_{new}}{A_{new}}} = 65.37\ mm$$

$$slenderness := \frac{k_{unbraced} \cdot L_{pile\_A6}}{r_{new}} = 466.275$$

$$F_e := \frac{\pi^2 \cdot E}{slenderness^2} = 9.08\ MPa$$

$$\lambda := \sqrt{\frac{F_y}{F_e}} = 5.748$$

$$C_r := \frac{\phi_s \cdot A_{new} \cdot F_y}{\left(1 + \lambda^{2 \cdot n}\right)^{\frac{1}{n}}} = 47.16\ kN$$

****See Spreadsheet for Remaining Current Pile Capacities.**

Check Existing Deck Capacity:

$t_{deck\_min} := 200\ mm$ Minimum thickness of the deck. $Cover := 75\ mm$

$t_{deck} := 225\ mm$ Average deck thickness. $f'_c := 30\ MPa$

$d_{bar} := 15\ mm$ Rebar diameter.

$S_{bars} := 300\ mm$ Bar spacing.

$A_{bar} := 200\ mm^2$ Rebar area.

$b_w := 1000\ mm$

$A_s := \frac{A_{bar}}{S_{bars}} \cdot b_w = 666.667\ mm^2$

$d_{deck} := t_{deck} - Cover - d_{bar} - \frac{d_{bar}}{2} = 127.5\ mm$

$A_{s\_min} := 0.002 \cdot t_{deck} \cdot b_w = 450\ mm^2$

$\alpha_1 := 0.85 - 0.0015 \cdot \frac{f'_c}{1\ MPa} = 0.805$ $\phi_s := 0.85$ $F_{y\_rebar} := 400\ MPa$

$\phi_c := 0.65$

$\beta_1 := 0.97 - 0.0025 \cdot \frac{f'_c}{1\ MPa} = 0.895$

$a := \frac{\phi_s \cdot A_s \cdot F_{y\_rebar}}{\phi_c \cdot \alpha_1 \cdot f'_c \cdot b_w} = 14.44\ mm$

$c := \frac{a}{\beta_1} = 16.134\ mm$

$\varepsilon_s := 0.0035 \cdot \frac{(d_{deck} - c)}{c} = 0.024$

$if(\varepsilon_s | 0.002, \text{“ok”}, \text{“Not Ok”}) = \text{“ok”}$

$M_{r\_deck\_1} := \phi_s \cdot A_s \cdot F_y \cdot \left(d_{deck} - \frac{a}{2}\right) = 20.448\ kN \cdot m$ Deck Capacity Transverse direction.

$d_{deck\_2} := t_{deck} - Cover - \frac{d_{bar}}{2} = 142.5\ mm$

$\varepsilon_s := 0.0035 \cdot \frac{(d_{deck\_2} - c)}{c} = 0.027$

$if(\varepsilon_s | 0.002, \text{“ok”}, \text{“Not Ok”}) = \text{“ok”}$

$M_{r\_deck\_2} := \phi_s \cdot A_s \cdot F_y \cdot \left(d_{deck\_2} - \frac{a}{2}\right) = 23\ kN \cdot m$ Deck Capacity Longitudinal direction.

Shear Capacity of Deck:

$d_v := \max\left(0.72 \cdot t_{deck}, 0.9 \cdot d_{deck}\right) = 162\ mm$

$\beta := 0.21$

$V_c := \phi_c \cdot \beta \cdot \sqrt{\frac{f'_c}{1\ MPa}} \cdot 1\ MPa \cdot 1\ m \cdot d_v = 121.118\ kN$

$V_{r\_max} := 0.25 \cdot \phi_c \cdot f'_c \cdot 1\ m \cdot d_v = 789.75\ kN$

$V_{r\_deck} := \min\left(V_c, V_{r\_max}\right) = 121.118\ kN$ Max Shear Capacity of deck.

$\gamma_{conc} := 23.5\ \frac{kN}{m^3}$ Density of concrete.

$DL_{deck} := \gamma_{conc} \cdot t_{deck} = 5.29\ kPa$

Capacity of 5inx10in beams:

$S_{timbers} := 2\ ft = 609.6\ mm$ Spacing of timbers.

$w_{timber} := 5\ in = 127\ mm$

$h_{timber} := 10\ in = 254\ mm$

$S_{x\_timber} := \frac{w_{timber} \cdot h_{timber}^2}{6} = \left(1.366 \cdot 10^6\right)\ mm^3$ Section modulus of timber piles.

Bending Capacity:

$ratio := \frac{h_{timber}}{w_{timber}} = 2$ $\phi := 0.9$

$K_L := 1.0$

$f_b := 11.8\ MPa$

$K_D := 0.65$ Long Term load.

$K_H := 1.1$

$K_{sb} := 1.0$

$K_T := 1.0$

$F_b := f_b \cdot K_D \cdot K_H \cdot K_{sb} \cdot K_T = 8.437\ MPa$

$K_{zb} := 1.2$

$M_{r\_timbers} := \phi \cdot F_b \cdot S_{x\_timber} \cdot K_{zb} \cdot K_L = 12.44\ kN \cdot m$ Capacity of Timber decking per meter.

Shear Capacity:

$K_{Zv} := 1.1$

$K_{Sv} := 1.0$

$f_v := 1.5\ MPa$

$F_v := f_v \cdot K_D \cdot K_H \cdot K_{Sv} \cdot K_T = \left(1.073 \cdot 10^6\right)\ Pa$

$A_n := w_{timber} \cdot h_{timber} \cdot 80\% = \left(2.581 \cdot 10^4\right) \ mm^2$

$V_r := \phi \cdot F_v \cdot \frac{2 \cdot A_n}{3} \cdot K_{Zv} = 18.267 \ kN$ Shear Capacity.

Approximate Weight of Timbers:

$\pi_{Fir\_wet} := 7.86 \ \frac{kN}{m^3}$ Approximate density of wet wood.

$W_{wood} := \frac{\pi_{Fir\_wet} \cdot h_{timber} \cdot w_{timber}}{S_{timbers}} = 0.416 \ kPa$ Approximate DL due to Timbers.

Loading Summary:

$M_{r\_beam} = 214.01\ kN-m$

$M_{r\_timbers} = 12.44\ kN-m$

$M_{r\_deck\_1} = 20.45\ kN-m$ Deck Capacity in Transverse Direction.

$M_{r\_deck\_2} = 23\ kN-m$ Deck Capacity in Longitudinal Direction.

****See Spreadsheet for remaining capacity checks.**

Loads that can be Applied over wharf

Desired Load over Wharf:

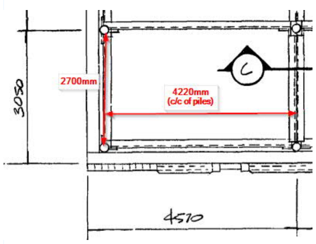
$P_{tote} := 2200\ lbf = 9.786\ kN$

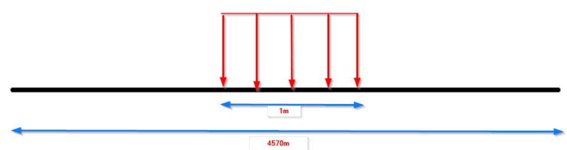
$d_{tote} := 1\ m$

$A_{tote} := \frac{\pi \cdot d_{tote}^2}{4} = \left(7.854 \cdot 10^5\right)\ mm^2$ Approximate footprint size of the tote.

$P_{kPa} := \frac{P_{tote}}{A_{tote}} = 12.46\ kPa$ Approximate area load of the tote.

Assume worst case Tote is over middle of span:





$L := 4570\ mm$

$LL := 4.8\ kPa$ Live load over wharf. Based on DFO design guide would typicall have been designed for 5-10kPa live load.

$S_{LL} := \frac{L - 1\ m}{2} = 1785\ mm$ Length that live load spans to each side of the tote.

$b_w := 1\ m$

$DL_{deck} := 23.5\ \frac{kN}{m^3} \cdot t_{deck} \cdot b_w = 5.288\ \frac{kN}{m}$

From Staad:

$M_{f\_max} := 36.31\ kN \cdot m$ Total moment caused by the tote load and dead load of the deck.

$V_{f\_max} := 33.33\ kN$

$\text{if}\left(M_{r\_deck\_2} \geq M_{f\_max}, \text{"Ok"}, \text{"Not Ok"}\right) = \text{"Not Ok"}$

Therefore, the deck cannot support the tote load.

2022 Average Pile Thicknesses

UT Readings 2022

Pile # (according to Harbourside report)	Pile # (according to reference Drawings)	Original Thickness (mm)	Top				Middle				Bottom				2022 Average Thickness (mm)	Average Thickness Loss since Construction (mm)	Average thickness Loss Since Construction (%)
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4			
7A	1A	12.7	11.1	10.9	10.6	11.6	10.5	10	9.8	9.9	7.8	7.6	7.8	7.8	9.62	3.08	24%
6A	2A	12.7	11	11.2	11.4	11.3	9.2	9.1	9.8	10.2	6.4	7.1	7.4	6.6	9.23	3.48	27%
5A	3A	12.7	9.8	9.7	9.8	10	7.4	7.9	7.6	7.8	7.9	7.9	7.1	7.4	8.36	4.34	34%
4A	4A	12.7	9.4	9.4	9.8	9.7	8.5	8.2	8.1	8	7.8	7.8	7.1	7.2	8.42	4.28	34%
3A	5A	12.7	8.6	9.1	8.2	8.7	8.1	8.5	9	8.5	5.5	7.7	8.8	7.8	8.21	4.49	35%
2A	6A	12.7	11.8	11.1	11.4	11.9	10.8	11	11.3	11.4	7.7	7.6	7.1	7.1	10.02	2.68	21%
1A	7A	12.7	12.2	N/A	N/A	12.2	10.3	9.8	9.7	9.6	9.4	8.2	8.4	7.4	9.72	2.98	23%
7B	1B	12.7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6B	2B	12.7	N/A	N/A	N/A	N/A	11.9	11.8	11.7	11.8	7.6	6.5	7.2	5.9	9.30	3.40	27%
5B	3B	12.7	11.4	11.9	11.7	11.8	11.1	10.9	11.1	11.4	7.5	7.6	6.4	7.7	10.04	2.66	21%
4B	4B	12.7	N/A	N/A	N/A	N/A	11.4	11.2	11.1	10.8	7.8	8.2	9.2	8.1	9.73	2.98	23%
3B	5B	12.7	11.3	11.1	10.9	10.9	12.2	11.4	11.2	11.1	7.9	7.9	7.3	8.2	10.12	2.58	20%
2B	6B	12.7	N/A	N/A	N/A	N/A	10.6	11	10.9	11.1	7.9	7.6	7.8	7.9	9.35	3.35	26%
1B	7B	12.7	12.1	11.6	11.6	11.9	12.2	11.1	11	12.3	8.4	7.7	8.1	7	10.42	2.28	18%
7C	1C	12.7	N/A	N/A	N/A	N/A	12.2	12.2	12.1	12	11.9	12	11.9	12.1	12.05	0.65	5%
6C	2C	12.7	N/A	N/A	N/A	N/A	12.3	12.4	12.1	12.2	12	11.9	12	11.8	12.09	0.61	5%
5C	3C	12.7	N/A	N/A	N/A	N/A	11.4	12.3	12.1	11.8	12.4	10.9	11.5	11.9	11.79	0.91	7%
4C	4C	12.7	11.3	11.2	11.5	11.3	11.4	10.7	11.4	11.2	11	11	10.9	10.9	11.15	1.55	12%
		Average=	10.91	10.72	10.69	11.03	10.68	10.56	10.59	10.65	8.64	8.54	8.59	8.40	**9.98**	**2.72**	**21%**
		Average=	10.84				10.62				8.54						
		Thickness loss (mm)=	1.86				2.08				4.16						
		Thickness loss (%)=	15%				16%				33%						

Original Pile Capacities

Pile # (according to Harbourside report)	Pile #	Length (m)	L_{brace} (m)	$L_{unbraced}$ (m)	kL/r	F_e (Mpa)	**λ**	C_r (kN)	Tributary Area Around Piles L_{TA} (m)	w_{TA} (m)	Area (m)	q_{f_max} (kPa)	q_{uf_max} (kPa)
7A	A1	11.58	1.975	9.605	130.68	115.59	1.61	646.01	2.29	1.35	3.08	209.42	134.39
6A	A2	11.58	1.975	9.605	130.68	115.59	1.61	646.01	4.57	1.35	6.17	104.71	64.59
5A	A3	12.19	1.975	10.215	138.98	102.19	1.71	585.71	4.57	1.35	6.17	94.94	58.07
4A	A4	13.72	1.975	11.745	159.80	77.30	1.97	463.85	4.45	1.35	6.00	77.30	46.31
3A	A5	15.24	1.975	13.265	180.48	60.60	2.22	374.57	5.01	1.35	6.76	55.42	31.72
2A	A6	15.24	1.975	13.265	180.48	60.60	2.22	374.57	4.27	1.35	5.76	64.98	38.10
1A	A7	13.72	1.975	11.745	159.80	77.30	1.97	463.85	1.42	1.35	1.92	241.40	155.71
7B	B1	7.62	1.975	5.645	76.80	334.64	0.95	1265.65	2.29	2.70	6.17	205.15	131.77
6B	B2	7.62	1.975	5.645	76.80	334.64	0.95	1265.65	4.57	2.70	12.34	102.57	63.39
5B	B3	7.92	1.975	5.945	80.88	301.72	1.00	1204.18	4.57	2.70	12.34	97.59	60.07
4B	B4	7.92	1.975	5.945	80.88	301.72	1.00	1204.18	4.45	2.70	12.00	100.34	61.90
3B	B5	7.92	1.975	5.945	80.88	301.72	1.00	1204.18	5.01	2.70	14.98	80.41	48.61
2B	B6	9.14	1.975	7.165	97.48	207.72	1.20	977.00	4.27	2.70	11.53	84.74	51.50
1B	B7	9.14	1.975	7.165	97.48	207.72	1.20	977.00	1.42	2.70	3.84	254.23	164.49
7C	C1	6.1	1.975	4.125	56.12	626.70	0.69	1590.19	2.29	1.35	3.08	515.50	338.45
6C	C2	6.1	1.975	4.125	56.12	626.70	0.69	1590.19	4.57	1.35	6.17	257.75	166.61
5C	C3	6.1	1.975	4.125	56.12	626.70	0.69	1590.19	4.57	1.35	6.17	257.75	166.61
4C	C4	3.66	1.975	1.685	22.93	3755.82	0.28	1964.81	4.45	1.35	4.54	432.52	283.12

**q_{uf_max} are the max unfactored additional loads that can be applied to the wharf (Does not include dead load of the concrete wharf deck, steel pile cap and timber beams).

