Q. Please describe how transmission line equipment repairs are prioritized and state the time limits for each prioritization.

A. **1. Transmission Maintenance in Context**

The reliability performance of Newfoundland Power's electrical system is largely a function of the condition of electrical system assets.[1] For this reason, the principal factor in the prioritization of capital and operating maintenance for all Newfoundland Power electricity network assets is the establishment of reasonable levels of overall system reliability.[2] This reliability based perspective was identified in the 1998 report to the Board on *Newfoundland Light & Power Co. Limited Quality of Service and Reliability of Supply* where it was indicated that:

"The reliability of supply to Company customers is considered to be acceptable, although lower than the average for Canadian utilities. It is important that the utility maintain and in fact seek to improve its performance in this regard."[3]

The reliability of Newfoundland Power's electrical system is examined by the Board in every Newfoundland Power general rate application.[4]

In Newfoundland Power's 2013/2014 General Rate Application, the evidence before the Board was that the reliability of the Company's service was improved from that in 1998. Newfoundland Power's SAIDI, or system average interruption duration index (excluding major events), was better than composite measures provided by the Canadian Electricity Association ("CEA") in 8 of the 10 years ended in 2011. Newfoundland Power's SAIFI, or system average interruption frequency index (excluding major events), was better than composite measures provided by the CEA in 4 of the 10 years ended in 2011.[5]

---

[1] This is a widely accepted engineering principle. It was recognized in, amongst other places, the 1991 *Report on the Technical Performance of Newfoundland Light & Power Co. Limited*, prepared by George Baker, P. Eng., for the Board.

[2] Newfoundland Power's electricity network assets include its transmission, substation and distribution system assets.

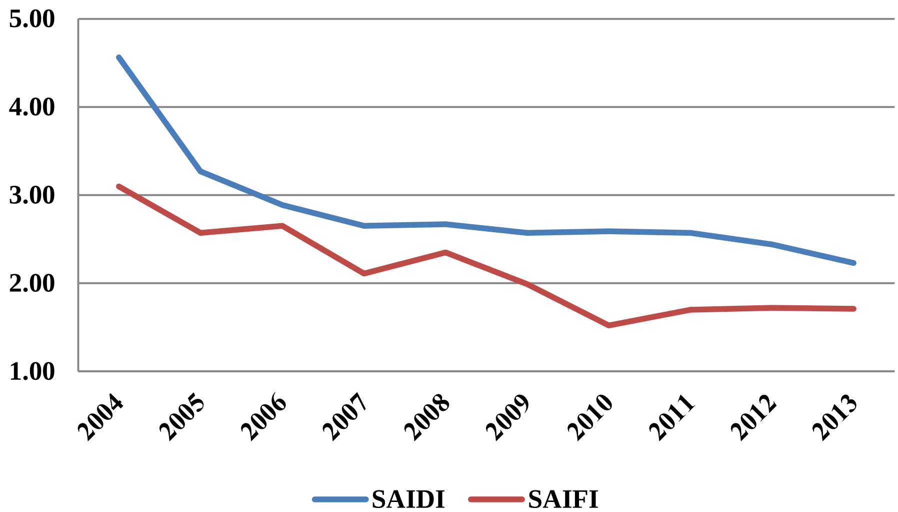
[3] See *Newfoundland Light & Power Co. Limited Quality of Service and Reliability of Supply*, prepared by D.G. Brown, P.Eng., page v.

[4] See, for example, Newfoundland Power's *2008 General Rate Application*, Company Evidence, Section 2: Customer Operations, Page 22, line 11 *et seq.* where reliability management was described, in effect, as a combination of (i) capital investment, (ii) maintenance practices and (iii) operational deployment. See also Newfoundland Power's *2010 General Rate Application*, Company Evidence, Section 2: Customer Operations, Page 2-7, line 6 *et seq.* where Newfoundland Power's evidence was that plant replacement was expected to continue to be the primary focus of capital expenditure for the Company. Finally, see Newfoundland Power's *2013/2014 General Rate Application*, Company Evidence, Section 2: Customer Operations, Page 2-3, line 8 *et seq.* where Newfoundland Power's evidence outlined the maintenance costs associated with its aging electricity system assets.

[5] Newfoundland Power's SAIDI, including all events, was better than the CEA composite in 6 of the 10 years ended in 2011; the Company's SAIFI, including all events, was better than the CEA composite in only 1 of the 10 years. See the response to Request for Information CA-NP-143 filed in Newfoundland Power's *2013/2014 General Rate Application*.

Graph 1 shows SAIDI and SAIFI for Newfoundland Power's electrical system from 2004 to 2013.[6]

Graph 1
SAIDI and SAIFI
2004 - 2013



Graph 1 indicates that the overall reliability of Newfoundland Power's electrical system, excluding extraordinary events, has steadily improved in the decade since 2004. This improvement reflects Newfoundland Power's overall management of the condition of its electricity network assets through the period. The condition of those network assets, including the transmission assets, is largely a function of the combination of the Company's ongoing capital investment and operating maintenance practices.[7]

2. Transmission Plant Replacement

Approximately ½ of Newfoundland Power's overall annual capital expenditures are directed at plant replacement.[8]

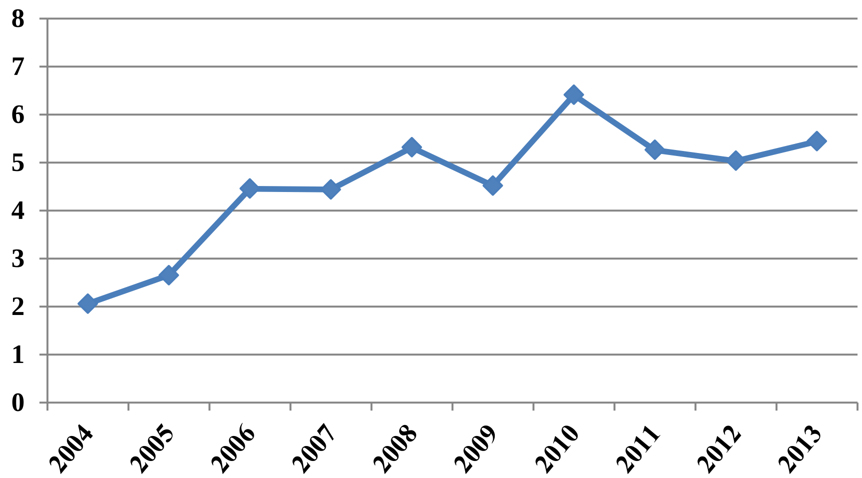
[6] SAIDI measures the average number of customer *hours* of electrical supply outage in a year. SAIFI measures the average *number* of customer outages in a year. The SAIDI and SAIFI from 2004 to 2013 shown in Graph 1 have been adjusted to remove the effects of severe weather events and major electrical system disruptions such as those experienced during the January 2-8, 2014 period.

[7] System reliability is also a reflection of Newfoundland Power's operational deployment and, in particular, its ability to respond to trouble on the electrical system in an organized and efficient manner. Since the Company's 2005 early retirement program, field operations staff and equipment deployment throughout the Company's service territory has not changed materially.

[8] See the *2014 Capital Plan* filed with Newfoundland Power's *2014 Capital Budget Application* where it is indicated that for the period 2014-2018, plant replacement is forecast to account for 52% of all capital expenditures. For the period 2009-2013, plant replacement accounted for 49% of annual capital expenditure.

Graph 2 shows Newfoundland Power's transmission plant replacement expenditures from 2004 to 2013.

Graph 2
Transmission Plant Replacement
2004 – 2013
($ millions)



Newfoundland Power aims to maintain stable annual capital expenditures on plant replacement for all asset classes, including transmission. This follows from the Board's determination that stable and predictable year over year capital budgets for Newfoundland Power are a desirable objective which assists in fostering stable and predictable rates for consumers into the future.[9]

Newfoundland Power's annual capital expenditures on transmission plant are guided by asset condition and its *Transmission Line Rebuild Strategy*.[10] This strategy recognizes the higher degree of overall electrical system criticality of transmission systems relative to distribution systems.[11] This strategy also recognizes the different construction standards associated with transmission systems of different vintages.

[9] See Order No. P.U. 36 (2002-2003), page 25.

[10] Newfoundland Power filed its *Transmission Line Rebuild Strategy*, June 2005 with the Board as part of its 2006 Capital Budget Application. Each year, the Company provides an update to the implementation of the *Transmission Line Rebuild Strategy* as part of its annual Capital Budget Application. See, for example, *2014 Transmission Line Rebuild*, June 2013, filed with Newfoundland Power's 2014 Capital Budget Application.

[11] This difference in electrical system criticality is specifically recognized in the *Transmission Line Rebuild Strategy* where it is observed that *"While the Company's approach to distribution reliability improvement includes rebuilding and upgrading those feeders that have the worst reliability performance on a targeted basis, that approach is not recommended for establishing priority for transmission line upgrading and rebuilding. Transmission lines serve more customers and therefore have a higher degree of overall electrical system criticality than distribution lines."*

The variability of annual capital expenditures for transmission plant can be largely explained by (i) differences in transmission line condition, (ii) differences in design standard, and (iii) severe weather events. The transmission lines or portions of transmission lines selected for rebuild in any particular year will not necessarily be of the same condition as the transmission lines rebuilt in previous years or scheduled to be rebuilt in subsequent years. For example, the cost of replacing 66 kV single pole transmission structures is less than replacing 138 kV H-frame transmission structures. In addition, significant design standard differences exist for parts of the Company's service territory subjected to heavy icing conditions (ie. the eastern portion of the island of Newfoundland) compared to those parts exposed to less icing. Severe weather events, such as ice storms and hurricanes, can impact expenditures in any particular year. The typical impact is the deferral of planned work to accommodate reconstruction of storm damaged lines.[12]

The following attachments to this response to Request for Information PUB-NP-061 provide additional information related to Newfoundland Power's annual capital expenditures on transmission plant which are aimed at maintaining or improving system reliability:

Attachment A: *Transmission Line Rebuild Strategy*, June 2005
Attachment B: *2014 Transmission Line Rebuild*, June 2013
Attachment C: *2013 Transmission Line Rebuild*, June 2012
Attachment D: *2012 Transmission Line Rebuild*, June 2011
Attachment E: *2011 Transmission Line Rebuild*, June 2010
Attachment F: *2010 Transmission Line Rebuild*, June 2009

Further Information concerning Newfoundland Power's utility plant can be found in its annual capital budget applications filed with the Board. These applications can be found on the Board's public website at www.pub.nf.ca.