2022 Pile Capacities (without Bracing in Place)

Pile # (according to Harbourside report)	Pile #	Length (m)	2022 Average Thickness	D_{0_new} (mm)	I_{new} (mm^4)	A_{new} (mm^2)	r (mm)	kL/r	F_e (Mpa)	λ	C_r (kN)	Tributary Area Around Piles L_{TA} (m)	w_{TA} (m)	Area (m)	q_{uf_max} (kPa)
7A	A1	11.58	9.62	193.83	23.7E+6	5565.49	65.22	355.11	15.65	4.38	77.31	2.29	1.35	3.08	11.49
6A	A2	11.58	9.23	193.05	22.6E+6	5327.47	65.07	355.90	15.58	4.39	73.68	4.57	1.35	6.17	2.74
5A	A3	12.19	8.36	191.32	20.1E+6	4804.21	64.75	376.51	13.92	4.64	59.48	4.57	1.35	6.17	1.21
4A	A4	13.72	8.42	191.43	20.3E+6	4839.28	64.77	423.62	11.00	5.22	47.48	4.45	1.35	6.00	0.06
3A	A5	15.24	8.21	191.02	19.7E+6	4714.12	64.70	471.11	8.89	5.81	37.48	5.01	1.35	6.76	-1.52
2A	A6	15.24	10.02	194.63	24.8E+6	5809.57	65.37	466.28	9.08	5.75	47.15	4.27	1.35	5.76	0.23
1A	A7	13.72	9.72	194.04	24.0E+6	5628.45	65.26	420.49	11.16	5.18	56.05	1.42	1.35	1.92	14.22
7B	B1	7.62	N/A	-	-	-	-	-	-	-	-	2.29	2.70	6.17	-
6B	B2	7.62	9.30	193.20	22.8E+6	5372.97	65.10	234.10	36.02	2.89	166.96	4.57	2.70	12.34	4.03
5B	B3	7.92	10.04	194.68	24.9E+6	5824.86	65.38	242.29	33.63	2.99	169.58	4.57	2.70	12.34	4.17
4B	B4	7.92	9.73	194.05	24.0E+6	5631.50	65.26	242.72	33.50	2.99	163.39	4.45	2.70	12.00	4.08
3B	B5	7.92	10.12	194.83	25.1E+6	5870.75	65.41	242.18	33.65	2.99	171.06	5.01	2.70	14.98	2.62
2B	B6	9.14	9.35	193.30	22.9E+6	5403.33	65.12	280.71	25.05	3.46	118.65	4.27	2.70	11.53	1.87
1B	B7	9.14	10.42	195.43	26.0E+6	6054.66	65.52	279.01	25.36	3.44	134.52	1.42	2.70	3.84	18.34
7C	C1	6.1	12.05	198.70	30.9E+6	7065.86	66.13	184.49	57.99	2.27	341.04	2.29	1.35	3.08	68.48
6C	C2	6.1	12.09	198.78	31.0E+6	7089.27	66.14	184.45	58.02	2.27	342.30	4.57	1.35	6.17	31.77
5C	C3	6.1	11.79	198.18	30.1E+6	6902.21	66.03	184.77	57.82	2.28	332.25	4.57	1.35	6.17	30.68
4C	C4	3.66	11.15	196.90	28.2E+6	6506.59	65.79	111.26	159.45	1.37	715.48	4.45	1.35	4.54	99.78

**q_{uf_max} are the max unfactored additional loads that can be applied to the wharf (Does not include dead load of the concrete wharf deck, steel pile cap and timber beams).

2022 Pile Capacities (with Bracing in Place)

Pile # (according to Harbourside report)	Pile #	Length (m)	2022 Average Thickness	D_{0_new} (mm)	I_{new} (mm^4)	A_{new} (mm^2)	r (mm)	kL/r	F_e (Mpa)	λ	C_r (kN)	Tributary Area Around Piles: L_{TA} (m)	Tributary Area Around Piles: w_{TA} (m)	Tributary Area Around Piles: Area (m)	q_{uf_max} (kPa)
7A	A1	11.58	9.62	193.83	23.7E+6	5565.49	65.22	177.56	62.61	2.19	287.71	2.29	1.35	3.08	56.96
6A	A2	11.58	9.23	193.05	22.6E+6	5327.47	65.07	177.95	62.33	2.19	274.31	4.57	1.35	6.17	24.42
5A	A3	12.19	8.36	191.32	20.1E+6	4804.21	64.75	188.25	55.70	2.32	223.58	4.57	1.35	6.17	18.94
4A	A4	13.72	8.42	191.43	20.3E+6	4839.28	64.77	211.81	44.00	2.61	181.39	4.45	1.35	6.00	14.93
3A	A5	15.24	8.21	191.02	19.7E+6	4714.12	64.70	235.56	35.57	2.90	144.77	5.01	1.35	6.76	9.06
2A	A6	15.24	10.02	194.63	24.8E+6	5809.57	65.37	233.14	36.32	2.87	181.92	4.27	1.35	5.76	15.82
1A	A7	13.72	9.72	194.04	24.0E+6	5628.45	65.26	210.24	44.66	2.59	213.90	1.42	1.35	1.92	68.99
7B	B1	7.62	N/A	-	-	-	-	-	-	-	-	2.29	2.70	6.17	-
6B	B2	7.62	9.30	193.20	22.8E+6	5372.97	65.10	117.05	144.08	1.44	549.57	4.57	2.70	12.34	24.70
5B	B3	7.92	10.04	194.68	24.9E+6	5824.86	65.38	121.14	134.50	1.49	566.35	4.57	2.70	12.34	25.61
4B	B4	7.92	9.73	194.05	24.0E+6	5631.50	65.26	121.36	134.02	1.50	546.08	4.45	2.70	12.00	25.34
3B	B5	7.92	10.12	194.83	25.1E+6	5870.75	65.41	121.09	134.62	1.49	571.18	5.01	2.70	14.98	20.43
2B	B6	9.14	9.35	193.30	22.9E+6	5403.33	65.12	140.36	100.20	1.73	417.51	4.27	2.70	11.53	19.15
1B	B7	9.14	10.42	195.43	26.0E+6	6054.66	65.52	139.51	101.42	1.72	472.47	1.42	2.70	3.84	76.97
7C	C1	6.1	12.05	198.70	30.9E+6	7065.86	66.13	92.25	231.98	1.14	989.13	2.29	1.35	3.08	208.55
6C	C2	6.1	12.09	198.78	31.0E+6	7089.27	66.14	92.23	232.07	1.14	992.65	4.57	1.35	6.17	102.04
5C	C3	6.1	11.79	198.18	30.1E+6	6902.21	66.03	92.38	231.28	1.14	964.54	4.57	1.35	6.17	99.01
4C	C4	3.66	11.15	196.90	28.2E+6	6506.59	65.79	55.63	637.82	0.69	1393.54	4.45	1.35	4.54	199.29

**q_{uf_max} are the max unfactored additional loads that can be applied to the wharf (Does not include dead load of the concrete wharf deck, steel pile cap and timber beams).

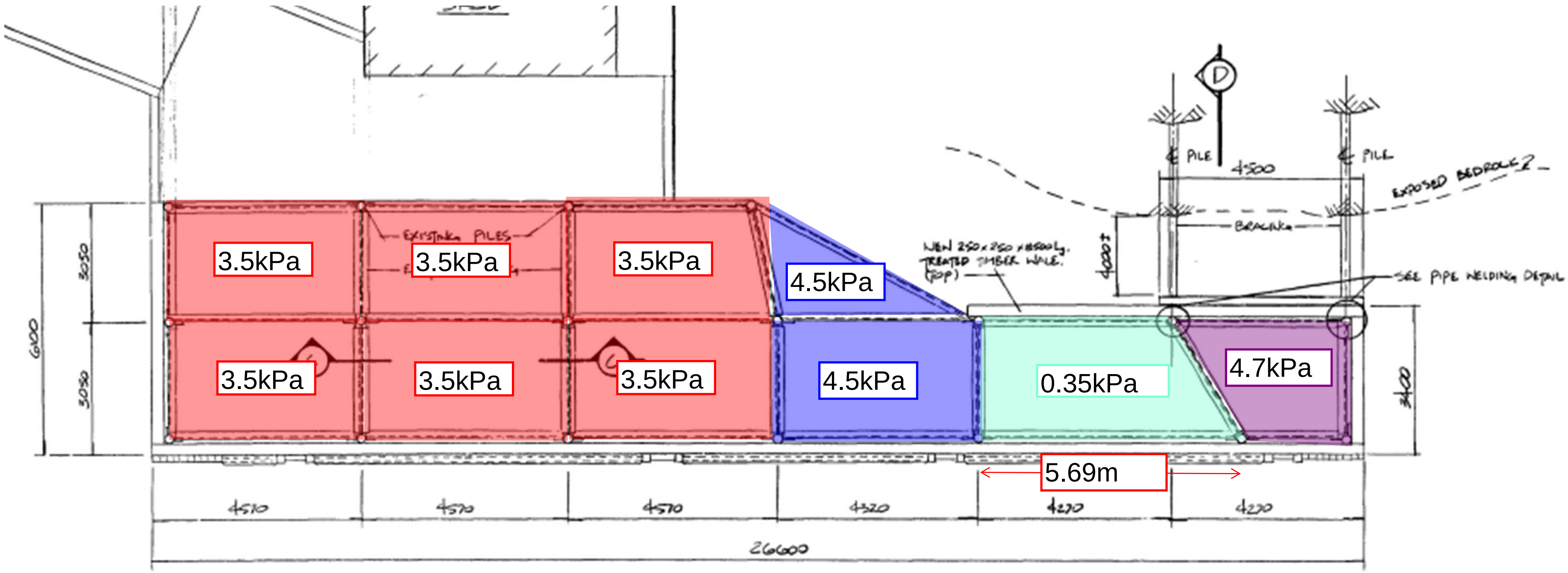
Existing Member Capacities

Pile # (according to Harbourside report)	Pile #	Spans (m)	Deck Capacity Longitudinal Direction (kPa)
7A - 6A	A1 - A2	4.57	3.5
6A - 5A	A2 - A3	4.57	3.5
5A - 4A	A3 - A4	4.57	3.5
4A - 3A	A4 - A5	4.32	4.5
3A - 2A	A5 - A6	5.69	0.35
2A - 1A	A6 - A7	4.27	4.7
7B - 6B	B1 - B2	4.57	3.5
6B - 5B	B2 - B3	4.57	3.5
5B - 4B	B3 - B4	4.57	3.5
4B - 3B	B4 - B5	4.32	4.5
3B - 2B	B5 - B6	4.27	4.7
2B - 1B	B6 - B7	4.27	4.7
7C - 6C	C1 - C2	4.57	3.5
6C - 5C	C2 -C3	4.57	3.5
5C - 4C	C3 - C4	4.57	3.5
		Min=	0.35

Pile #	Spans (m)	Beam Capacity (kPa)
A1 - B1	2.7	102.5
B1 - C1	2.7	102.5
A2 - B2	2.7	51.2
B2 - C2	2.7	51.2
A3 - B3	2.7	51.2
B3 - C3	2.7	51.2
A4 - B4	2.7	52.7
B4 - C4	2.7	52.7
A5 - B5	2.7	46.8
A6 - B6	2.7	54.8
A7 - B7	2.7	109.7
	Min=	46.8