Planned annual capital expenditures to rebuild Newfoundland Power's transmission lines on a program basis plays a significant role in ensuring that the Company's transmission systems are maintained in appropriate physical condition on an ongoing basis. This, in turn, contributes to the ongoing performance of the Company's overall electricity network. Together, it is the stable annual replacement of deteriorated and damaged equipment *and* the Company's operating maintenance regime that ensures the Company is in a position to deliver reliable electrical service to its customers.

3. Transmission Line Maintenance

Please refer to the response to Request for Information PUB-NP-060 for detailed information on priorities and time limits concerning Newfoundland Power's

[12] In 2010, Newfoundland Power experienced a major ice storm and a hurricane. The reconstruction of storm-damage infrastructure resulted in deferral of some planned transmission rebuild work to subsequent years. See, for example, Newfoundland Power's *2010 Capital Expenditure Report*, filed March 1, 2011.

transmission pole and line equipment inspection, testing and maintenance programs and practices.

Please refer to the response to Request for Information PUB-NP-062 for information concerning transmission line inspection, maintenance testing and repair jobs for 2011, 2012 and 2013.

4. Conclusion

Newfoundland Power conducts transmission line equipment repairs so that, when taken in combination with annual capital investment in the system and current deployment of employees and equipment, reliability to customers is maintained at an acceptable level.

In the 10 years ending 2013, the overall reliability of the service provided by Newfoundland Power to its customers has materially improved.

Transmission Line Rebuild Strategy
June 2005

Transmission Line Rebuild Strategy

June 2005

Prepared by:

Keith Whiteway, P.Eng.

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G.R. SPURRELL
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PROVINCE OF NEWFOUNDLAND

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1.0 Executive Summary

This report outlines a 10 year plan to rebuild Newfoundland Power's aging transmission lines to ensure a safe and reliable supply of electricity to customers.

The important role transmission lines play in providing reliable service to large numbers of customers requires they be rebuilt before they deteriorate to the point that they fail in service. While the Company's approach to distribution reliability improvement includes rebuilding and upgrading those feeders that have the worst reliability performance on a targeted basis, that approach is not recommended for establishing priority for transmission line upgrading and rebuilding. Transmission lines serve more customers and therefore have a higher degree of overall electrical system criticality than distribution lines.

Assessment of current reliability performance statistics alone will not necessarily identify transmission lines that are at risk of failure. Field assessment of actual asset conditions are essential to establishing a sound capital maintenance strategy for transmission systems.

Newfoundland Power intends to redesign and rebuild its oldest and most deteriorated lines on a priority basis over the next 10 years at a total estimated cost of $43.5 million. Priority will be determined by the physical condition of the lines, the risk of line failure and the impact failure would have on customers.

Those transmission lines built in the late 1960s, the 1970s and beyond were designed and built to a higher standard than many of the older lines and are close to, or meet, present design and construction standards. These lines are expected to require only regular capital maintenance and component replacement to maintain their integrity through the 10 year transmission planning horizon.

2.0 Description of Newfoundland Power's Transmission Lines

Newfoundland Power has 104 transmission lines in service with a total length of 2,056 km. These lines range in length from 2 km to 94 km with an average length of 19 km.

2.1 Line Classification

Three different voltage classes exist within Newfoundland Power's electrical system, 33 kV, 66 kV, and 138 kV. The total length of lines in each of these voltages is set out in Table 1.

Table 1
Transmission Lines by Voltage

Voltage	Length (km)	%
33 kV	26	1
66 kV	1,410	69
138 kV	620	30

The total number of transmission poles in service is approximately 27,000, with the vast majority being pressure treated wood. A small number are specialty constructions of either steel or laminated wood. Lines are one of two structural configurations: H-frame or Single Pole, with 138 kV lines being of H-frame design and 66 kV lines being of either H-frame or Single Pole design. Table 2 summarizes the Company's transmission lines by structure configuration.

Table 2
Transmission Lines by Structure

Structure	Length (km)	%
H-Frame	1,186	58
Single Pole	870	42

2.2 Radial and Looped Lines

Many of Newfoundland Power's transmission lines are radial (i.e. there is only one transmission line path from the main supply point to the customer). These lines are predominately found in rural areas. When radial lines fail, customers are without power until the line is repaired.

Some of Newfoundland Power's radial lines have backup capability in the form of diesel generators, gas turbines or hydro generating plants. In the event of the failure of one of these radial lines the backup generation may be able to provide sufficient power to serve some or all of the customers depending on the time of year and how much generating capacity is available at the time of line failure.

When there is more than one transmission path from the customer to the main grid, these lines are categorized as looped lines. These are more common in urban areas. Failure of a looped line normally does not result in an outage to customers. Customers served by looped transmission lines receive a higher reliability of service than those served from radial transmission systems. As well, looped lines are more conveniently maintained as repair work can be completed on a de-energized line without the need for coordinating planned service interruptions with customers.

Table 3 summarizes the Company's transmission lines as radial or looped, identifying the proportion of radial lines with generation backup.

Table 3 Transmission Lines Radial or Looped		
Type	**Length (km)**	**%**
Radial	496	24
Radial (partial backup)	440	22
Looped	1,120	54

2.3 Age of Lines

Currently, the oldest original transmission line still in service was built in 1942 while the newest line was built in 1997. Several lines and parts of lines have been upgraded or completely rebuilt over the years. Table 4 shows the vintage of transmission lines in service and takes into account the sections of lines that have been rebuilt.

Table 4 Transmission Lines by Vintage	
Vintage	**km**
1940s	11
1950s	321
1960s	470
1970s	748
1980s	269
1990s	120
2000s	117
Total	**2,056**

3.0 Transmission Line Design

Newfoundland Power designs lines to meet Canadian Standard Association ("CSA") standards and guidelines. In keeping with CSA standards Newfoundland Power generally designs transmission lines to withstand 12.5 mm of radial ice on conductors with 90 km/hr wind or 25 mm of radial ice on conductor with no wind. On the Avalon and Bonavista Peninsulas, where ice loading is more severe, Newfoundland Power designs its lines to withstand 18.0 mm of radial ice on conductors with 90 km/hr wind.

Prior to the amalgamation of the three largest utilities in the province in 1966 (United Towns Electric, Newfoundland Light & Power, and Union Electric) there was limited transmission design expertise in any utility. There was little consistency in the design of transmission lines and, as a result, many lines built before 1960 were not designed to any standard (and do not meet present day standards).

During the 1960s a number of lines were designed by out of province engineering consultants. For example, Montreal Engineering Company designed many lines during the 1960s and early 1970s when the transmission system was expanding quickly with the drive to electrify the island following the formation of the Power Commission and development of the large Bay d'Espoir hydro generation station. In addition, by the 1970s, the amalgamated Newfoundland Light & Power had developed its own transmission line design and construction expertise. These developments largely explain why the majority of lines built in the 1970s and beyond were designed and constructed to meet present day standards.

4.0 Transmission Line Construction

A transmission line is only as strong as its weakest component or structure. Transmission lines are often built "across country", away from roads in long straight sections which results in the least cost construction to connect system supply points and substations. Along straight transmission line sections, the structures are more exposed to cascading failure (when one structure fails the additional loading placed on adjacent structures causes a chain reaction of multiple structure failures). Reducing the risk of cascading structure failures requires careful line inspection and replacement of components and structures before a single component failure occurs.

Two relatively recent examples of cascading failures occurred in 1992 and 1998. In 1992, a 4.3 km section of H-frame 138 kV line failed on 123L on the Bonavista Peninsula. In 1998, a 6.6 km section of H-frame 66 kV line failed on 305L on the Burin Peninsula.

Lines that are built away from the roadside or in remote locations are more difficult to patrol and locate problems and take a longer time to repair and restore to service. Often when sections of transmission lines fail (such as major ice storm damage) the requirement to restore power as soon as possible eliminates the opportunity to redesign and upgrade the line to a stronger standard.

Such was the case in the example of 123L noted above. In that case, because it was a radial line, the section that failed was temporarily rebuilt under emergency conditions to the same design standard prior to failure. The following year this newly constructed section of line was re-designed to a higher ice loading standard and rebuilt again.

5.0 Transmission Line Aging

Transmission lines can supply a single substation but generally supply several substations and multiple distribution feeders. They are a critical link in the electrical system in the transport of generated power to the distribution system. While feeders typically supply several hundred up to two thousand customers, transmission lines often supply a few thousand up to tens of thousands of customers. Therefore it is important that transmission lines be designed, constructed and maintained to provide a high degree of reliability. As transmission lines age and deteriorate they become subjected to increased risk of component failure. To ensure reliable performance: (i) older lines must be inspected regularly, (ii) the risk of component and structural failure must be assessed carefully, and (iii) any suspect components and structures must be replaced before failure occurs.

Newfoundland's weather and environment subjects transmission lines to high winds, salt contamination, lightning, ice and snow loading, and frequent freeze/thaw and wet/dry cycles. Wooden components of transmission lines are susceptible to fungi growth (rot), insect damage and weathering causing deep splits and cracks which further advances rotting. Wind causes stresses and vibration on structures with resulting wear and tear on hardware components and conductors. Exposure to lightning, salt contamination and mechanical stresses can cause insulators to age and breakdown. After 40 to 50 years of exposure to the elements many line components are deteriorated to the point they are weakened and at risk of failure.

Transmission lines of sub-standard design and lines that are not engineered to withstand the local environmental conditions in which the line operates will be more susceptible to failure.

6.0 Line Rebuild and Maintenance Strategy

The important role transmission lines play in providing reliable service to large numbers of customers requires that they be rebuilt before they deteriorate to the point that they are at significant risk of failure. While the Company's approach to distribution reliability improvement includes rebuilding and upgrading those feeders that have the worst reliability performance, that approach is not recommended for establishing priority for transmission line upgrading and rebuilding. Transmission lines serve more customers and have a higher degree of overall electrical system criticality than distribution lines. Therefore the strategy is to proactively rebuild transmission lines before they start experiencing failures due to deteriorated condition and aging.

Rebuilding lines after they have collapsed is expensive and the pressure to restore service quickly does not permit sufficient time to design and construct the new line to a higher standard (i.e. often the only practical approach following a major line failure is to put back the line as it was beforehand). This replacement strategy identifies lines at risk and establishes a plan for replacement in a proactive manner.

6.1 Sub-Standard Lines

Sub-standard lines will be rebuilt completely to meet present design and construction standards. Newfoundland Power will rebuild its oldest and most deteriorated lines on a priority basis. Priority will be determined by the physical condition of the lines, the risk of line failure and the impact failure would have on customers.