Deck Capacity

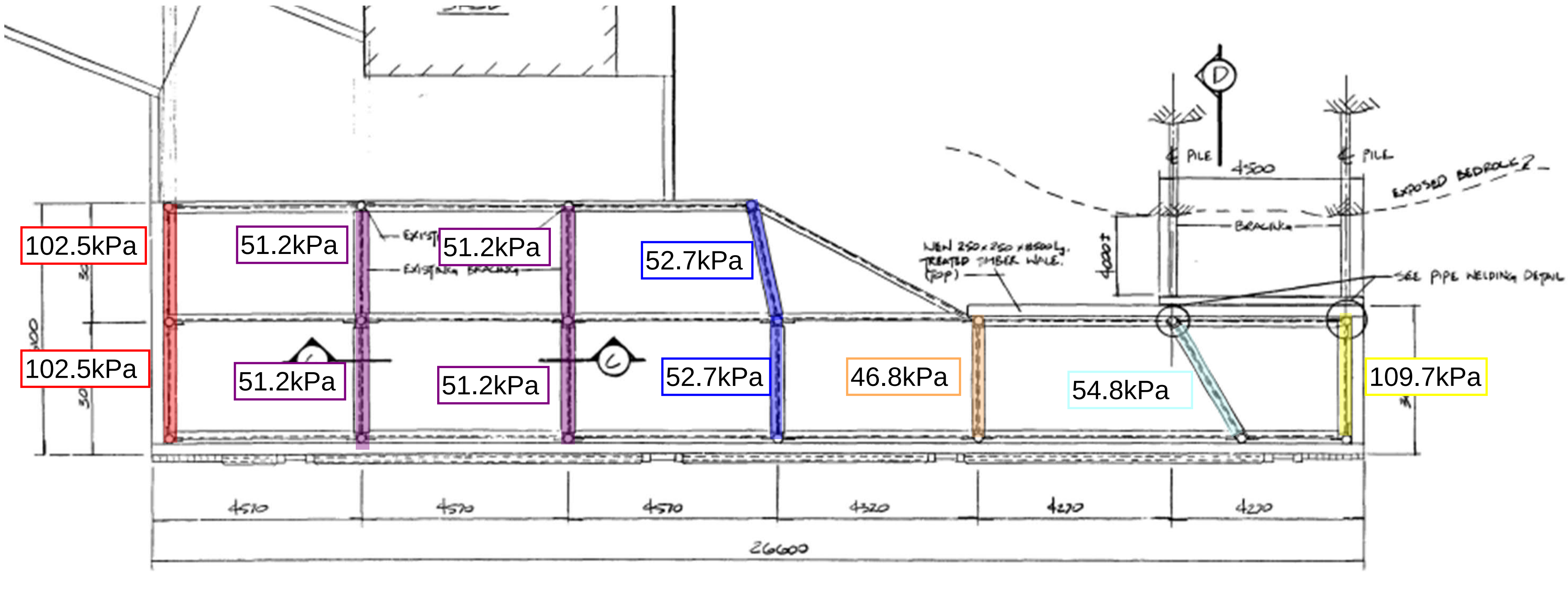
These are additional loads excluding the self weight of the member.



PLAN OF PILES, WALES & BRACING
SCALE: 1:75

W16x50 Beam Capacities

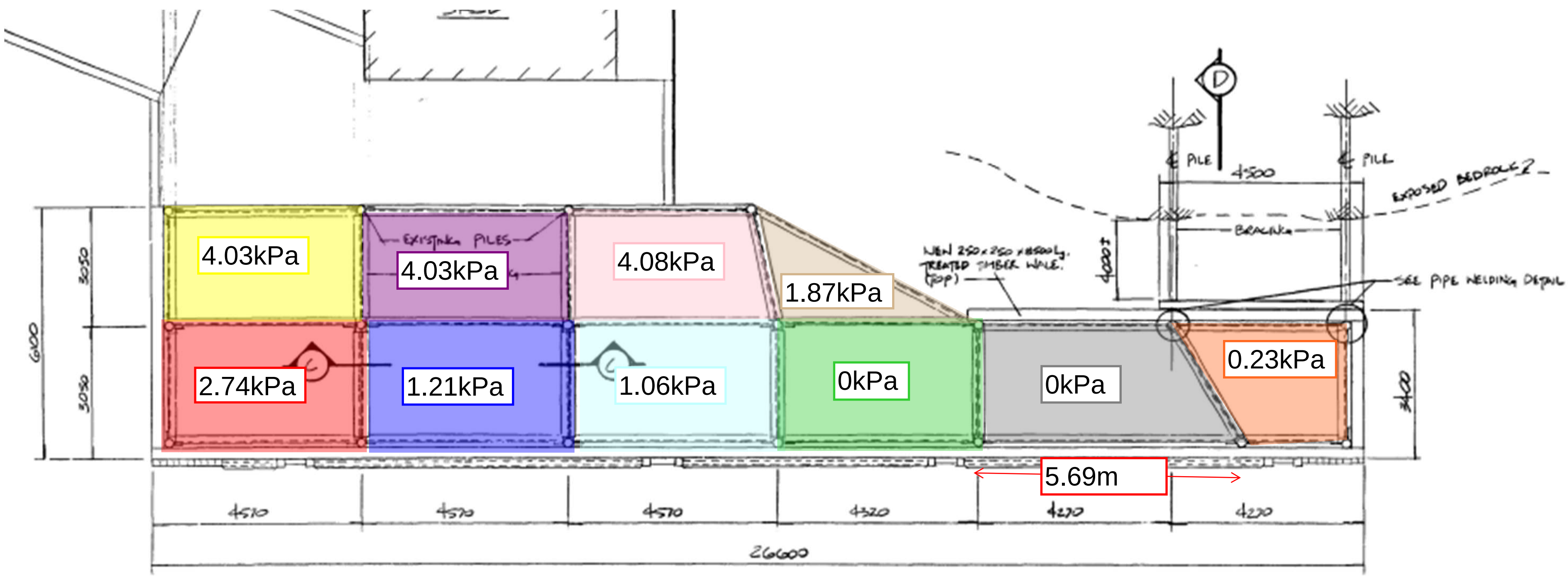
These are additional loads excluding the self weight of the member.



PLAN OF PILES, WALES & BRACING
SCALE: 1:75

Pile Capacities

These are additional loads that can be applied to the wharf excluding the self weight of the deck and timber members above.



PLAN OF PILES, WALES & BRACING
SCALE: 1:75

APPENDIX C

MDI DIVING REPORT

MCCALLUM, NL, WHARF INSPECTION, JUNE 27, 2022

M.D.I CONTRACTING
37 Deborah Lynn Heights, Paradise, NL, A1L 3E6

DATE:

June 27, 2022

LOCATION:

McCallum, NL

REPORT WRITTEN BY:

Phil Brace, Diving Supervisor
M.D.I Contracting

DIVING CREW:

Phil Brace, Supervisor
Justin Penton, Diver
Nathan Bulger, Diver
Nic Wadden, Tender

WEATHER CONDITIONS:

Temperature: $+15^{0}$C
Wind: NW 15-20km
Visibility: Foggy/ Overcast
Tide: N/A

UNDERWATER CONDITIONS:

Temperature: $+5^{0}$C
Visibility: 5m
Current: Tidal

Introduction:

The purpose of the diving operation is to assess the condition of the steel pile wharf (Ferry wharf) and walkway between the two. Diving crew mobilized to McCallum, Newfoundland on June 27, 2022. This assessment is a follow up from a previous survey conducted in May of 2019.

Diving crew will assess topside condition of wharf then follow up with ultrasonic testing of the steel piles and a full inspection of the underside of the wharf.

Wheel guard:

Overall, the wheel guard appears to be in decent shape in most locations. In the heavy traffic area "tie up" zone of the wharf the wheel guard appears to show signs of wear but is still functional with no hardware showing or splitting. Pictures in report to show.

Ladders:

Diving crew noted a total of three ladders along the wharf. One ladder is functional and appears to be in good condition while the other two ladders noted appear to be missing rungs and timber along the sides to be rotted.

While checking the ladders, diving crew assessed the bumpers protecting the corners of the wharf. Two in total, one on each corner. The southeast bumper appears to still have its majority of rubber tire left intact, followed by the northeast mat in worse shape. Missing a fair amount of rubber. Wire rope holding the mats in place appear in decent shape and eye bolts attached to the deck also look in good condition with minimal signs of wear around the rings and are holding fast into the concrete.

Fendering/Gump's:

Four gump's are recorded along the wharf. All appear to be in good working order. Hardware all in place and concrete platform which gump's are laid on noted with minimal signs of wear as well.

Fendering along the front face of the wharf appear to be compromised. Whether a piece of fendering is missing the top or bottom, some may not even be present. Fair amount of rot has been noted in fendering from one end to the other exposing hardware in various locations.

Three tractor tires are chained on where ferry ties up and appear to have all hardware in place and in good working order. Keeping any vessels well and clear from any hardware protruding from wharf.

Walkway:

Walkway travelling from one wharf to another is built on 8' x 8' timbers which approximately span six feet apart. Minor deterioration around LNT is noted but all timbers appear to be intact with bracing all accounted for tying into bedrock. As dive crew travelled diving equipment across walkway, they noticed decking in good shape and walkway felt solid.

Ultrasonic Testing Survey:

A visual survey was conducted on the 19 piles listed below as well as a series of ultrasonic measurements. These measurements were taken at three different elevations on every pile. Each elevation was then divided into quadrats. Quadrats were located on the pile being Q1 (12 o'clock) the front face of the wharf then following around in a clockwise fashion until getting to Q4 (9 o'clock) ending facing North.

PILE # 1A											
Top				***Middle***				***Bottom***			
Q1 (12)	***Q2 (3)***	***Q3 (6)***	***Q4 (9)***	***Q1 (12)***	***Q2 (3)***	***Q3 (6)***	***Q4 (9)***	***Q1 (12)***	***Q2 (3)***	***Q3 (6)***	***Q4 (9)***
12.2	***N/A***	***N/A***	***12.2***	***10.3***	***9.8***	***9.7***	***9.6***	***9.4***	***8.2***	***8.4***	***7.4***

PILE #1 B											
Top				Middle				Bottom			
Q1 (12)	Q2 (3)	Q3 (6)	Q4 (9)	Q1 (12)	Q2 (3)	Q3 (6)	Q4 (9)	Q1 (12)	Q2 (3)	Q3 (6)	Q4 (9)
12.1	11.6	11.6	11.9	12.2	11.1	11.0	12.3	8.4	7.7	8.1	7.0

PILE #2 A											
Top				Middle				Bottom			
Q1 (12)	Q2 (3)	Q3 (6)	Q4 (9)	Q1 (12)	Q2 (3)	Q3 (6)	Q4 (9)	Q1 (12)	Q2 (3)	Q3 (6)	Q4 (9)
11.8	11.1	11.4	11.9	10.8	11.0	11.3	11.4	7.7	7.6	7.1	7.1

PILE #2 B											
Top				Middle				Bottom			
Q1 (12)	Q2 (3)	Q3 (6)	Q4 (9)	Q1 (12)	Q2 (3)	Q3 (6)	Q4 (9)	Q1 (12)	Q2 (3)	Q3 (6)	Q4 (9)
N/A	N/A	N/A	N/A	10.6	11.0	10.9	11.1	7.9	7.6	7.8	7.9

PILE #3 A											
Top				Middle				Bottom			
Q1 (12)	Q2 (3)	Q3 (6)	Q4 (9)	Q1 (12)	Q2 (3)	Q3 (6)	Q4 (9)	Q1 (12)	Q2 (3)	Q3 (6)	Q4 (9)
8.6	9.1	8.2	8.7	8.1	8.5	9.0	8.5	5.5	7.7	8.8	7.8

PILE #3 B											
Top				Middle				Bottom			
Q1 (12)	Q2 (3)	Q3 (6)	Q4 (9)	Q1 (12)	Q2 (3)	Q3 (6)	Q4 (9)	Q1 (12)	Q2 (3)	Q3 (6)	Q4 (9)
11.3	11.1	10.9	10.9	12.2	11.4	11.2	11.1	7.9	7.9	7.3	8.2

PILE #3 C											
Top				Middle				Bottom			
Q1 (12)	Q2 (3)	Q3 (6)	Q4 (9)	Q1 (12)	Q2 (3)	Q3 (6)	Q4 (9)	Q1 (12)	Q2 (3)	Q3 (6)	Q4 (9)
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

PILE # 4 A											
Top				***Middle***				***Bottom***			
Q1 (12)	***Q2 (3)***	***Q3 (6)***	***Q4 (9)***	***Q1 (12)***	***Q2 (3)***	***Q3 (6)***	***Q4 (9)***	***Q1 (12)***	***Q2 (3)***	***Q3 (6)***	***Q4 (9)***
9.4	***9.4***	***9.8***	***9.7***	***8.5***	***8.2***	***8.1***	***8.0***	***7.8***	***7.8***	***7.1***	***7.2***

PILE #4 B											
Top				***Middle***				***Bottom***			
Q1 (12)	***Q2 (3)***	***Q3 (6)***	***Q4 (9)***	***Q1 (12)***	***Q2 (3)***	***Q3 (6)***	***Q4 (9)***	***Q1 (12)***	***Q2 (3)***	***Q3 (6)***	***Q4 (9)***
N/A	***N/A***	***N/A***	***N/A***	***11.4***	***11.2***	***11.1***	***10.8***	***7.8***	***8.2***	***9.2***	***8.1***

PILE #4 C											
Top				***Middle***				***Bottom***			
Q1 (12)	***Q2 (3)***	***Q3 (6)***	***Q4 (9)***	***Q1 (12)***	***Q2 (3)***	***Q3 (6)***	***Q4 (9)***	***Q1 (12)***	***Q2 (3)***	***Q3 (6)***	***Q4 (9)***
11.3	***11.2***	***11.5***	***11.3***	***11.4***	***10.7***	***11.4***	***11.2***	***11.0***	***11.0***	***10.9***	***10.9***