Some 37 transmission lines built in the 1940s, 50s and 60s have been identified as sub-standard lines to be rebuilt over the next 10 years.

6.2 Standard Lines

Those lines built in the 1970s and beyond, and some built in the 1960s, were designed and built to a higher standard than many of the older lines and are close to, or meet, present design and construction standards.

Standard lines are expected to require only regular maintenance and component replacement to maintain their integrity through the 10 year transmission planning horizon.

7.0 Proposed Transmission Line Rebuilds: 2006 to 2015

To redesign and rebuild Newfoundland Power's sub-standard transmission lines will require an expenditure of approximately $43.5 million. To fulfill the Company's obligation to provide reliable electric service at least cost, it is recommended that these capital costs be allocated over a ten year period beginning in 2006. The rebuilding of sub-standard transmission lines is prioritized based on several factors including age, condition, location and impact on customers should the line fail.

Table 5 shows the proposed transmission rebuilds for the period 2006 to 2015.

The timing of actual rebuilds may change, however, it is anticipated that proposed expenditures for transmission rebuilds for each year will form part of Newfoundland Power's annual capital budget applications through to 2015.

Table 5
Transmission Line Rebuilds: 2006 – 2015 ($000s)

Line	Year Built	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Totals
12L KBR-MUN	1950			240								**240**
13L SJM-SLA	1962										180	**180**
14L SLA-MUN	1950				70							**70**
15L SLA-MOL	1958				140							**140**
16L PEP-KBR	1950						250					**250**
18L GOU-GDL	1952				420							**420**
20L MOB-CAB	1951		675	567	567							**1,809**
21L 20L-HCP	1952					355						**355**
23L MOB-PBK	1942					357						**357**
25L GOU-SJM	1954			760								**760**
30L RRD-KBR	1959		340									**340**
32L OXP-RRD	1963					217						**217**
35L OXP-KEN	1959					238					160	**398**
41L CAR-HCT	1958					1,425						**1,425**
43L HCT-NCH	1956	1,081	441									**1,522**
49L HWD-CHA	1966				189							**189**
55L BLK-CLK (upgrading)	1971		250									**250**
57L BRB-HGR	1958				1,350							**1,350**
68L HGR-CAR	1958				390							**390**
69L KEN-SLA	1951		269									**269**
94L BLK-RVH (upgrading)	1969				250							**250**
95L RVH-TRP (upgrading)	1969		250									**250**
102L GAN-RBK	1958					690	1,193	1,500		1,193		**4,576**
110L CLV-LOK	1958	604	1,269		900		990				990	**4,753**
111L LOK-CAT	1956			2,325								**2,325**
124L CLV-GAM	1964		390				1,000	756	1,500	1,593	900	**6,139**
146L GAN-GAM	1964			1,105					1,190	1,190		**3,485**
302L SPO-LAU	1959		200			1,560						**1,760**
407L STV-STG	1956	658										**658**
24L MOB-BIG	1964							539				**539**
53L 38L-GEA	1961						420					**420**
301L SPO-GRH	1959								70			**70**
100L SUN-CLV	1964							1,500				**1,500**
101L GFS-RBK	1957						2,100					**2,100**
105L GFS-SBK	1963								980			**980**
400L BBK-WHE	1967										2,000	**2,000**
403L TAP-ROB	1960								280			**280**
Total		**$ 2,343**	**$ 4,084**	**$ 4,997**	**$ 4,276**	**$ 4,842**	**$ 5,953**	**$ 4,295**	**$ 4,020**	**$ 3,976**	**$ 4,230**	**$43,016**

2014 Transmission Line Rebuild
June 2013

2014 Transmission Line Rebuild

June 2013

Prepared by:

M. R. Murphy, P.Eng.

NEWFOUNDLAND POWER
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Appendix A: Transmission Line Rebuild Strategy Schedule
Appendix B: Maps of Transmission Lines 12L, 13L, 18L, 35L, and 68L
Appendix C: Photographs of Transmission Lines 12L, 13L, 18L, 35L, and 68L

1.0 Transmission Line Rebuild Strategy

Transmission lines are the bulk transmitter of electricity providing service to customers. Transmission lines operate at higher voltages, either 66 kV or 138 kV and are often located across country, away from road right of way.

In 2006, Newfoundland Power ("the Company") submitted its *Transmission Line Rebuild Strategy* outlining a 10-year plan to rebuild aging transmission lines. This plan prioritized the investment in rebuild projects based on physical condition, risk of failure, and potential customer impact in the event of a failure.

The *Transmission Line Rebuild Strategy* is regularly updated to ensure it reflects the latest reliability data, inspection information, and condition assessments.

Appendix A contains the updated Transmission Line Rebuild Strategy Schedule.

2.0 2014 Transmission Line Rebuild Projects

In 2014, the Company proposes to rebuild sections of 5 transmission lines with an average age of 59 years, totalling 16 km. Appendix B contains maps of each of the lines to be rebuilt. Appendix C contains photographs of the existing lines. The transmission lines sections to be rebuilt in 2014 are included in Table 1.

Table 1
2014 Transmission Line Rebuilds

Transmission Line	Distance to be Rebuilt	Year Constructed
12L	1.00 km	1950
13L	1.84 km	1962
18L	4.62 km	1951
35L	3.39 km	1959
68L	5.15 km	1958

All of these sections of transmission line have deteriorated poles, crossarms, hardware, and conductor. This makes the lines vulnerable to large scale damage when exposed to heavy wind, ice, and snow loading, thus increasing the risk of power outages. Inspections have identified evidence of decaying wood, worn hardware and damage to insulators.

Upgrading of these sections of line will improve the overall reliability of the transmission system that services customers in these areas.

2.1 Transmission Line 12L ($370,000)

Transmission line 12L is a 66 kV line running between Memorial University Substation (“MUN”) and King’s Bridge Road Substation (“KBR”). The line consists of a 2.2 km aerial section and a 1.0 km underground cable section located through the university campus area.[1] 12L in conjunction with transmission line 14L, are the transmission lines that provide service to Memorial University, the Health Sciences Centre and the Janeway Children’s Health and Rehabilitation Centre.

The aerial section of transmission line was originally constructed in 1950 and consists of 59 single pole structures all of which have under built distribution circuitry. The route taken by the transmission line, as shown by Figure 1 of Appendix B, is through heavy residential areas of the City of St. John’s. Recognizing the added complexity associated with access to private property, obtaining permits from municipal authorities and construction in heavy traffic areas, the Company has chosen to complete the rebuild of transmission line 12L over 2 years.

With the infrastructure additions in this area, load growth at MUN substation will continue to increase.[2] With this increase in load, the existing 1/0 copper conductor on 12L will not be able to carry peak load without 14L also in service. To address these loading concerns the 1/0 copper conductor on 12L will be replaced with 477 ASC.

Inspections have identified deterioration due to decay, splits and checks in the poles and crossarms.[3] Many of these wooden components are in advanced stages of deterioration and require replacement. The majority of the wooden poles are original vintage and have surpassed their normal life expectancy. The copper conductor is deteriorated and at the end of its service life. Due to the age and condition of the line it is susceptible to damage should it become exposed to severe wind, ice or snow loading.

The transmission line has reached a point where continued maintenance is no longer feasible and it has to be rebuilt to continue its safe, reliable operation.

In Order No. P.U. 31 (2012) the Board approved a multiyear project to rebuild transmission line 12L. In 2013 work is ongoing to rebuild 1.2 km of 12L at an estimated cost of $380,000.

In 2014, the remaining 1.0 km of 12L will be rebuilt at an estimated cost of $370,000.

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[1] The 2013 and 2014 projects only involve the rebuild of the 2.2 kilometre aerial section of transmission line.

[2] Recent infrastructure additions have taken place at the Health Science Centre and the Janeway Children’s Health and Rehabilitation Centre. Planned infrastructure additions include 2 new residence buildings.

[3] Most of the poles are located adjacent to city streets and are prone to damage by passing snowploughs and other vehicles. Where practical, new poles will be located behind the curb and sidewalk to mitigate future damage. Relocating these poles will add to the complexity of the rebuild project.

2.2 Transmission Line 13L ($816,000)

Transmission line 13L is a 66 kV single pole line running between St. John's Main Substation ("SJM") and Stamps Lane Substation ("SLA"). It consists of 0.42 km of underground cable from SJM Substation to a termination steel tower on Southside Road, and a 2.64 km aerial section to SLA Substation.

The aerial section was originally constructed in 1962 and consists of 81 single pole structures, most of which have distribution circuits under built. Over the years a number of sections have been replaced and relocated for road widening and other third party development, leaving a total of 1.84 km or 56 structures of original construction.

Due to the age and condition of the line, it is susceptible to damage when it becomes exposed to severe wind, ice or snow loading. Inspections have identified deterioration due to decay, splits and checks in the poles and crossarms. Many of these wooden components are in advanced stages of deterioration and require replacement. The most recent inspections have also identified deficiencies with guys and anchors, hardware, and insulators on the line.

The transmission line route as shown in Figure 2 of Appendix B is through heavy residential and high traffic areas of the City of St. John's.[4] Considerable damage to the poles caused by contact with snowploughs and other vehicles is evident. Relocating the poles away from high traffic areas will serve to minimize future maintenance costs and extend structure life. The transmission line has reached a point where continued maintenance is no longer feasible and it has to be rebuilt to continue its safe, reliable operation.

Based on the overall deteriorated condition of the line, it is recommended the line be rebuilt in 2014 at an estimated cost of $816,000.

2.3 Transmission Line 18L ($700,000)

Transmission line 18L is a 66 kV line running between Goulds Substation ("GOU") and Glendale Substation ("GDL") in Mount Pearl. The line was originally constructed in 1951 and ran from GOU Substation to Stamp's Lane Substation ("SLA"). Upon construction of GDL Substation in 1977 transmission line 18L was rerouted to power the new substation.

The line is 5.82 km in length and is comprised of 84 single pole structures. Approximately 1.19 km or 22 structures was erected along Old Placentia Road as part of the 1977 reroute, leaving 4.62 km or 64 structures of original construction from Brookfield Road to GOU Substation. Inspections have identified deterioration due to decay, splits and checks in the poles and crossarms. Many of these wooden components are in advanced stages of deterioration and require replacement. This section of line is built with 266.8 ACSR conductor which has

4 Most of the poles are located adjacent to city streets and are prone to damage by passing snowploughs and other vehicles. Where practical, new poles will be located behind the sidewalk to mitigate future damage.

deteriorated to the point of failure at some locations in recent years.[5] This conductor size is not adequate to support the future load growth in the Mount Pearl area served by GDL substation.

Due to the age and condition of the line it is susceptible to damage should it become exposed to severe wind, ice or snow loading. Inspections have identified deterioration of the old conductor and hardware, as well as decay, splits and checks in the wooden components.

The transmission line has reached a point where continued maintenance is no longer feasible and it has to be rebuilt to continue its safe, reliable operation. Upgrading the conductor size to 715.5 ASC is also required to service the increased load forecast in the area.

Based on the overall deteriorated condition of the line, it is recommended the line be rebuilt at an estimated cost of $700,000 in 2014.

2.4 Transmission Line 35L ($514,000)

Transmission line 35L is a 66 kV line running between Kenmount Substation ("KEN") and Oxen Pond Substation ("OXP") in St. John's. The line was originally constructed in 1959, while sections near the substations were rebuilt during a subsequent system reconfiguration. Approximately 3.39 km of original vintage line consisting of 39 single-pole wood structures remain in service.

Due to its location transmission line 35L has been subjected to extreme weather loading resulting in significant damage.[6] Due to age and condition of the remaining original structures the line remains susceptible to damage in the event of further exposure to ice, wind and snow loads.

Recent inspections have identified substantial deterioration of the poles and crossarms. Many of the wooden components show decay, splits and checks.

The transmission line has reached a point where continued maintenance is no longer feasible and it has to be rebuilt to continue its safe, reliable operation. Upgrading the conductor size on the section being replaced to match the conductor size on the remainder of the line will increase the overall transfer capacity of the line.

Based on the age, deteriorated condition and weather loadings on this section of line it is recommended that the section be rebuilt in 2014 using 715.5 ASC conductor at an estimated cost of $514,000.

---

5 Failures were caused by damaged conductor surfaces as a result of corrosion and contact between phases during high winds.

6 Most recently in 2012 three poles in this section failed due to heavy wind loading during Tropical Storm Leslie.

2.5 Transmission Line 68L ($770,000)

Transmission line 68L is a 66 kV line running between Carbonear Substation ("CAR") and Harbour Grace Substation ("HGR"). The line was originally constructed in 1958, with the exception of a 2.01 km section extending into CAR substation which was constructed in 1974. Approximately 5.15 km of original vintage line consisting of 50 two-pole and three-pole H-Frame structures with non-standard 4/0 ACSR conductor, remain in service.

Inspections have identified significant deterioration of the line due to decay, splits and checks in the poles and crossarms, cracks in insulators and other hardware deficiencies. Many of these components are in advanced stages of deterioration and require replacement.

In 1958 transmission line 68L was built using the construction standards of the time, which did not include crossbraces on the H-Frame structures. Some of the structure types used on the line has since been identified as failure points when subjected to extreme weather loads and have thus been removed from the Company's construction standards.

The transmission line has reached a point where continued maintenance is no longer feasible and it has to be rebuilt to continue its safe, reliable operation.

Based on the age, deteriorated condition and weather loadings on this section of line it is recommended that the section be rebuilt in 2014 at an estimated cost of $770,000.

3.0 Concluding

In 2014, the Company will rebuild the remaining section of 12L, along with sections of 13L, 18L, 35L and 68L. Each of these transmission lines has structures experiencing deterioration of the poles, crossarms, hardware, and conductor. Recent inspections and engineering assessment has determined the transmission lines have reached a point where continued maintenance is no longer feasible and they have to be rebuilt to continue providing safe, reliable electrical service.

This project is justified based on the need to replace deteriorated transmission line infrastructure in order to ensure the continued provision of safe, reliable electrical service.

Appendix A
Transmission Line Rebuild Strategy Schedule

Transmission Line Rebuilds 2014 – 2018 ($000s)						
Line	**Year**	**2014**	**2015**	**2016**	**2017**	**2018**
012L KBR-MUN	1950	370				
013L SJM-SLA	1962	816				
018L GOU-GDL	1951	700				
035L KEN-OXP	1959	514				
068L HGR-CAR	1958	770				
015L SLA-MOL	1958		166			
014L SLA-MUN	1950		263			
069L KEN-SLA	1951		1,036			
030L RRD-KBR	1959		567	546		
400L BBK-WHE	1967		1,731	1,807		
032L OXP-RRD	1963			320		
057L BRB-HGR	1958			1,492	1,535	
302L SPO-LAU	1959				1,432	3,524
041L CAR-HCT	1958				1,366	1,067
101L GFS-RBK	1957				1,701	2,179
	Total	**3,170**	**3,763**	**4,165**	**6,034**	**6,770**

Transmission Line Rebuilds 2019 – 2025 ($000s)								
Line	**Year**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
102L GAN-RBK	1958	4,213	4,251	4,507				
363L BVJ-SCR	1963	2,923	3,088	3,265	4,090			
403L TAP-ROB	1960				956			
124L CLV-GAM	1964				3,685	4,316	2,229	5,388
146L GAN-GAM	1964					2,682	3,590	4,216
100L SUN-CLV	1964					2,438	3,099	
035L KEN-OXP	1965							584
049L HWD-CHA	1966			608				
	Total	**7,136**	**7,339**	**8,380**	**8,731**	**9,436**	**8,918**	**10,188**