PILE #5 A											
Top				***Middle***				***Bottom***			
Q1 (12)	***Q2 (3)***	***Q3 (6)***	***Q4 (9)***	***Q1 (12)***	***Q2 (3)***	***Q3 (6)***	***Q4 (9)***	***Q1 (12)***	***Q2 (3)***	***Q3 (6)***	***Q4 (9)***
9.8	***9.7***	***9.8***	***10.0***	***7.4***	***7.9***	***7.6***	***7.8***	***7.9***	***7.9***	***7.1***	***7.4***

PILE #5 B											
Top				***Middle***				***Bottom***			
Q1 (12)	***Q2 (3)***	***Q3 (6)***	***Q4 (9)***	***Q1 (12)***	***Q2 (3)***	***Q3 (6)***	***Q4 (9)***	***Q1 (12)***	***Q2 (3)***	***Q3 (6)***	***Q4 (9)***
11.4	***11.9***	***11.7***	***11.8***	***11.1***	***10.9***	***11.1***	***11.4***	***7.5***	***7.6***	***6.4***	***7.7***

PILE #5 C											
Top				***Middle***				***Bottom***			
Q1 (12)	***Q2 (3)***	***Q3 (6)***	***Q4 (9)***	***Q1 (12)***	***Q2 (3)***	***Q3 (6)***	***Q4 (9)***	***Q1 (12)***	***Q2 (3)***	***Q3 (6)***	***Q4 (9)***
N/A	***N/A***	***N/A***	***N/A***	***11.4***	***12.3***	***12.1***	***11.8***	***12.4***	***10.9***	***11.5***	***11.9***

PILE #6 A											
Top				***Middle***				***Bottom***			
Q1 (12)	***Q2 (3)***	***Q3 (6)***	***Q4 (9)***	***Q1 (12)***	***Q2 (3)***	***Q3 (6)***	***Q4 (9)***	***Q1 (12)***	***Q2 (3)***	***Q3 (6)***	***Q4 (9)***
11.0	***11.2***	***11.4***	***11.3***	***9.2***	***9.1***	***9.8***	***10.2***	***6.4***	***7.1***	***7.4***	***6.6***

PILE #6 B											
Top				***Middle***				***Bottom***			
Q1 (12)	***Q2 (3)***	***Q3 (6)***	***Q4 (9)***	***Q1 (12)***	***Q2 (3)***	***Q3 (6)***	***Q4 (9)***	***Q1 (12)***	***Q2 (3)***	***Q3 (6)***	***Q4 (9)***
N/A	***N/A***	***N/A***	***N/A***	***11.9***	***11.8***	***11.7***	***11.8***	***7.6***	***6.5***	***7.2***	***5.9***

PILE #6 C											
Top				***Middle***				***Bottom***			
Q1 (12)	***Q2 (3)***	***Q3 (6)***	***Q4 (9)***	***Q1 (12)***	***Q2 (3)***	***Q3 (6)***	***Q4 (9)***	***Q1 (12)***	***Q2 (3)***	***Q3 (6)***	***Q4 (9)***
N/A	***N/A***	***N/A***	***N/A***	***12.3***	***12.4***	***12.1***	***12.2***	***12.0***	***11.9***	***12.0***	***11.8***

PILE #7 A											
Top				***Middle***				***Bottom***			
Q1 (12)	***Q2 (3)***	***Q3 (6)***	***Q4 (9)***	***Q1 (12)***	***Q2 (3)***	***Q3 (6)***	***Q4 (9)***	***Q1 (12)***	***Q2 (3)***	***Q3 (6)***	***Q4 (9)***
11.1	***10.9***	***10.6***	***11.6***	***10.5***	***10.0***	***9.8***	***9.9***	***7.8***	***7.6***	***7.8***	***7.8***

PILE #7 B											
Top				***Middle***				***Bottom***			
Q1 (12)	***Q2 (3)***	***Q3 (6)***	***Q4 (9)***	***Q1 (12)***	***Q2 (3)***	***Q3 (6)***	***Q4 (9)***	***Q1 (12)***	***Q2 (3)***	***Q3 (6)***	***Q4 (9)***
N/A	***N/A***	***N/A***	***N/A***	***N/A***	***N/A***	***N/A***	***N/A***	***N/A***	***N/A***	***N/A***	***N/A***

PILE #7 C											
Top				***Middle***				***Bottom***			
Q1 (12)	***Q2 (3)***	***Q3 (6)***	***Q4 (9)***	***Q1 (12)***	***Q2 (3)***	***Q3 (6)***	***Q4 (9)***	***Q1 (12)***	***Q2 (3)***	***Q3 (6)***	***Q4 (9)***
N/A	***N/A***	***N/A***	***N/A***	***12.2***	***12.2***	***12.1***	***12.0***	***11.9***	***12.0***	***11.9***	***12.1***

Bracing:

On low tide, diving crew was able to walk underneath ferry wharf and assess the condition of "X" bracing. "X" bracing from pile to pile is compromised. If not rusted off both connection points, they are hanging on the one side with very little to no structural support. Pictures attached to report to show severity of this.

Steel piles are running up to a "I" beam pile cap. All piles appear to have strong touchdown points, top and bottom.

Where the wharf widens out, underneath there is a wooden crib with some wooden piles tying both sides together. Overall, this section of wharf appears in good condition with crib still full of ballast.

However, diving crew seen on low tide that three timber piles that have been severed from the bottom. These timbers are located between steel piles and timber crib noting everything else in this location in good condition.

Bent/Row Spacing:

Bent and row spacing is not all exactly even. Multiple measurements in various locations were obtained to follow this information up.

Back of crib to "C" row – 2.89m
"C" row to "B" row – 2.74m
"B" row to "A" row – 2.74m
Bent 1 to 2 – 4.57m

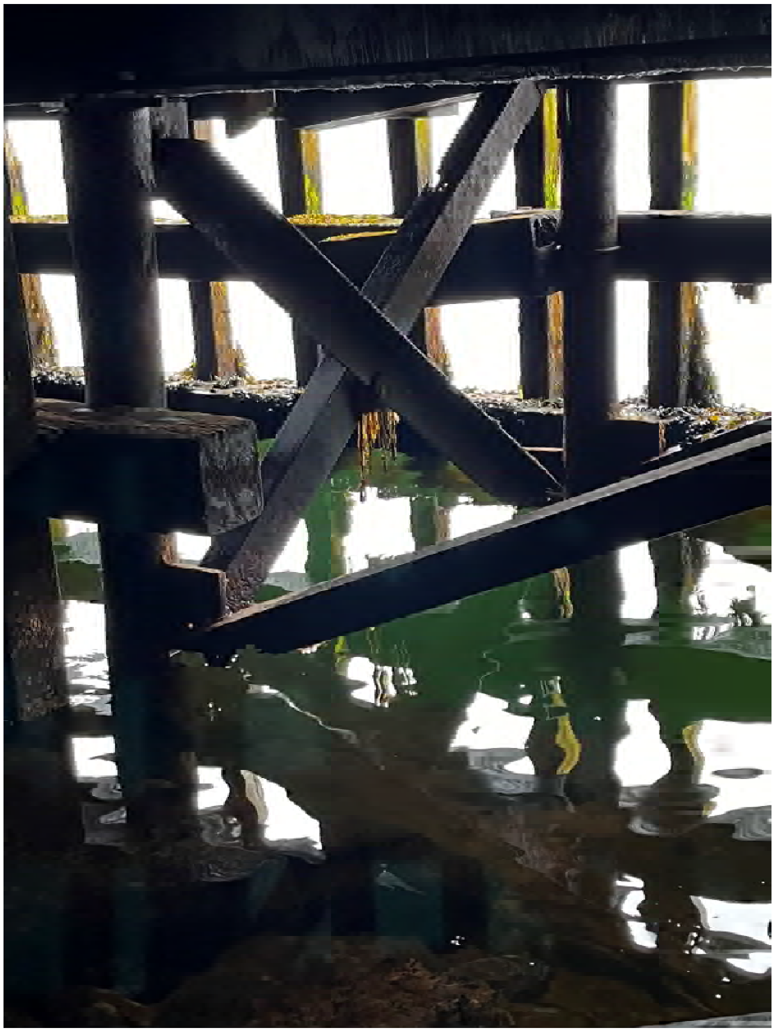
Photos:

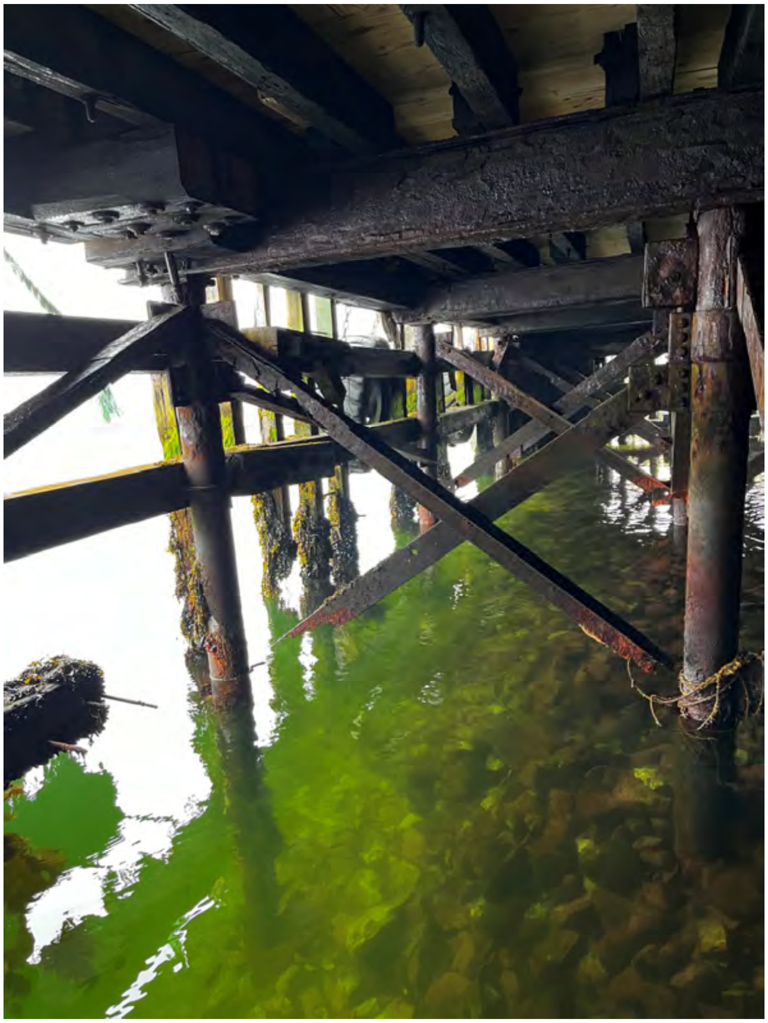
A series of still photos were taken throughout topside and underneath wharf. These photos are included with report and are organized to make viewing specific locations easier.

<u>Conclusion:</u>

Overall, bracing from pile to pile obtains the worse condition with minimal contact points. High percentage of main whalers above and underwater appear in good shape. While collecting ultrasonic testing results diver used his knife in various locations where timber was present to check rot and small amount was found. Leaving the front face of the wharf (fendering) in the most severe shape of the timber aspect of the wharf.

If you have any further concerns regarding this report and/or survey, please contact M.D.I Contracting at (709)770-3808.





$750,000 to $1,000,000

Upgrade Core OT Infrastructure

(2026)

newfoundland labrador hydro

Contents

Upgrade Core OT Infrastructure (2026)

Location: Various

Investment Classification: General Plant

Asset Category: Information Systems

Estimated Cost: $799,600

1.0 Introduction

Operational Technology ("OT") at Newfoundland and Labrador Hydro ("Hydro") provides support for infrastructure and applications that control, monitor, and operate the electrical grid, Hydro's Industrial Control Systems, and Supervisory Control and Data Acquisition system. Hydro supports and enhances OT through maintaining backend server and storage equipment to permit OT software applications to function in conjunction with the Energy Management System ("EMS"), in order to support the operation and reliability of the electrical grid. This project involves the replacement and expansion of data center equipment such as servers, storage, and rack components for this OT infrastructure.

2.0 Project Description and Justification

This project involves the replacement, addition and upgrade of hardware components related to Hydro's EMS server and storage infrastructure. To ensure that Hydro has a reliable and secure environment to support EMS system operations, core OT infrastructure components are identified for refresh and replacement each year.

The proposed 2026 project scope will include replacing OT workstations, servers, cabling and adapters to interface servers and storage to existing infrastructure, racking and additional components, and devices such as Human-Machine Interfaces ("HMI") and switches as required. Additionally, Hydro will develop and test an OT recovery plan, which will ensure recovery of services and applications happens in a prioritized manner, in the unlikely case of a full system loss.

This project is required to ensure the reliable operation of Hydro's OT Systems. Hydro must keep its critical infrastructure current to adequately support its business needs.

3.0 Asset Overview

3.1 Asset Background

Hydro has an ongoing refresh program with an objective to maintain hardware performance. Hydro's OT infrastructure includes over 200 servers, running a variety of operating systems, as well as 400 terabytes of disk storage. The 200 servers are a combination of physical and virtualized servers, where the virtual servers are spread across 27 physical servers, configured in highly available clusters. In addition to the servers and storage, Hydro's core OT infrastructure also includes switches, routers, keyboard, video and mouse, consoles, network clocks, cabling, firewalls, backup servers and storage, and rack components. These devices are used to maintain and monitor the EMS. Hydro's OT infrastructure components are used on a continuous basis and are active for the life of the equipment. To ensure reliability, Hydro's standard is to use enterprise-grade hardware for the EMS and all related applications.