Appendix B
Maps of Transmission Lines
12L, 13L, 18L, 35L and 68L

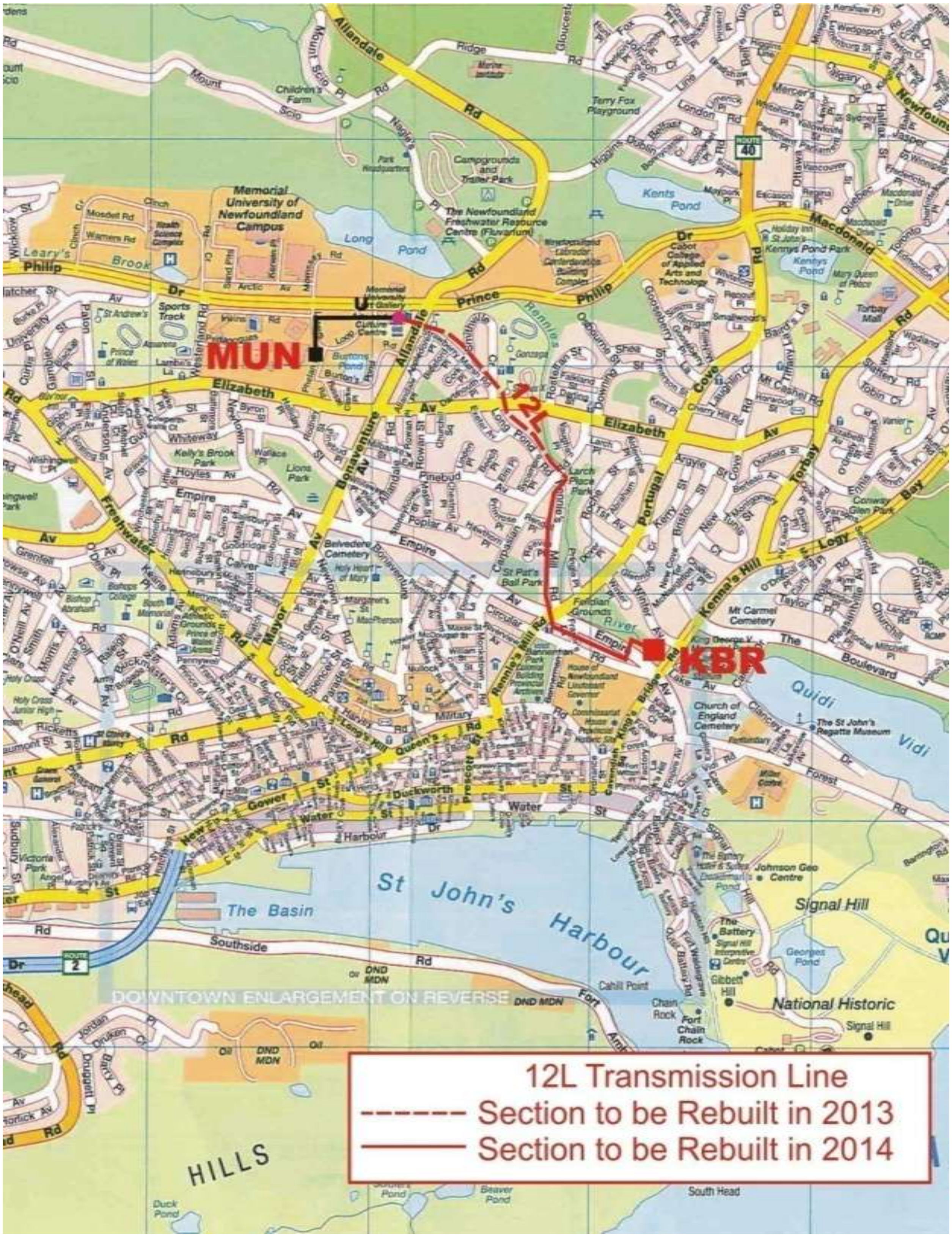

Figure 1 – Map of 12L Route

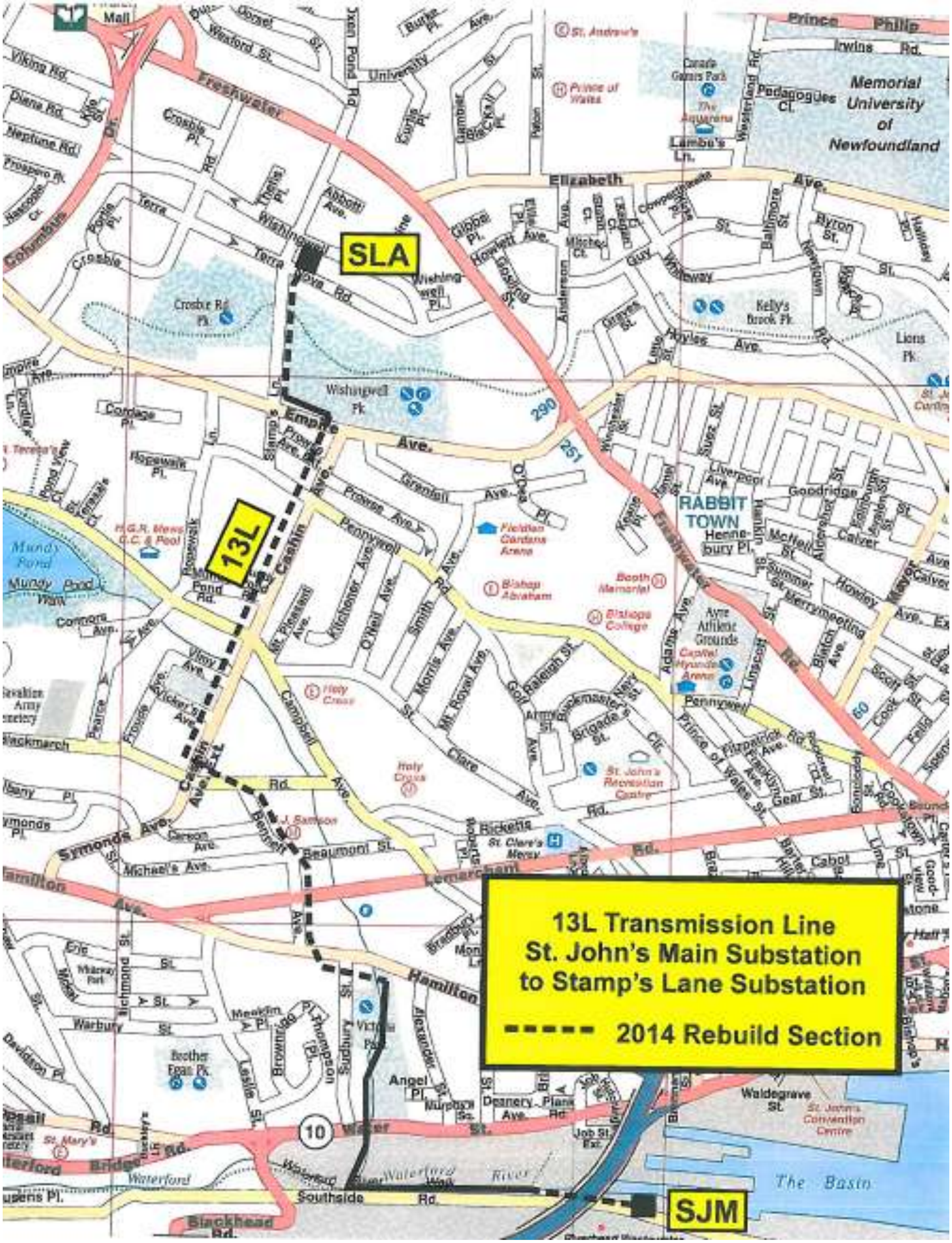

Figure 2 – Map of 13L Route

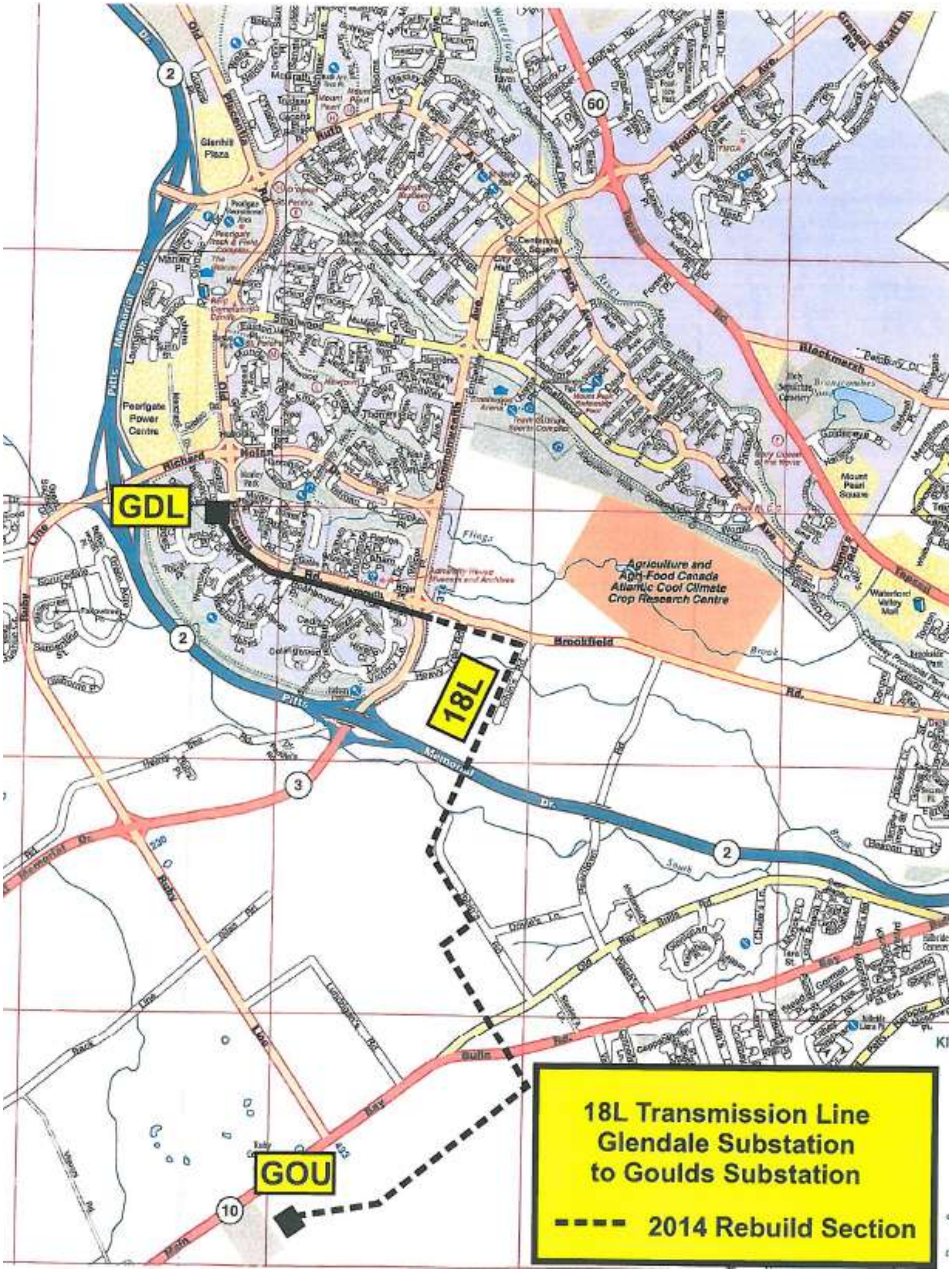

Figure 3 – Map of 18L Route

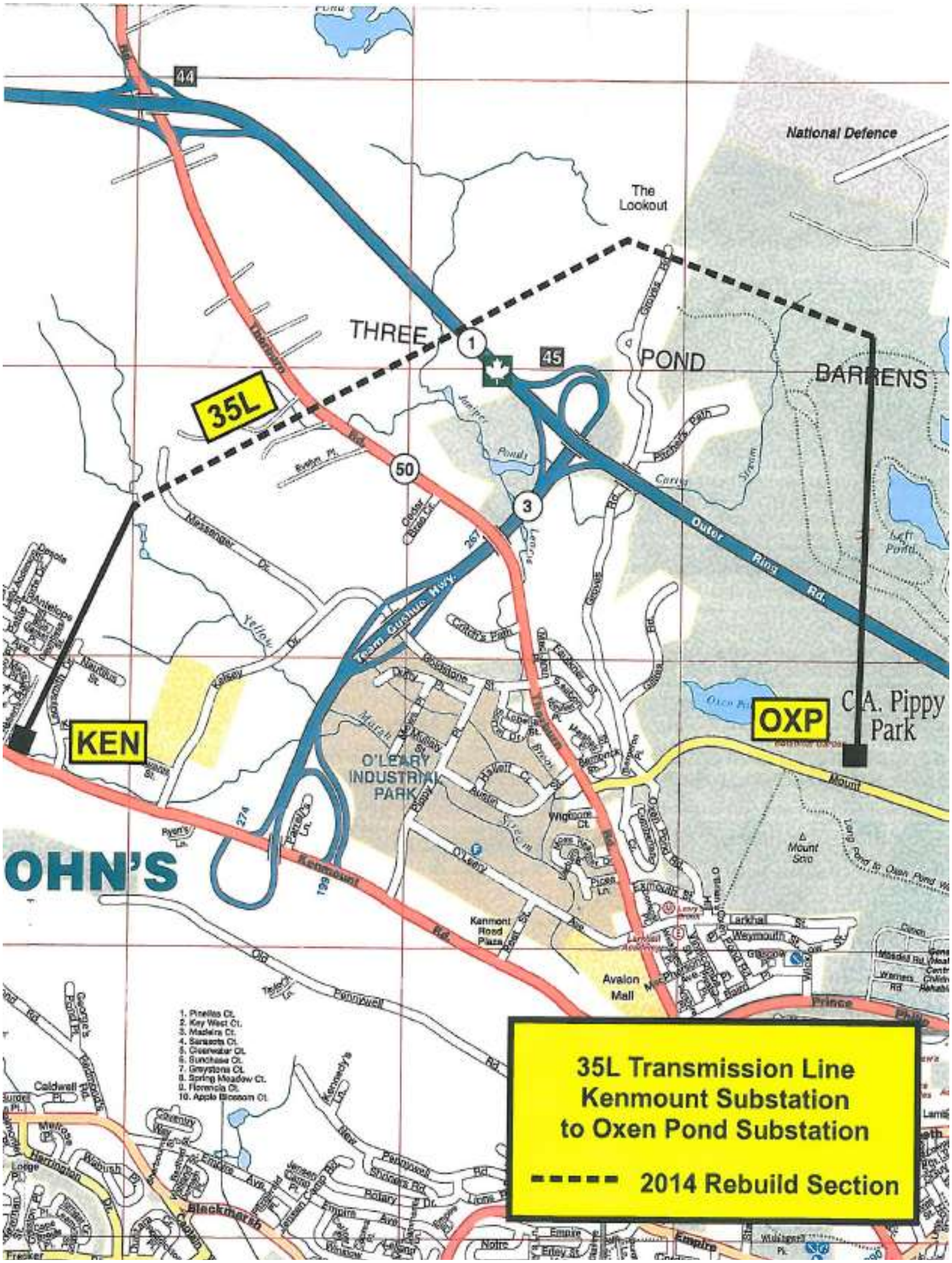

Figure 4 – Map of 35L Route

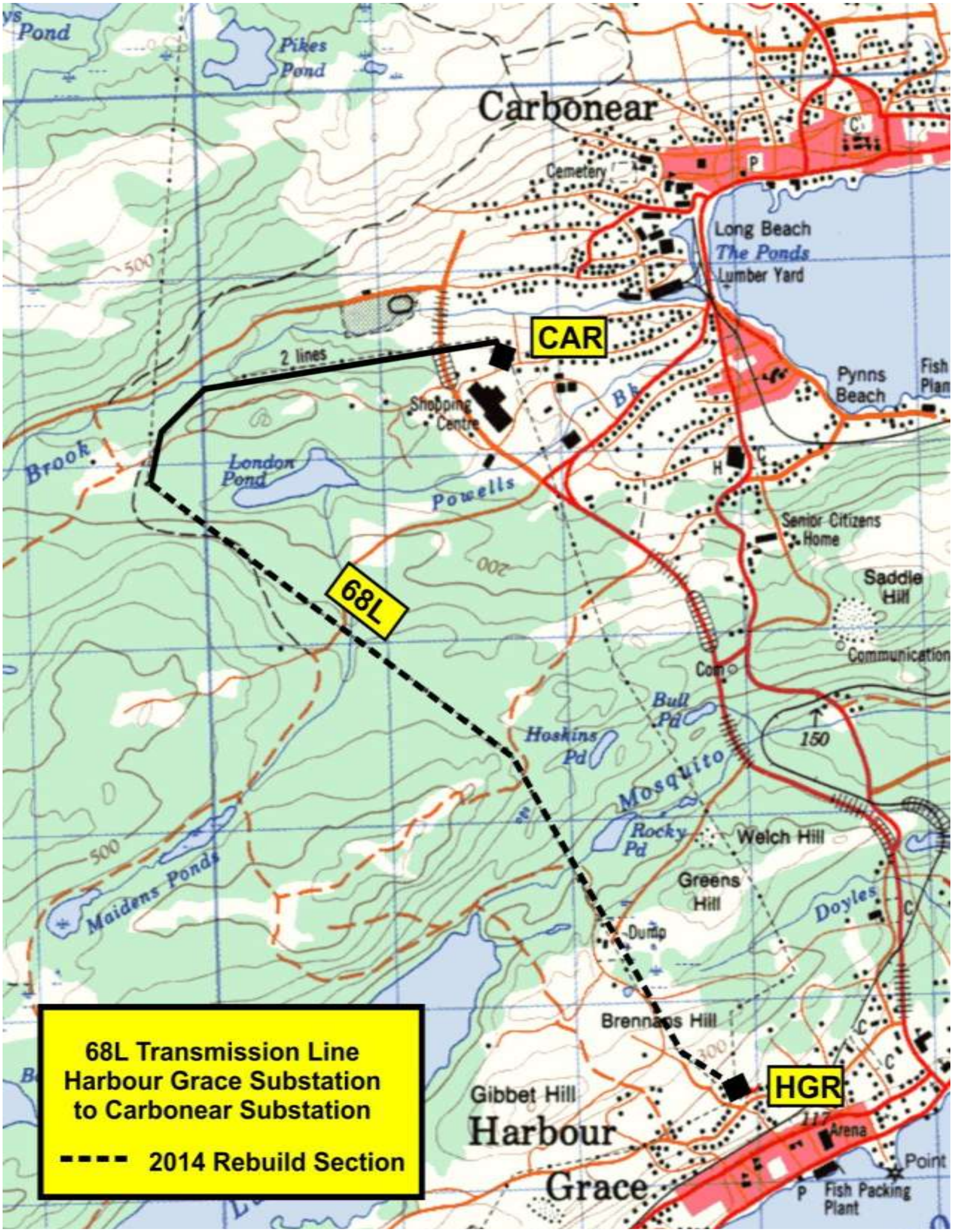

Figure 5 – Map of 68L Route

Appendix C
Photographs of Transmission Lines
12L, 13L, 18L, 35L and 68L

Transmission Line 12L

Figure 1 – 12L - Pole showing checking around bolts

Figure 2 – 12L - Pole showing shell separation and damage

Figure 3 – 12L - Pole bent due to significant loading caused by high voltage aerial cables

Figure 4 – 12L - Deteriorated Crossarms

Transmission Line 13L

Figure 5 – 13L - Conductor removed from 13L - damage due to phase contact

Figure 6 – 13L - Pole showing vehicular or snow plough damage

Figure 7 – 13L - Deteriorated pole showing shell separation

Figure 8 – 13L - Heavily loaded pole leaning

Transmission Line 18L

Figure 9 – 18L - Deteriorated Pole Crib

Figure 10 – 18L - Split crossarm and nonstandard guy wire

Figure 11 – 18L - Pole with severe checks

Figure 12 – 18L - Conductor damage removed in 2012

Transmission Line 35L

Figure 13 – 35L - Split crossarm

Figure 14 – 35L - Severely deteriorated pole

Figure 15 – 35L - Broken pole - Tropical Storm Leslie

Figure 16 – 35L - Horizontal crack in pole

Transmission Line 68L

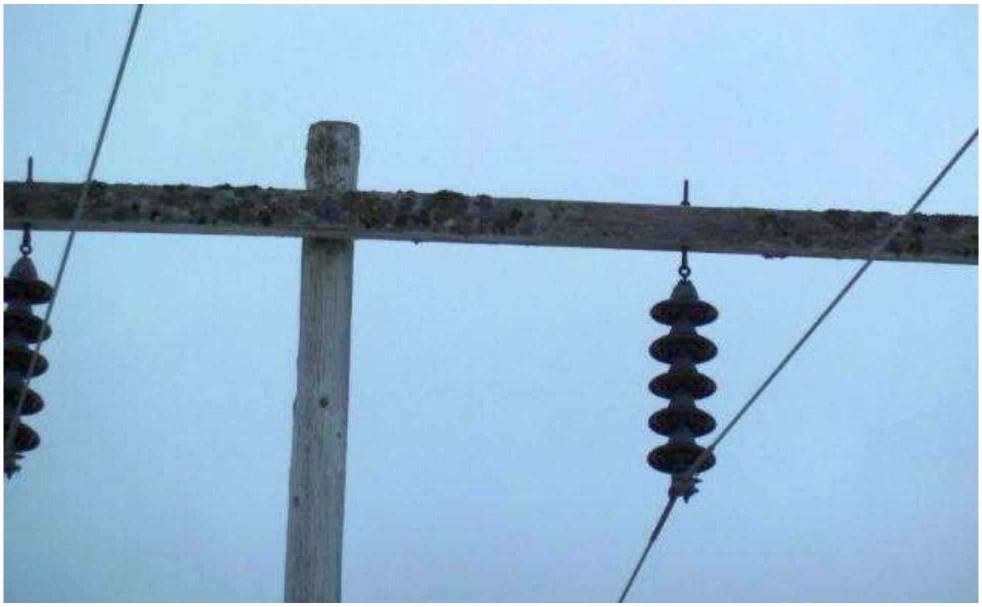

Figure 17 – 68L - Mossy/rotten crossarm

Figure 18 – 68L - Deep check in pole

Figure 19 – 68L - Pole showing shell separation

Figure 20 – 68L - Deteriorated pole and crossarm

2013 Transmission Line Rebuild
June 2012

2013 Transmission Line Rebuild

June 2012

Prepared by:

M. R. Murphy, P.Eng.

NEWFOUNDLAND POWER
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1.0 Transmission Line Rebuild Strategy

Transmission lines are the bulk transmitter of electricity providing service to customers. Transmission lines operate at higher voltages, either 66 kV or 138 kV and are often located across country away from road right of way.

In 2006, Newfoundland Power ("the Company") submitted its *Transmission Line Rebuild Strategy* outlining a 10-year plan to rebuild aging transmission lines. This plan prioritized the investment in rebuild projects based on physical condition, risk of failure, and potential customer impact in the event of a failure.

The *Transmission Line Rebuild Strategy* is regularly updated to ensure it reflects the latest reliability data, inspection information, and condition assessments.

Appendix A contains the updated Transmission Line Rebuild Strategy Schedule.

2.0 2013 Transmission Line Rebuild Projects

In 2013, the Company will rebuild a 21.1 kilometre section of 110L transmission line and a 1.1 kilometre section of 12L transmission line. Appendix B contains maps of each of the lines to be rebuilt. Appendix C contains photographs of the existing lines.

By 2013, both of these sections of transmission line will be in excess of 55 years old. They have deteriorated poles, crossarms, hardware, and conductor. This makes the lines vulnerable to large scale damage when exposed to heavy wind, ice, and snow loading, thus increasing the risk of power outages. Inspections have identified evidence of decaying wood, worn hardware and damage to insulators.

In addition, the replacement of the conductor from 1/0 copper to 477 ASC on both lines will increase the load carrying capability of the line which will improve the overall reliability of the transmission system that services customers in these areas.

2.1 Transmission Line 110L ($2,739,000)

The Bonavista Peninsula is supplied electricity by two separate transmission circuits. The first is 123L, a 138 kV H-Frame transmission line running between Clarenville and Catalina. The second transmission circuit consists of a pair of 66 kV single pole lines, 110L and 111L. They run between Clarenville and Lockston and between Lockston and Catalina respectively.

Newfoundland Power filed with its 2006 Capital Budget Application the *Bonavista Loop Transmission Planning* report comparing alternatives for addressing transmission line requirements on the Bonavista Peninsula. The analysis completed in the *Bonavista Loop Transmission Planning* report determined that the rebuilding of 110L/111L transmission circuit and increasing conductor sizing is the least cost alternative to ensuring the continued provision of safe, reliable electrical service to the area.

Rebuilding the 110L/111L transmission circuit to current construction standards improves the mechanical strength of the transmission line by replacing poles, crossarms and guy wires. Also, increasing conductor sizing increases the load carrying capacity of the transmission lines. The use of larger conductor increases the period of time each year where the entire Bonavista Peninsula load can be carried by the 110L/111L transmission circuit.[1]

In the 7 years since the report was filed the Company has undertaken approximately $11 million in capital projects to rebuild these critical transmission lines. In 2013, the final section of transmission line 110L will be rebuilt, and the Bonavista transmission loop upgrade will be completed.

110L was constructed in 1958 and is 79 kilometres in length. It helps service approximately 4,300 customers on the Bonavista Peninsula between Milton and Lockston. This line also connects the Company's Lockston hydro plant to the main electricity grid.

By the end of 2012, 58 kilometres of 110L will have been upgraded. The remaining 21.1 kilometres of the original construction consists of 227 structures with 1/0 ACSR conductor located between the substation in Lethbridge and the substation in Summerville.

Recent inspections have identified deterioration of the existing conductor along this 21 kilometre section.[2] At times the conductor has been subjected to heavy electrical loading and also heavy ice loading. The steel core and the aluminum strands are corroded which has reduced the physical strength and the electrical capacity of the conductor. This deterioration is such that the line has been de-rated to about one-half of its original electrical current carrying capacity for safety reasons.

It is recommended the line be rebuilt in 2013 at an estimated cost of $2,738,633.