3.2 Historical Reliability

OT utilizes a performance and conditioning software which monitors the health of the infrastructure. This software consistently reports high reliability and availability of the infrastructure.

3.3 Asset Condition

Hydro's OT department has maintenance and support contracts with external vendors and employs preventative maintenance strategies to ensure the operational condition of assets.

Infrastructure within the scope of this project has varying lifecycles per Hydro's evergreen lifecycle program for OT assets. Hydro's approach to determining OT infrastructure lifecycles was refreshed in 2022 to ensure the most reliable, least-cost approach is used. Additional review for the program is conducted on an annual basis for completeness and accuracy to align with evolving technology standards. Cabling, adaptors, and rack components for existing assets can potentially be used with new infrastructure, and therefore are not always replaced with each new iteration of hardware. Hydro determines the need for replacement of these supporting components on an ad-hoc basis.

Table 1 outlines the complete hardware lifecycles.

Table 1: OT Evergreen Lifecycle

Device	Lifecycle
Keyboard/Video/Mouse Consoles	10 years
Firewalls	8 years
Network Clocks	10 years
Laptops	5 years
Peripherals	Run to Failure
Storage Area Networks	6 Years
Servers	8 years
Switches	10 years
Workstations/Desktops	6 years
HMI	8 Years
Anomaly Detection Sensors	Run to Failure
Immutable Backup Storage	6 Years
Secondary Video Wall	6 years
Control Center Video Wall	20 Years (Engine 10 years)

Hydro manages OT infrastructure based on defined lifecycles. The numerous assets covered under this project vary in age and are generally less than ten years old.

4.0 Analysis

4.1 Evaluation of Alternatives

Hydro evaluated the following alternatives:

- Deferral;
- Like-for-like replacement; and
- Alternative strategies.

4.1.1 Deferral

Under this alternative, system upgrades would be deferred for one additional year beyond the planned lifecycle. As noted above, Hydro's OT infrastructure lifecycle program was recently refreshed in 2022 to ensure accuracy and alignment with industry standards. Hydro believes that modifying the OT infrastructure replacement schedule to extend the use of infrastructure beyond set guidelines could lead to risks relating to security and integration with other hardware and software, and also lead to diminishing performance of technology key to managing the EMS. Deferral is not a viable alternative as upgrades will always be required for some infrastructure annually.

4.1.2 Like-for-Like Replacement

Under this alternative, components of the OT server and storage hardware will be replaced with the modern equivalent. This includes devices such as workstations, servers, HMIs, and switches. Upgrading hardware in line with Hydro's approach to OT infrastructure lifecycles is necessary to ensure the reliability of critical applications for the management of the province's electrical grid. Continuing without the proposed upgrades significantly increases the risk of failure of these critical applications and hardware.

4.1.3 Alternative Strategies

Hydro has not identified any alternative strategies for this project.

4.2 Least-Cost Evaluation

Hydro has not identified any viable alternatives to facilitate a least-cost evaluation.

4.3 Recommended Alternative

Hydro proposes to upgrade its core OT infrastructure in 2026 to ensure that Hydro has a reliable and secure environment to support EMS operations.

4.3.1 Risk of Asset Stranding

Due to the relatively short lifecycle of OT infrastructure and the criticality of the services running on this infrastructure, the risk of asset stranding is minimal. Cabling, adaptors, and rack components could potentially be used with new infrastructure.

4.3.2 Risk Mitigation

Hydro assessed the pre- and post-implementation risk of the scope of work for this project by Hydro's Capital Risk Assessment process, as outlined in Section 7.0 of Schedule 1. The outcome of this assessment is provided in Table 2.

Table 2: Risk Scoring Pre- and Post-Implementation

	Impact	Likelihood	Score
Pre-Implementation	5	4	**20**
Post-Implementation	5	2	**10**
		Risk Mitigated	**10**
		Risk Mitigated per $1 Million	**12.5**

1 # 5.0 Scope of Work

2 Hydro's Evergreen Lifecycle Program indicates that 11 OT workstations, 7 OT servers, 2 HMIs, and 5 switches require replacement in 2026. Cabling and adapters to interface servers and storage to existing infrastructure, and racking and associated components are also required for purchase. The development and testing of an OT recovery plan is also included within the scope of this project.

6 ## 5.1 Project Budget

7 The estimate for this project is shown in Table 3.

Table 3: Project Estimate ($000)

Project Cost	**2026**	**2027**	**Beyond**	**Total**
Material Supply	425.0	0.0	0.0	**425.0**
Labour	112.7	0.0	0.0	**112.7**
Consultant	159.8	0.0	0.0	**159.8**
Contract Work	0.0	0.0	0.0	**0.0**
Other Direct Costs	0.0	0.0	0.0	**0.0**
Interest and Escalation	32.4	0.0	0.0	**32.4**
Contingency	69.7	0.0	0.0	**69.7**
Total	**799.6**	**0.0**	**0.0**	**799.6**

5.2 Project Schedule

The schedule for this project is shown in Table 4.

Table 4: Project Schedule

Activity	Start Date	End Date
Planning: Open project, review schedule, and create requests for proposals.	January 2026	March 2026
Procurement: Tender and award the supply and installation contract.	March 2026	July 2026
Implementation: Installation, Implementation and commissioning of new equipment.	June 2026	November 2026
Closeout: Project closeout.	November 2026	December 2026

6.0 Conclusion

Hydro must keep its OT infrastructure current to ensure the reliability of critical applications and services used to monitor and control the province’s electrical grid. Hydro proposes the upgrade of hardware components related to Hydro’s EMS infrastructure that have aged past internal program and industry standard lifespans to ensure Hydro has a reliable and secure environment to support EMS operations.

Programs and Projects under $750,000

Programs and Projects

Under $750,000

newfoundland labrador hydro

Description of Newfoundland and Labrador Hydro ("Hydro") Proposed Programs and Projects Under $750,000 by Investment Class ($000)

General Plant			
Title	**Total Spend**	**Project/Program**	**Description**
Refurbish Meteorological Stations – Phase 2 (2026–2027)	695.5	Project	Hydro operates several meteorological measurement stations in the Bay d'Espoir and Cat Arm Reservoirs, which regularly transmit data used to make critical decisions related to hydrology, reservoir operations, and system production. Current meteorological data logging equipment at seven of Hydro's meteorological sites are at the end of their useful life and contains obsolete equipment that cannot be appropriately maintained to ensure consistent and reliable data reporting. The scope of this project also includes relocating four remote sites currently only accessible by helicopter to new locations that will provide similar environmental information, but provide road access.
Procure Accommodations (2026) – Makkovik	684.7	Project	Hydro is obligated to provide reliable power generation to the people of Makkovik. The unavailability of suitable living accommodations is impacting Hydro's ability to complete critical work, placing this isolated system at risk. It is also paramount that Hydro secure safe, reliable accommodations for its employees, without placing crews at risk of becoming stranded in the community with no access to appropriate living arrangements. To address the issue, Hydro is planning to purchase dedicated accommodations within Makkovik.
Migrate Legacy Applications (2026)	611.0	Project	Hydro has legacy Information Systems ("IS") custom-built applications that require replacement due to platform supportability and compatibility issues with new technologies, and exposure of the system to cybersecurity vulnerabilities. In 2026, Hydro will replace 12 of its custom-built applications with newer, standard, and custom technology solutions. The new technologies will offer better integration with existing tools and additional security features. Costs will be allocated by Hydro to each entity via the IS Administration Fee.

General Plant (Cont'd)			
Title	**Total Spend**	**Project/Program**	**Description**
Rollout Document Control System (2026)	607.3	Project	Hydro requires document control software with functionality to maintain version control and history, including the management of technical drawings and specifications for engineering. This functionality ensures control is maintained for critical documentation, such as engineering drawings, as they evolve over the life of assets. The project addresses the requirement for an electronic Document Management System that was identified in an Information Management Assessment conducted by a third party in 2024. Hydro is proposing to roll out its Document Management System for the management of technical drawings and specifications.
Replace Walkway to Toe of Dam (2026–2027) – Paradise River	582.9	Project	The scope of the project includes the demolition of the current walkway, a consultant evaluation of the nearby rock face, and the subsequent construction of a new walkway. Construction of a new walkway mitigates worker safety risks and enables prompt implementation of corrective measures, contributing to the long-term integrity and stability of the Paradise River Hydroelectric Generating Station ("Paradise River") dam.
Replace GRID Application (2026–2027)	498.8	Project	This project is proposed to replace Hydro's existing intranet with a modern, new, supported platform. The current platform lacks compatibility with modern technologies, exposing the system to cybersecurity vulnerabilities. The new intranet platform will offer better integration with existing tools, ensuring continued vendor support and additional security features. Costs will be allocated by Hydro to each entity via the IS administration fee.
Replace Back-up Generators at Microwave Repeater Sites (2026–2027)	485.8	Project	Hydro operates and maintains a private telecommunications transport network which provides critical connectivity to terminal stations and generating stations, including 14 microwave radio repeater sites located across the island portion of the province. Support systems for these sites include 48V batteries and rectifiers, a backup generator and transfer switch, HVAC,[1] fire suppression, site monitoring, and administrative network connectivity for remote access and telephony. This project proposes to replace four propane generators and associated transfer switches at four sites, which have reached the end of service life, with new units to ensure the reliable operation of Hydro's microwave repeater sites.

[1] Heating, Ventilation, and Air Conditioning ("HVAC").

General Plant (Cont'd)

Title	Total Spend	Project/Program	Description
Install CCTV Systems (2026)	450.2	Project	To address physical security concerns, Hydro currently operates Internet Protocol-based Closed Circuit Television ("CCTV") systems at some operating sites. This project is required to expand Hydro's coverage of CCTV systems to ten additional Hydro sites. These systems are required to improve physical security at Hydro's sites and to enable the ability to detect and/or deter unauthorized access and theft. These activities represent a safety risk to the public and personnel, and a financial risk to Hydro and its customers; installation of such equipment will mitigate these risks.
Modify Office Buildings and Procure Furniture, Fixtures, and Equipment (2026)	447.5	Program	Hydro is required to perform office retrofits and purchase office furniture, tools, and equipment to support operations at its office facilities. Existing furniture and equipment assets have a short average lifespan of approximately five years; as such, unanticipated failures and deterioration of these assets are likely to occur. Office retrofits are typically driven by changes in the organizational structure, which require spatial changes in the physical environment, or unforeseen requests to accommodate departmental or individual employee needs. This program allows for the immediate capital refurbishment and replacement work required in such cases, with the 2026 scope focusing on Hydro Place. Purchases may include new equipment to address in-service failures or purchases of capital spares. Any delay in replacing existing equipment that has failed or is underperforming, or accommodating the needs of the changing business, has the potential to disrupt business operations or performance levels.
Update Cybersecurity Infrastructure (2026)	413.3	Project	Hydro's computer systems and network infrastructure require continuous protection from cyber threats. In 2026, this project will refresh Hydro's cybersecurity infrastructure by upgrading firewalls, configuring and replacing network switches, completing network segmentation for video upgrade replacements, and miscellaneous upgrades. Hydro proposes this project to ensure it has adequate cybersecurity tools to mitigate security threats to Information Technology and Operating Technology infrastructure. A serious incident involving the loss of corporate data or access to critical business, plant, or energy control systems could result in significant unplanned costs and negatively affect financial results, reputation, customers (i.e., reliability), and the province's electricity grid. Costs will be allocated by Hydro to each entity via the IS Administration Fee.

General Plant (Cont'd)			
Title	**Total Spend**	**Project/Program**	**Description**
Backup Critical Control Systems (2026) – Holyrood	329.4	Project	The Holyrood Thermal Generation Station ("Holyrood TGS") has many complex software systems used to manage equipment, ensuring safe and reliable operations. The Distributed Control System and Burner Management System are the primary systems used to monitor and control the station. The current method of backup for these systems is not reliable and is a risk to the operation of the station. In the event of system failure, without a reliable backup system, a significant amount of time would be required to rebuild the infrastructure, configure the control systems, and return to service. With off-site back-ups completed over a network, in the event of a failure that leads to a loss of software, restoration could be completed quickly and accurately. The proposed solution will leverage existing Operational Technology infrastructure with some additional hardware to accommodate Holyrood TGS systems to allow critical system backups to be completed and stored off-site.
Replace UPS System – Back Up Control Center (2026) – Holyrood	322.8	Project	This project is proposed to replace the existing Back-up Control Center ("BCC") Uninterruptible Power Supply ("UPS"), which will reach the end of its 20-year service life in 2026. Since installation, the site load has more than doubled, reducing the battery runtime and associated response time by approximately 50%. Operating the UPS beyond its useful service life increases the likelihood of failure, affecting the ability to complete repairs in a timely manner. If the UPS were to fail, power to critical backup equipment would be lost, limiting Hydro's ability to operate the electrical system and perform other business-critical functions during a disaster scenario. This project will replace the existing BCC UPS and batteries with a unit to meet current and future site needs.
Purchase Mobile Devices (2026)	315.9	Program	This program is proposed to replace mobile devices at the end of the lifecycle following Hydro's established replacement criteria, mitigating the risk of device malfunction, lost productivity, and unplanned replacement expenses. Using mobile devices that are beyond their end of life could impede Hydro's ability to communicate effectively and securely. An allowance for net new devices and unplanned replacements is also included in the budget.