2.2 Transmission Line 12L ($380,000 in 2013 and $358,000 in 2014)

12L is a 66kV transmission line running between Memorial University Substation ("MUN") and King's Bridge Road Substation ("KBR"). The line consists of a 2.2 kilometre aerial section and a 1.0 kilometre underground cable section located through the university campus area.[3] 12L in conjunction with transmission line 14L, are the transmission lines that provide service to Memorial University, the Health Science Centre and the Janeway Children's Health and Rehabilitation Centre.

1 The principle benefit of the increase in load carrying capability for the 110L/111L transmission circuit is the ability of the Bonavista transmission system to tolerate a planned or unplanned outage on transmission line 123L. Following the rebuild of the final 21.1 kilometres of 110L in 2013, the 110L/111L transmission circuit will be capable of carrying the entire Bonavista customer load for approximately 38 weeks of the year. For the remaining 14 weeks of the year the 110L/111L transmission circuit will be able to carry 75% of the Bonavista customer load. This is a significant improvement for the Bonavista transmission system as the existing conductor limits the 110L/111L transmission circuit to only 6 weeks of the year when it is capable of carrying the entire Bonavista customer load.

2 Photographs of deteriorated conductor are included in figures 1 and 4 of Appendix C.

3 The 2013 and 2014 projects only involve the rebuild of the 2.2 kilometre aerial section of transmission line.

The aerial section of transmission line was originally constructed in 1950 and consists of 59 single pole structures all of which has under built distribution circuitry. The route taken by the transmission line, as shown by Figure 2 of Appendix B, is through heavy residential areas of the City of St. John's. Recognizing the added complexity associated with access to private property, obtaining permits from municipal authorities and construction in heavy traffic areas, the Company has chosen to complete the rebuild of transmission line 12L over 2 years.

With the infrastructure additions in this area load growth at MUN substation will continue to increase.[4] With this increase in load the existing 1/0 copper conductor on 12L will not be able to carry peak load without 14L also in service. To address these loading concerns the 1/0 copper conductor on 12L will be replaced with 477 ASC.

Inspections have identified deterioration due to decay, splits and checks in the poles and crossarms.[5] Many of these wooden components are in advanced stages of deterioration and require replacement. The majority of the wooden poles are original vintage and have surpassed their normal life expectancy. The copper conductor is deteriorated and at the end of its service life. Due to the age and condition of the line it is susceptible to damage should it become exposed to severe wind, ice or snow loading.

The transmission line has reached a point where continued maintenance is no longer feasible and it has to be rebuilt to continue its safe, reliable operation.

Based on the overall deteriorated condition of the line, it is recommended the line be rebuilt at an estimated cost of $380,000 in 2013 and $358,000 in 2014.

3.0 Concluding

In 2013, the Company will rebuild the remaining section of 110L and a section of 12L, with the remainder of 12L to be rebuilt in 2014. Each of these transmission lines is more than 55 years old, with structures experiencing deterioration of the poles, crossarms, hardware, and conductor. Recent inspections and engineering assessment has determined the transmission lines have reached a point where continued maintenance is no longer feasible and they have to be rebuilt to continue providing safe, reliable electrical service.

This project is justified based on the need to replace deteriorated transmission line infrastructure in order to ensure the continued provision of safe, reliable electrical service.

---

4 Recent infrastructure additions have taken place at the Health Science Centre and the Janeway Children's Health and Rehabilitation Centre. Planned infrastructure additions include 2 new residence buildings.

5 Most of the poles are located adjacent to city streets and are prone to damage by passing snowploughs and other vehicles. Where practical, new poles will be located behind the curb and sidewalk to mitigate future damage. Relocating these poles will add to the complexity of the rebuild project.

Appendix A
Transmission Line Rebuild Strategy Schedule

Transmission Line Rebuilds 2013 – 2017 ($000s)						
Line	**Year**	**2013**	**2014**	**2015**	**2016**	**2017**
012L KBR-MUN	1950	380	358			
110L CLV-LOK	1958	2,739				
013L SJM-SLA	1962		658			
018L GOU-GDL	1951		772			
035L KEN-OXP	1959		567			
068L HGR-CAR	1951		828			
015L SLA-MOL	1958			163		
030L RRD-KBR	1959			554	539	
032L OXP-RRD	1963			353		
400L BBK-WHE	1967			1,863	1,947	
069L KEN-SLA	1951			1,013		
014L SLA-MUN	1950				260	
057L BRB-HGR	1958				1,608	1,655
302L SPO-LAU	1959					1,582
041L CAR-HCT	1958					1,472
	Total	**3,119**	**3,183**	**3,946**	**4,354**	**4,709**

Transmission Line Rebuilds 2018 – 2024 ($000s)								
Line	**Year**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
041L CAR-HCT	1958	1,151						
101L GFS-RBK	1957	2,408						
302L SPO-LAU	1959	3,894						
102L GAN-RBK	1958		4,659	4,705	4,991			
049L HWD-CHA	1966				674			
100L SUN-CLV	1964						2,643	3,363
124L CLV-GAM	1964					3,990	4,677	2,418
403L TAP-ROB	1960					1,060		
146L GAN-GAM	1964						2,907	3,895
363L BVJ-SCR	1963		3,156	3,338	3,532	4,429		
	Total	**7,453**	**7,815**	**8,043**	**9,197**	**9,479**	**10,227**	**9,676**