General Plant (Cont'd)

Title	Total Spend	Project/Program	Description
Implement Safety Audits and Inspections System (2026)	304.7	Project	As part of its Safety and Health Monitoring Plan, Hydro monitors its compliance with safety and health requirements, with auditing activities identified and planned based on risk, operational control, safety and health objectives, and/or legal and other requirements. Audits and assessments are currently paper-based and completed via a manual process. This project proposes to implement an electronic solution for safety audits and inspections, based on defined business requirements and supported by recent safety incident investigation recommendations and Environmental Management System audit findings. The implementation of this electronic system will improve accessibility to real-time data from audits and assessments, increase oversight of the Safety and Health Monitoring Plan, and improve efficiency and analytical ability to report on the resulting data. Costs will be allocated by Hydro to each entity via the IS Administration Fee.
Replace Peripheral Infrastructure (2026)	278.5	Program	Hydro maintains peripheral equipment to support and conduct business processes such as printing, scanning, and presentations. The current peripheral hardware replacement lifecycle ranges from six to ten years based on equipment type and support arrangements. Devices to be replaced under this project have been in service for a period beyond the expected service life and have exceeded their expected useful life. Replacement parts may not be available as maintenance agreements and warranties have expired. Failure of, and technological issues with, this equipment could result in loss of productivity and interrupt key activities. In 2026, the program will replace approximately 18 printing devices, one plotter, and 15 display units. Costs will be allocated by Hydro to each entity via the IS Administration Fee.
Perform Software Upgrades and Minor Enhancements – Operational Technology (2026)	262.8	Project	Hydro maintains many software systems and applications to support its business processes. Upgrades and enhancements are planned regularly to improve the functionality and security of systems and applications. This project includes planned upgrades and enhancements to Hydro's Operational Technology software and allows Hydro to respond to additional unforeseen requests for system improvements that cannot be deferred to a subsequent year.

General Plant (Cont'd)

Title	Total Spend	Project/Program	Description
Upgrade Remote Terminal Units (2026)	252.2	Program	This program is required to replace obsolete Remote Terminal Units ("RTU") processor cards. Hydro uses RTUs to remotely control equipment and to transmit real-time grid performance information from the equipment site to the Energy Control Center, helping to maintain reliability and respond to issues as they arise. Obsolete processor failures will lead to forced and unscheduled upgrades of the RTU, resulting in Supervisory Control and Data Acquisition outages and continual staffing to maintain operations and prevent prolonged customer outages. In 2026, Hydro anticipates the upgrade of six RTUs with new processors, selected for upgrade based on criticality or impact on the system, as well as other planned capital and operations work occurring in the same year. New processors also have enhanced monitoring, control, and security functionality.
Telecommunications In-Service Failures (2026)	123.6	Program	The Telecommunications In-Service Failures Program will allow Hydro to undertake timely refurbishment and replacement work that is not included in its Preventive Maintenance Program, supporting Hydro's effort to maintain safe and reliable operations. Hydro operates a telecommunication network that serves more than 150 operational and administrative sites province-wide and provides critical services to the real-time operation and reliability of the electrical system. Due to the quantity, geographical spread, and variety of the telecommunications assets, unanticipated failures and deterioration are likely to occur. This program mitigates the risk of detrimental impacts of failures to customer power supply, threats to the reliability of the network, or unacceptable risks to worker or public safety. This program will also allow Hydro to continue to proactively manage the pool of critical spare parts to meet its telecommunications requirements.

Mandatory			
Title	**Total Spend**	**Project/Program**	**Description**
Purchase Meters and Metering Equipment (2026)	705.6	Program	Hydro is required under legislation to provide reliable and accurate revenue metering to its customers and maintain compliance with the Government of Canada's *Electricity and Gas Inspection Act and Regulations*. This program will enable Hydro to purchase new meters for its inventory of residential, commercial, and industrial customer base to ensure meter availability for new service applications and replacements as required. The program mitigates the risk associated with meeting regulatory requirements and inaccurate readings and maintains the integrity of the metering installations.

Renewal			
Title	**Total Spend**	**Project/Program**	**Description**
Perform Major Inspection – Synchronous Condenser 1 (2026–2027) – Wabush Terminal Station	743.7	Project	This project supports the reliable operation of synchronous condensers through the optimal timing of condition assessment and refurbishment. The Level 2 Condition Assessment requires the synchronous condensers to be partially dismantled to complete electrical testing and the inspection of bearings, resistance rings, stators, rotors, and other internal components. It also requires the rotor to be pulled from the unit for a thorough inspection. These activities on synchronous condensers are required to identify equipment, environmental, safety, and reliability deficiencies. Preparation of contract documentation and technical conditions will take place in 2026, with the assessment and refurbishment activity occurring in 2027.
Replace Fuel Storage Tanks (2026) – Happy Valley	696.4	Project	The Happy Valley Gas Turbine features three horizontal diesel fuel tanks, each with a capacity of approximately 55,000 Litres, and with their own built-in containment system. These three horizontal fuel tanks are original to the facility, have reached their expected useful service life, and require replacement due to age. Replacement of fuel storage tanks at the Happy Valley Gas Turbine is required to maintain the continuity of supply of fuel to the generating unit. Failure to complete the proposed replacement could result in tank failure, requiring environmental remediation and additional costs associated with emergency replacement, and impact the availability of the generating unit due to reduced plant fuel storage capacity. The existing horizontal fuel storage tanks will be replaced with three new double-walled, vacuum-sealed, vertical tanks to align with Hydro's internal standards, each with a capacity of approximately 60,000 Litres.

Renewal (Cont'd)

Title	**Total Spend**	**Project/Program**	**Description**
Perform Level 2 Condition Assessment – North Salmon Spillway (2026) – Upper Salmon	636.5	Project	Constructed in the early 1980s, the North Salmon Spillway includes a concrete gated spillway equipped with three steel vertical slide gates. An inspection completed in 2015 indicated varying levels of concrete deterioration, particularly along the downstream side of the gate guides. This project involves the completion of a Level 2 Condition Assessment of the North Salmon Spillway, including the superstructure, gates, concrete, embedded parts, and support building and electrical components. This information will allow Hydro to comprehensively evaluate the integrity of the structure, identify deficiencies, and prioritize mitigation measures to optimize the long-term performance and reliability of this critical asset.
Perform Level 2 Condition Assessment – Condenser and Condenser Tubes (2026–2027) – Holyrood	629.0	Project	Condenser tubes within each unit at the Holyrood TGS are exposed to corrosive effects of seawater and steam, combined with the effects of high temperature and pressure of the steam, which lead to tube wall cracking, thinning and leakage. Condenser tube leaks lead to an increased back pressure on the turbine, resulting in decreased efficiency of power generation at Holyrood TGS for the same level of steam input. This project consists of a Level 2 Condition Assessment of the condenser, including a thorough internal visual inspection to identify visible signs of damage, corrosion, erosion, fouling, or mechanical wear on condenser components. Additionally, eddy current testing, a non-destructive testing technique, will be employed to detect defects, corrosion, cracks and wall thinning in the condenser tubes without the need for tube removal. These inspections are critical in mitigating the risk of condenser tube leaks and internal component failures by assessing the condition of the condenser and identifying areas of concern that may require repair or replacement.
Replace Instrument Transformers (2026–2027)	567.3	Program	Instrument transformers included in the Replace Instrument Transformers Program are used continuously to measure current or voltage in a terminal station. Instrument transformers are critical components allowing the protection, control, and metering systems within their terminal stations to function properly. Under this program, six instrument transformers will be replaced due to age. Extending the in-service time of these units past the manufacturer-recommended design life increases the risk of in-service failures.

Renewal (Cont'd)

Title	Total Spend	Project/Program	Description
Replace Terminal Station Battery Banks and Chargers (2026–2027)	562.8	Program	Battery banks and chargers are used to supply direct current ("dc") power to critical terminal station components (such as circuit breakers, protection and control relays, and disconnect switch motor operators) and provide alternating current ("ac") power in the event of a loss of the normal supply. This program reviews battery banks and chargers and recommends replacement based on age, following Hydro's established practices and Terminal Stations Asset Management Strategy. For this year's program scope, four battery chargers at four sites and two battery banks at two sites have been identified for replacement. Failure to replace these assets could result in station service outages at the affected operational sites, which would result in a station outage and additional costs associated with emergency replacements.
Inspect Fuel Storage Tanks (2026) – Rigolet	504.8	Project	Inspection of fuel storage tanks is required to ensure compliance with regulatory requirements, identify necessary maintenance and repair items, and maximize forecasted remaining asset service life. In 2026, Hydro will inspect the two vertical fuel storage tanks at the Rigolet Diesel Plant in accordance with its tank inspection program, which targets internal inspection of its storage tanks on a 10-year interval.[2] The completion of the proposed inspections will highlight internal tank defects, enable the completion of identified refurbishments, and extend the service life of the assets. Failure to complete the proposed inspections in accordance with the inspection schedule could result in tank failure, requiring environmental remediation, and impact the availability of the generating unit due to reduced plant fuel storage capacity.

[2] Hydro notes that the proposed inspection is for the tanks that will not be replaced under the Additions for Load Growth – Rigolet Unit 2065 Replacement and Fuel Storage Upgrades supplemental project, which will install three new horizontal tanks in 2025 as approved in Board of Commissioners of Public Utilities Order No. P.U. 25(2024).

Renewal (Cont'd)

Title	**Total Spend**	**Project/Program**	**Description**
Gas Turbine In-Service Failures (2026)	500.1	Program	The Gas Turbine In-Service Failures program will allow Hydro to undertake timely refurbishment and replacement work that is not included in its preventive maintenance program, supporting Hydro's effort to maintain safe and reliable operations. This program will also allow Hydro to continue to proactively manage the pool of capital spare equipment to support gas turbine generation operations. Failure to continue this program could result in a detrimental impact to customer power supply or an unacceptable risk to workers or public safety.
Perform Dam Infrastructure Refurbishments (2026)	500.0	Project	On the Island, Hydro's reservoir system is comprised of more than 80 dykes, dams and hydraulic structures, with the majority of these structures being of earth and rockfill construction. Structures are primarily located throughout the southern, central, and northern parts of the province. Hydro employs a Dam Safety Management System for all structures, which requires ongoing refurbishment work to ensure continued safe operation. In 2026, the scopes to be completed under this project include refurbishment and replacement of dam instrumentation, as well as riprap replacement for locations which have been identified in recent studies as having significantly undersized riprap for the embankments.
Replace Parts of Stage 1: 129 Vdc Batteries and Battery Chargers (2026–2027) – Holyrood	329.2	Project	The purpose of this project is to replace the Holyrood TGS Stage 1: 129 Vdc battery bank and its two associated chargers, following Hydro's established practices. The battery bank is crucial for the operation of Unit 1 and Unit 2 at Holyrood and will reach the end of its service life in 2026 based on age. A loss of dc power could result in catastrophic turbine failure and disrupt dc power to key protection, control, and metering systems for critical plant equipment, including the turbine, generator, backup diesel, auxiliary systems, and life safety systems. Replacing this asset will help ensure the continued function of these units and systems and reduce the risk of 340 MW of generation capacity being unavailable to the power system, potentially affecting grid stability and system reliability.

Renewal (Cont'd)

Title	**Title**	**Title**	**Title**
Replace Air Dryer (2026–2027) – Hardwoods	273.2	Project	The Hardwoods Gas Turbine compressed air system supplies air to gas turbine starters and the pneumatic snow door actuation system. The compressed air system plays a critical role in the operation of the gas turbine, and includes two compressors, air storage tanks, an air dryer, and associated piping designed to support up to three consecutive gas turbine starts. The air dryer located at the Hardwoods Gas Turbine is original to the facility and is recommended for replacement based on age and obsolescence. Failure to replace this asset could result in the inability to start the unit, causing a forced outage until the air dryer is either replaced or temporarily bypassed. As communicated in Hydro's 2024 Resource Adequacy Plan,[3] Hydro is supporting the continued operation of the unit through the Bridging Period;[4] thus, it is prudent to complete this replacement. In the event that the Hardwoods Gas Turbine is no longer required and decommissioned, this air dryer can be relocated to a number of different Hydro facilities for re-use.
Perform Level 2 Condition Assessment – Penstock 4 (2026) – Bay d'Espoir	237.2	Project	Hydro is proposing this project of external inspections and Level 2 Condition Assessments to support the reliable operation of its hydraulic generation fleet and is recommending Penstock 4 at the Bay d'Espoir Hydroelectric Generating Station for review in 2026. Since 2018, Hydro has set up a framework to carry out Level 2 Condition Assessments of the penstocks on a six-year frequency. This allows Hydro to assess the current condition and degradation rate of the penstocks to help develop a plan to ensure long-term reliability. Completing this work during a planned outage in 2026 will allow Hydro to perform critical trending on the condition of the penstock, facilitating informed decisions on any future maintenance.

[3] "2024 Resource Adequacy Plan – An Update to the Reliability and Resource Adequacy Study," Newfoundland and Labrador Hydro, rev. August 26, 2024 (originally filed July 9, 2024).
[4] Hydro considers the Bridging Period to be from the present to 2030. During the Bridging Period, the system would rely primarily on existing sources of generation capacity to maintain reliability while new generation capacity is being built. The primary, readily available supply options in this period are extending the retirements of the Holyrood TGS, Stephenville Gas Turbine and the Hardwoods Gas Turbine until their capacities can be adequately replaced.

Renewal (Cont'd)

Title	Total Spend	Project/Program	Description
Perform Level 2 Condition Assessment – Penstock (2026) – Hinds Lake	209.6	Project	Hydro is proposing this project of external inspections and Level 2 Condition Assessments to support the reliable operation of its hydraulic generation fleet and is recommending the penstock at the Hinds Lake Hydroelectric Generating Station for review in 2026. Since 2018, Hydro has set up a framework to carry out external inspections and internal Level 2 Condition Assessments of the penstocks on a six-year frequency. This allows Hydro to assess the current condition and degradation rate of the penstocks to help develop a plan to ensure long-term reliability. Completing this work during a planned outage to the Hinds Lake unit in 2026 will allow Hydro to perform critical trending on the condition of the penstock, facilitating informed decisions on any future maintenance.
Transmission In-Service Failures (2026)	183.4	Program	The Transmission In-Service Failures Program allows Hydro to undertake timely refurbishment and replacement work that is not included in its preventive maintenance program, supporting Hydro's effort to maintain safe and reliable operations. This program mitigates the risk of detrimental impacts of failures to customer power supply or unacceptable risks to worker or public safety. This program will also allow Hydro to continue to proactively manage the pool of capital spare equipment to support its transmission system. Hydro's transmission assets deliver the majority of customer power needs throughout the province.
Replace Battery Bank (2026–2027) – Granite Canal	183.0	Project	Battery banks are used to supply dc power to critical station components (such as circuit breakers, protection and control relays, and disconnect switch motor operators) and provide ac power in the event of a loss of the normal supply. This project proposes the replacement of the 125 Vdc battery bank at the Granite Canal Powerhouse, which has reached the end of its service life based on age, following Hydro's established practices. Failure to replace the asset could result in station service outages at the Powerhouse and 40 MW of generation capacity being unavailable to the power system, potentially affecting grid stability and system reliability.

Renewal (Cont'd)			
Title	**Title**	**Title**	**Title**
Replace dc Fuel Pump (2026–2027) – Hardwoods	148.8	Project	The Hardwoods Gas Turbine dc fuel pump is required to deliver fuel in the event of issues with both the primary and auxiliary pumps, or if there is a loss of ac station service. This liquid fuel system is driven by a dc motor and plays a critical role in the operation of the gas turbine, ensuring the unit remains operational during ac station service loss and supplies fuel during a black start scenario. The dc fuel pump located at the Hardwoods Gas Turbine is original to the facility and is recommended for replacement based on age and obsolescence. As communicated in Hydro's 2024 Resource Adequacy Plan, Hydro is supporting the continued operation of the unit through the Bridging Period; thus, it is prudent to complete this replacement.
Replace 125 Vdc Battery Bank (2026–2027) – Hardwoods	146.7	Project	Battery banks are used to supply dc power to critical station components (such as circuit breakers, protection and control relays, and disconnect switch motor operators) and provide ac power in the event of a loss of the normal supply. This project proposes the replacement of the 125 Vdc battery bank at the Hardwoods Gas Turbine, based on age, as it will reach the end of its useful service life in 2026, following Hydro's established practices. Failure to replace the asset could result in station service outages at the Hardwoods Gas Turbine, and 50 MW of generation capacity being unavailable to the power system, potentially affecting grid stability and system reliability.

Service Enhancement

Title	Total Spend	Project/Program	Description
Replace Expansion Joint and Rock Scaling (2026–2027) – Paradise River	747.3	Project	Hydro is proposing this project to replace the existing penstock slip pipe expansion joint at Paradise River with a modern, more reliable design. To ensure worker safety during the replacement, necessary rock scaling, screening, and bolting will be carried out in the rock tunnel before the new joint is installed. While the penstock remains in good operational condition, recurring issues with the expansion joint have persisted over the past decade. Previous efforts to address leaks—such as patching and packing material replacements—have provided only temporary solutions, with failures leading to forced outages and increased safety risks. Given the degraded condition of the expansion joint and the potential hazards associated with rock falls, continued reliance on packing replacement is no longer viable. This project proposes a proactive approach that will enhance the long-term reliability of the system while minimizing safety risks, maintenance requirements in a hazardous area, and overall operational costs by eliminating the need for frequent packing replacements. This upgrade also mitigates the risk of joint failure, which could otherwise lead to significant generation losses and potential damage to critical powerhouse equipment due to flooding, ultimately ensuring stable and cost-effective services.
Upgrade Cooling (2026–2027) – Hardwoods	445.1	Project	Several auxiliary systems are essential for the operation of the Hardwoods Gas Turbine, with the lubrication oil and glycol cooling systems being among the most critical. The function of the main lube oil system is to supply oil for lubrication of the power turbine, journal and thrust bearings, clutch bearings, generator bearings, exciter journal bearings and jacking pumps. The lube oil and glycol systems are original to the facility and are recommended for modernization upgrades to enhance reliability and efficiency. Failure to complete the upgrade results in a 60% reduction in the capacity of the facility when the ambient air temperature and relative humidity increase above 25 degrees Celsius and 60% respectively, due to lube oil bearing drain temperatures reaching alarm values. The Hardwoods Gas Turbine is frequently operated during periods of high ambient temperatures to ensure the loading of TL201/217 remains within their reliability guidelines. As communicated in Hydro's 2024 Resource Adequacy Plan, Hydro is supporting the continued operation of the unit through the Bridging Period; thus, it is prudent to complete this upgrade.

Service Enhancement (Cont'd)

Title	Total Spend	Project/Program	Description
Upgrade Excitation System (2026–2027) – Paradise River	422.2	Project	The excitation system is a critical component of operations at Paradise River, providing continuous dc power to the turbine rotor winding. The current excitation system has been in service for over 35 years and has reached the end of its useful service life. Failure of this asset could result in a loss of precise voltage control and the inability to synchronize the generation unit to the grid. This project will upgrade the existing excitation system to a modern, digitally-controlled unit, which will include functionality in self-monitoring, fault detection, event recording, and sequence of event data collection to support the continued reliable operation of Paradise River.
Upgrade Terminal Station for Mobile Substation (2026–2027) – St. Anthony Diesel	394.7	Project	The St. Anthony Diesel Plant Terminal Station yard is not large enough to allow the installation of a mobile substation inside the existing fenced area, nor does its ground grid extend to any area in which a mobile substation can be placed. Extension of the St. Anthony Diesel Plant Terminal Station to accommodate a permanent, fenced, mobile laydown area with an upgraded ground grid provides an increased level of safety for workers and members of the public and improves reliability for the service area through reduced outage time.
Remove Safety Hazards (2026)	240.6	Program	The Remove Safety Hazard program ensures Hydro can remove potential hazards in situations where immediate refurbishment or replacement must be completed due to the safety hazard imposed on customers, employees, contractors, and the general public. The program is required as part of Hydro's legislated obligation to provide a safe work environment for its employees in compliance with the Newfoundland and Labrador Occupational Health and Safety Regulations. This program will rectify these safety hazards in a timely manner.
Perform Minor Telecommunications Enhancements (2026)	175.5	Program	Hydro's communications network provides connectivity for users to access critical business systems that enable day-to-day operations. Requests for immediate business needs are made of Network Services for minor capital expenditures to respond to business needs, improve service delivery, or reduce recurring operating expenditures (i.e., monthly service fees). Examples of requests include expansion of network coverage to unserved facilities, increases to bandwidth, additional telecommunications equipment, and enhancements to remote monitoring capability and communication site facilities. Hydro proposes to bundle such requests under this program to mitigate risks associated with failing to respond to business requirements, network connectivity to field locations, and the ability to achieve cost savings.

Schedule 8

Major Projects – Five-Year Capital Plan (2026–2030)

2026 Capital Budget Application

Major Projects Five-Year Capital Plan (2026–2030)

Contents

List of Appendices

1.0 Introduction

Beginning in its 2026 Capital Budget Application ("CBA"), Newfoundland and Labrador Hydro ("Hydro") has segregated its five-year capital expenditure plan between regulated projects and programs under $50 million, and those with an anticipated cost of $50 million or greater ("Major Projects"). Major Projects are executed under the accountability of Hydro's Major Projects department.

The capital plan for Major Projects is provided in line with the Board of Commissioners of Public Utilities ("Board") direction as outlined in Board Order Nos. P.U. 30(2007),[1] and P.U. 28(2024).[2] This report provides an overview of Major Projects capital expenditures for the 2026–2030 period, as well as those associated with Bay d'Espoir and its capital plan for the 2031–2035 period.

Hydro's Major Projects capital plan, provided as Appendix A to this schedule, was developed consistent with its investment philosophy to invest responsibly in the electrical system to the benefit of its customers. Hydro's Major Projects Five-Year Capital Plan (2026–2030) reflects the major capital investments necessary to maintain infrastructure and provide safe, reliable, least-cost electricity for customers, while aiming to balance cost, reliability, and environmental impacts.

The majority of Major Projects' capital expenditures are related to the installation of Bay d'Espoir Unit 8 and the Avalon Combustion Turbine ("Avalon CT"), as outlined in the 2025 Build Application.[3] Looking ahead to the 2026–2035 period, significant investment requirements are primarily for Bay d'Espoir, with the most significant expenditures including installation of Bay d'Espoir Unit 8, life extension of Penstock 2 and Penstock 3, and a life extension of the Unit 7 turbine. At this time, Hydro's Major Projects five-year capital plan excludes any future application by Hydro for the long-term supply for Southern Labrador, as Hydro is currently reviewing, studying, and implementing ways to ensure that Charlottetown, Pinsent's Arm, and the other communities in the region receive safe, reliable service

[1] Board Order No. P.U. 30(2007), p. 5/37–42.
[2] In Board Order No P.U. 28(2024), the Board directed Hydro to file, in conjunction with its 2026 CBA, a report about the Bay d'Espoir Hydroelectric Generating Station ("Bay d'Espoir"), addressing the capital plan for this facility over the 2026–2035 period.
[3] "2025 Build Application – Bay d'Espoir Unit 8 and Avalon Combustion Turbine," Newfoundland and Labrador Hydro, March 21, 2025.

now, and long term. This work is underway, intended to supplement the data Hydro has previously developed for its application.[4]

In this report, Hydro has provided a discussion of the major drivers of expenditure in each of the investment classifications.

2.0 Status of Major Projects Applications

The Major Projects discussed within this capital plan are in various stages of the capital planning and execution stages.

In the 2024 Resource Adequacy Plan,[5] Hydro recommended the Minimum Investment Expansion Plan that meets reliability standards while balancing cost and environmental considerations. The preferred, least-cost, environmentally responsible resource options under this recommendation are a combustion turbine with renewable fuel capabilities on the Avalon Peninsula and Bay d'Espoir Unit 8. Hydro subsequently applied for these projects in the 2025 Build Application, which is currently under review before the Board. Hydro also applied for Board approval of an Early Execution Application that will mitigate risks associated with supply chain delays and market pressures to allow for project continuity through year-end 2025, while the Board and parties consider the 2025 Build Application.[6]

In addition to the Avalon CT and Bay d'Espoir Unit 8 projects, which are driven by system growth, Hydro is also currently undertaking or planning to undertake several renewal projects to extend the life of assets in Bay d'Espoir, including:

- The approved Penstock 1 life extension;[7]
- Unit 7 life extension, which is currently under review before the Board;[8] and
- The planned life extensions of Penstock 2 and Penstock 3.

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[4] For further information, please refer to "Newfoundland and Labrador Hydro's 2021 Capital Budget Supplemental Application for Approval of the Construction of Hydro's Long-Term Supply Plan for Southern Labrador – Update," Newfoundland and Labrador Hydro, June 25, 2025.
[5] "2024 Resource Adequacy Plan – An Update to the Reliability and Resource Adequacy Study," Newfoundland and Labrador Hydro, rev. August 26, 2024 (originally filed July 9, 2024).
[6] In Board Order No. P.U. (17)2025, the Board approved Hydro's application to proceed with $47.4 million of early execution work for the Avalon CT and Bay d'Espoir Unit 8 projects.
[7] As approved in Board Order Nos. P.U. 6(2023) and P.U. 26(2024).
[8] "Life Extension Application – Bay d'Espoir Unit 7," Newfoundland and Labrador Hydro, June 20, 2025.

Hydro began its penstock life extension work in 2023, with the receipt of approval for Phase 1 of this initiative, which involves the refurbishment of Penstock 1 at Bay d'Espoir.[9] For Phase 2, Kleinschmidt Group ("Kleinschmidt") is undertaking a review of the findings from inspections on Penstocks 2 and Penstock 3, which were completed in 2024 and will provide recommendations for future life extension work. Kleinschmidt's recommendations will be considered in the project planning for the life extension projects for Penstocks 2 and Penstock 3, planned to commence in 2029 and 2026, respectively. Hydro is currently completing front-end planning for Phase 2 of the project and intends to put forward an application to the Board for Penstock 3 in 2026.

3.0 Five-Year Capital Plan Overview

Hydro's Major Projects five-year capital plan reflects an investment of approximately $1.97 billion in plant and equipment over the 2026–2030 period. The average total annual capital expenditure for Major Projects is approximately $394.4 million.

Chart 1 outlines the total planned capital spend per year from 2026 to 2030 related to Major Projects.

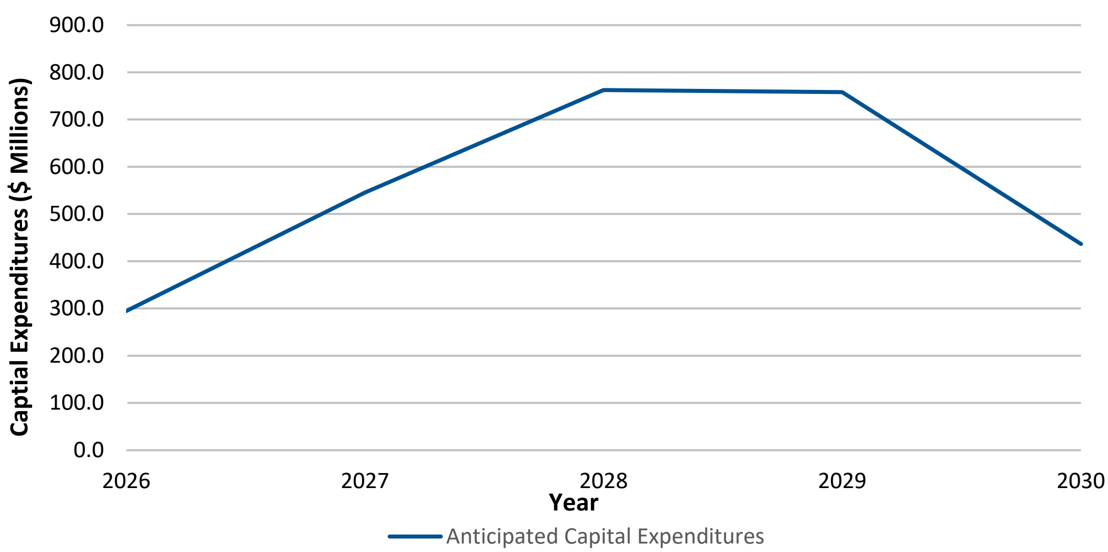

Chart 1: Total Anticipated Major Projects Capital Expenditures (2026–2030)[10]

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[9] In Board Order No. P.U. 26(2024), the Board directed Hydro to report monthly on the execution of the project, including expenditures to date. The most recent report was provided within "Bay d'Espoir Penstock 1 Life Extension Project Update for the Period Ended April 30, 2025," Newfoundland and Labrador Hydro, June 18, 2025.

[10] The shown values represent a portfolio of project estimates generally considered a Class 3 Association for the Advancement of Cost Engineering ("AACE") classification. The "Authorized Cost" for each estimate includes management reserve, contingency, escalation, interest during construction and the base cost estimate.

The projects identified for 2026–2030 are required for system growth and renewal-driven capital.

As shown in Chart 1, total projected spending rises to a peak in 2028, followed by a decline due to the construction schedules of the proposed infrastructure required to increase the generation capacity of existing assets to meet evolving electricity needs.

Through Hydro's ongoing *Reliability and Resource Adequacy Study Review* proceeding ("*RRA Study Review*"), Hydro identified the need for additional generation to meet load growth and system reliability requirements. In the most recent update, the 2024 Resource Adequacy Plan, Hydro focused on the production of an Island Interconnected System Expansion Plan that satisfied both capacity and energy requirements. In the 2024 Resource Adequacy Plan, Hydro recommended the Minimum Investment Expansion Plan. The Minimum Investment Expansion Plan indicates the need for additional generating assets to: (i) ensure reliable system operation in the event of an extended outage on the Labrador-Island Link; and (ii) accommodate anticipated load growth on the Island Interconnected System.[11] A Settlement Agreement arising out of the *RRA Study Review* and the review of the 2024 Resource Adequacy Plan was agreed to by the parties[12] and Hydro filed its application for additional generation in March 2025 for two critical additions to the resource supply—a new 154 MW unit at Bay d'Espoir (Unit 8) and a new 150 MW combustion turbine on the Avalon Peninsula. As such, Hydro's planned system growth expenditures trend significantly upward over the 2026–2030 period, primarily as a result of the execution of major projects required for additional generation. Hydro also recognizes that transmission capacity expansion will be required to address transmission bottlenecks; in support of Hydro's expansion plans, Hydro is exploring the viability of technical options, including special protection schemes and dynamic line rating, which would help minimize the transmission investment required and inform a future capital application, if required. Hydro anticipates that further details regarding these potential investments will be provided through the *RRA Study Review;* therefore, pending confirmation of Hydro's plan to address these constraints, these expenditures have been excluded from the capital plan at this time. Future Major Projects may be included as system demands continue to evolve and will be incorporated into Hydro's five-year capital plan, consistent with the outcomes of the *RRA Study Review* at that time.

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[11] *Supra*, f.n. 5.

[12] "2025 Build Application – Bay d'Espoir Unit 8 and Avalon Combustion Turbine," Newfoundland and Labrador Hydro, March 21, 2025, sch. 2.

Renewal expenditures are largely driven by the age of Hydro's assets. The majority of Hydro's assets, including the hydroelectric installation at Bay d'Espoir, are more than 40–50 years old and require prudent sustaining capital investment to ensure their continued safe and reliable operation. Renewal-driven capital investments include Major Projects to extend the life of Unit 7 and Penstock 1,[13] Penstock 2, and Penstock 3 at Bay d'Espoir. Front-end planning and design is ongoing for the life extension projects for Penstock 2 and Penstock 3 which may impact the timing, cost and scope of these projects upon Hydro's submission of an application to the Board for approval; however, high level estimates of these expenditures have been included in Hydro's Major Projects Five-Year Capital Plan (2026–2030).[14]

4.0 Investment Drivers

In accordance with the provisional CBA Guidelines,[15] and continuing its approach initially presented in the 2023 CBA, Hydro has provided a discussion of significant expenditures within each investment classification. This approach allows Hydro to focus its analysis and discussion of planned expenditures to highlight major drivers of investment across its assets. Hydro recognizes that segmentation by asset category also provides valuable insight into its strategy and the drivers of planned investment in its assets; all proposed Major Projects for the 2026–2030 period are classified within the generation category.

Hydro's five-year planned expenditures for the period 2026–2030 are presented in Chart 2. The drivers of investment are provided herein, all of which have been segmented by investment classification.

[13] The life extension project for Penstock 1 is anticipated to be complete in 2025.
[14] Hydro's five-year capital plan may be updated as more details become available. Currently, Hydro forecasts the installation of the new Avalon CT and construction of Bay d'Espoir Unit 8, with the majority of these costs expected in 2028 and 2029.
[15] "Capital Budget Application Guidelines (Provisional)," Board of Commissioners of Public Utilities, January 2022.

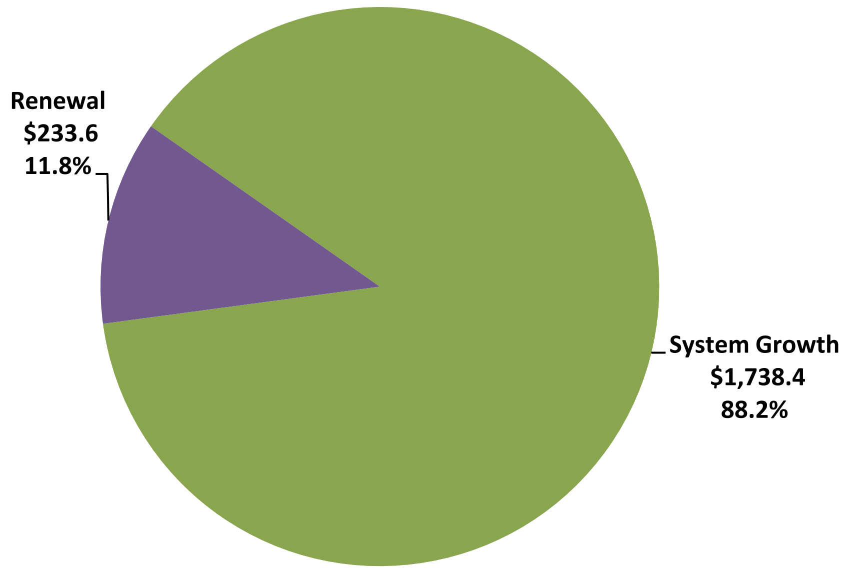

Chart 2: Five-Year Anticipated Authorized Capital Expenditures by Investment Classification (2026–2030) ($ Millions)[16]

4.1 System Growth

Projects and programs classified as "system growth" are those that are required to modify Hydro's system to meet forecast changes in customers' electricity resource requirements. Major Project system growth accounts for $1.7 billion, or approximately 88%, of Hydro's anticipated Major Project capital expenditures for the next five years.

Hydro's Major Project planned system growth expenditures for the period 2026–2030 are provided in Appendix A. As forecast, within the 2026–2030 period, Hydro's planned system growth Major Project expenditures trend significantly upward, followed by a decline, primarily as a result of the execution of multiple major projects required for additional generation on the Island Interconnected System to respond to a rapidly changing energy landscape. As per the findings of the 2024 Resource Adequacy

[16] The shown values represent a portfolio of project estimates generally considered Class 3 AACE classification. The "Authorized Cost" for each estimate include management reserve, contingency, escalation, interest during construction and the base cost estimate.

Plan, these investments include the installation of a new 150 MW Avalon CT with renewable fuel capabilities and Unit 8 – a new 154 MW hydroelectric unit in Bay d'Espoir.

4.2 Renewal

Projects and programs classified as "renewal" are those that are required to replace and/or refurbish system assets to maintain the ability to provide customers with their current electricity services. Renewal expenditures are critical to ensuring Hydro's ability to sustain its assets and to continue to safely and reliably provide the level of service required to its customers. Asset renewal comprises approximately $233.6 million, or approximately 12%, of Hydro's anticipated Major Project capital expenditures for the next five years.

Hydro's Major Project planned renewal expenditures for the period 2026–2030 are provided in Appendix A. Hydro's anticipated Major Project renewal expenditures fluctuate for the 2026–2030 period.

The primary drivers of the anticipated renewal investment in Hydro's five-year capital plan are as follows:

- Penstock Life Extension – Hydro received approval for Phase 1 of this initiative, which involves the refurbishment of Penstock 1 at Bay d'Espoir in 2023, planned for completion in 2025. Phase 2, which will see the refurbishment of Penstock 2 and Penstock 3, is planned to commence in 2029 and 2026, respectively.
- Renewal of Hydraulic Generating Assets – Required to renew aging or deteriorating assets associated with Hydro's hydraulic generating assets. In particular, the life extension of Unit 7 at Bay d'Espoir, currently under review with the Board.

5.0 Conclusion

Hydro's Major Projects five-year capital plan reflects an investment of approximately $1.97 billion in plant and equipment over the 2026–2030 period. Capital expenditures in the five-year capital plan are primarily driven by investments in system growth consistent with the Minimum Investment Expansion Plan as recommended by the 2024 Resource Adequacy Plan and asset renewal.

The five-year capital plan is consistent with its investment philosophy to invest responsibly in the electrical system to the benefit of its customers. Hydro has planned and identified projects to balance capital expenditures with customer reliability, safety, and the environment. The five-year capital plan reflects Hydro's continued focus on cost management to minimize impacts to ratepayers while delivering safe and reliable service.

Appendix A

Capital Plan by Investment Class, and Major Asset Category (2026–2035)

Newfoundland and Labrador Hydro
2026 Capital Budget Application
Major Projects Capital Plan By Investment Classification[1]
($000)

	2025 and Prior Years	2026	2027	2028	2029	2030	2031–2035	Total
Renewal								
Penstock Life Extension - Phase 1	[redacted]							65,876.1
Penstock 3 Life Extension[2]	[redacted]							69,650.5
Bay d'Espoir Unit 7 Life Extension	[redacted]							85,346.2
Penstock 2 Life Extension[2]	[redacted]							80,598.3
Total Renewal	[redacted]							**301,471.1**
System Growth								
Bay d'Espoir Unit 8	[redacted]							1,079,221.0
Avalon CT	[redacted]							891,415.2
Total System Growth	[redacted]							**1,970,636.2**
Total Capital Plan	**122,876.9**	**154,138.9**	**376,047.1**	**562,322.7**	**560,413.7**	**319,048.3**	**177,259.7**	**2,272,107.3**

[redacted]

Chart 1: Major Projects Capital Plan by Investment Classification (2025–2035)

[1] Numbers may not add due to rounding.
[2] Not an AACE Class 3 estimate. Hydro has utilized an escalated Penstock 1 Life Extension budget to forecast costs for the purposes of the capital plan.

Newfoundland and Labrador Hydro
2026 Capital Budget Application
Major Projects Capital Plan By Asset Category[1]
($000)

	2025 and Prior Years	2026	2027	2028	2029	2030	2031–2035	Total
Generation								
Gas Turbines								
Avalon CT	[redacted]							891,415.2
Total Gas Turbines								**891,415.2**
Hydraulic Plant								
Penstock Life Extension - Phase 1	[redacted]							65,876.1
Penstock 3 Life Extension[2]								69,650.5
Bay d'Espoir Unit 7 Life Extension								85,346.2
Penstock 2 Life Extension[2]								80,598.3
Bay d'Espoir Unit 8								1,079,221.0
Total Hydraulic Plant								**1,380,692.1**
Total Capital Plan	**122,876.9**	**154,138.9**	**376,047.1**	**562,322.7**	**560,413.7**	**319,048.3**	**177,259.7**	**2,272,107.3**

[1] Numbers may not add due to rounding.

[2] Not an AACE Class 3 estimate. Hydro has utilized an escalated Penstock 1 Life Extension budget to forecast costs for the purposes of the capital plan.