Appendix B
Maps of Transmission Lines
110L and 12L

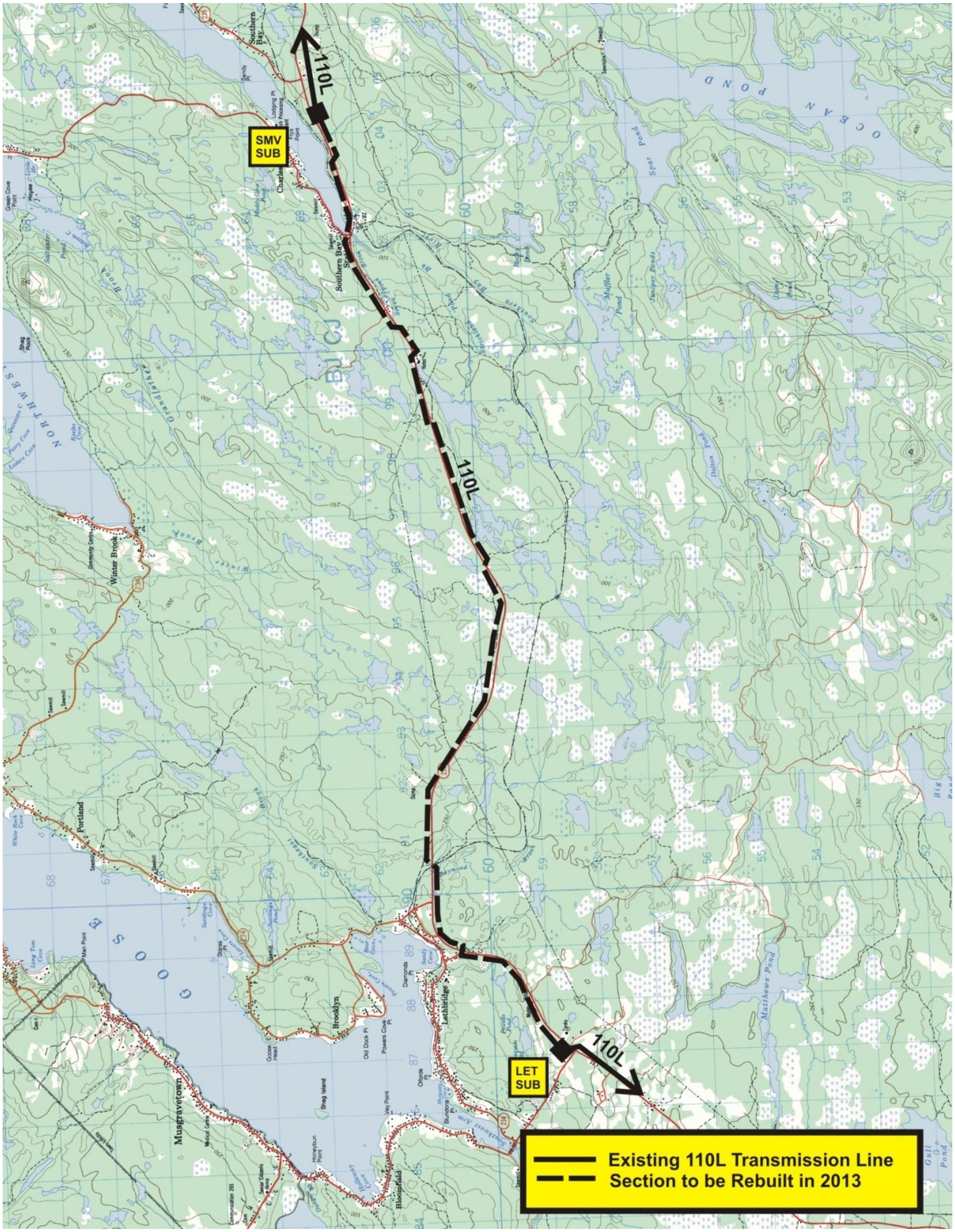

Figure 1 – Map of 110L route

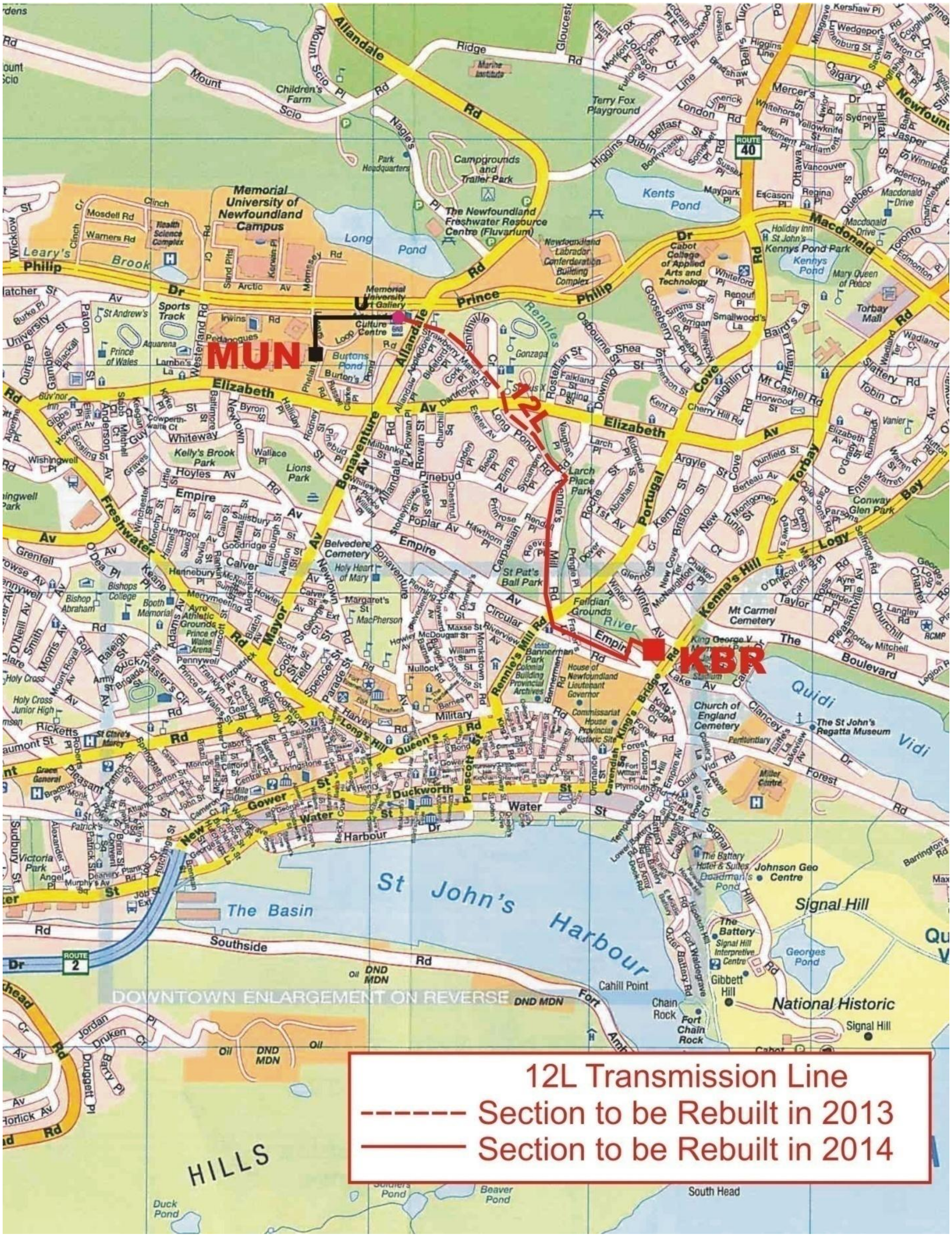

Figure 2 – Map of 12L route

Appendix C
Photographs of Transmission Lines
110L and 12L

Transmission Line 110L

Figure 1 – 110L – Multiple sleeves to repair conductor damage

Figure 2 – 110L – Checks in pole

Figure 3 – 110L – Deteriorated pole and crib

Figure 4 – 110L – Damaged conductor removed from 110L in December 2011

Transmission Line 12L

Figure 5 – 12L - Pole showing checking around bolts

Figure 6 – 12L – Pole showing shell separation and damage

Figure 7 – 12L – Pole bent due to significant loading

Figure 8 – 12L – Deteriorated crossarms

Figure 9 – 12L – Distribution aerial cable arrangement (1)

Figure 10 – 12L – Distribution aerial cable arrangement (2)

2012 Transmission Line Rebuild
June 2011

2012 Transmission Line Rebuild

June 2011

Prepared by:

Brian Combden

Approved by:

Michael Comerford P.Eng.

NEWFOUNDLAND POWER
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Appendix B: Topographic Maps of Transmission Lines 110L, 21L, and 124L
Appendix C: Photographs of Transmission Lines 110L, 21L, and 124L

1.0 Transmission Line Rebuild Strategy

Transmission lines are the bulk transmitter of electricity providing service to customers. Transmission lines operate at higher voltages, either 66 kV or 138 kV and are often located across country away from road right of way.

In 2006, Newfoundland Power ("The Company") submitted its *Transmission Line Rebuild Strategy* outlining a 10-year plan to rebuild aging transmission lines. This plan prioritized the investment in rebuild projects based on physical condition, risk of failure, and potential customer impact in the event of a failure.

The *Transmission Line Rebuild Strategy* is regularly updated to ensure it reflects the latest reliability data, inspection information and condition assessments.

Appendix A contains the updated Transmission Line Rebuild Strategy Schedule.

2.0 Transmission Line Rebuild Projects Planned for 2012

In 2012, the Company plans to rebuild transmission line 21L and sections of 110L and 124L. Appendix B contains topographic views of each of the lines to be rebuilt. Appendix C contains photographs of the existing lines.

By 2012, all of these lines will be in excess of 48 years old. They have deteriorated poles, crossarms, hardware, and conductor. This makes the lines vulnerable to large scale damage when exposed to heavy wind, ice, and snow loading, thus increasing the risk of power outages. Inspections have identified evidence of decaying wood, worn hardware and damage to insulators.

2.1 Transmission Line 110L ($1,853,000)

The Bonavista Peninsula is supplied electricity by two separate transmission lines. The first is 123L, a 138 kV H-Frame transmission line running between Clarenville and Catalina. The second transmission circuit consists of a pair of 66 kV single pole lines, 110L and 111L. They run between Clarenville and Lockston and between Lockston and Catalina respectively.

The report *Bonavista Loop Transmission Planning*, filed with Newfoundland Power's 2006 Capital Budget Application, compared alternatives for addressing transmission line requirements on the Bonavista Peninsula. The analysis determined that the rebuilding of 110L and increasing conductor sizing is the least cost alternative to ensuring the continued provision of safe, reliable electrical service to the area.

110L was constructed in 1958 and is 79 kilometres in length. It helps service approximately 4,300 customers on the Bonavista Peninsula between Milton and Lockston. This line also connects the Company's Lockston hydro plant to the main electricity grid.

Sections of 110L have been upgraded with a total of 52 kilometres rebuilt. Based on the condition of the remaining sections of the line, it is recommended that 10.3 kilometres be rebuilt in 2012. The 10.3 kilometres being rebuilt include an 8.7 kilometre section near Lockston substation and a 1.6 kilometre section on the Trans Canada Highway in Clarenville. The 1.6 kilometre section along the Trans Canada Highway was delayed from 2010 as a result of Hurricane Igor.[1]

The conductor on 110L has been subjected to severe ice loading since its original installation and is damaged and deteriorated. The steel core and the aluminum strands are corroded, decreasing the physical strength and electrical capacity of the conductor. This deterioration is such that the line has been de-rated to about one-half of its original electrical current carrying capacity for safety reasons. Increasing the conductor size on the transmission line, as recommended in the *Bonavista Loop Transmission Planning* report, increases the length of time during the year (from 6 weeks to 38 weeks) when 110L can carry the Bonavista Peninsula load with transmission line 123L out of service.

The most recent 2011 inspection of 110L noted the following deficiencies on the 99 structures comprising the 10.3 kilometre section of line:

Table 1
110L Deficiencies

Deficiency Category	Number of Structures
Insulators	17
Deteriorated/Damaged Crossarms	9
Pole Deteriorated/Damaged	39

Based on the overall deteriorated conditions observed, it is recommended that this section of line be rebuilt to current CSA Severe Weather Loading Standards in 2012 at an estimated cost of $1,653,000.

2.2 Transmission Line 21L ($822,000)

21L is a 66kV H-Frame transmission line running between the Horse Chops Hydroelectric Plant and transmission line 20L.[2] 21L connects the Horse Chops plant to the main electricity grid.[3] It is 5.3 kilometres in length and was originally constructed in 1952. The line consists of 36 two and three-pole H-Frame structures utilizing 266.8 ACSR conductors, with a number of road crossing spans along the route.

---

[1] Attempts to reschedule the work on 110L following Hurricane Igor were hampered by increased electrical loading at that particular time of year thus preventing the project from being completed in 2010.

[2] 21L terminates at the intersection of Horse Chops Road and the Southern Shore Highway near Cape Broyle.

[3] Horse Chops plant produces 42 GWH of electricity annually, or 9.8% of Newfoundland Power's annual hydroelectric production

Inspections have identified substantial deterioration due to decay, woodpecker holes, and splits and checks in the poles, crossarms and crossbraces. Many of these wooden components are in advanced stages of deterioration and require replacement. Most of the wooden poles are original vintage (59 years old) and have surpassed their normal life expectancy. Transmission line 21L also contains insulators manufactured by Canadian Ohio Brass (COB). These insulators are identified as deficient due to a history of premature failure caused by cement growth. As the cement expands, cracks in the porcelain insulators occur making them more susceptible to flashovers.

The poles, crossarms and crossbraces have had their strength compromised due to severe deterioration. Long span lengths combined with physical condition, make the line susceptible to damage should it become exposed to wind, ice or snow loading.

Recent inspections have determined the transmission line has reached a point where continued maintenance is no longer feasible and it has to be rebuilt to continue its safe, reliable operation.

The most recent 2010 inspection of 21L noted the following deficiencies:

Table 2
21L Deficiencies

Deficiency Category	**Number of Structures**
Insulators	25
Crossarms Deteriorated/Damaged	7
Crossbraces Deteriorated/Damaged	17
Pole Deteriorated/Damaged	11

Based on the advanced age and overall deteriorated condition observed, it is recommended this section of line be rebuilt to current CSA Severe Weather Loading Standards in 2012 at an estimated cost of $822,000.

2.3 Transmission Line 124L ($802,000)

124L is a 138 kV transmission line between Clarenville Substation and Gambo Substation. The line has a total length of 90 kilometres and is of H-frame wood pole construction. The line was originally built in 1964.

Due to the elevation and type of terrain in the White Hills area near Clarenville, the line in that location has had a history of problems. This area is prone to heavy ice loading and high winds. On several occasions, poles, crossarms and conductors have failed because of the severe weather conditions.

The transmission line was originally designed to withstand conductor ice loading of 12.7 mm (½") of radial ice. Actual accumulation of 38 mm (1½") has been measured on this line in the White Hills area. Loading has been severe enough that the conductor in this section of the line has been permanently stretched, thus increasing the sag of the conductor and decreasing the ground clearance. In this same area there are several extra long spans which present potential risks to the line's structural integrity and of decreased ground clearance.[4]

During the period 2001 to 2005, a total of 16 kilometres of line were rebuilt between Clarenville and Thorburn Lake. These upgrades were necessary to correct several ground clearance issues and addressed line failure in the area caused by severe wind and ice loading. The only remaining original section of line in that particularly harsh location is the 5 kilometre section planned for 2012.

The most recent 2011 inspection of 124L noted the following deficiencies in the 23 structures comprising the 5 kilometre section planned for 2012:

Table 3
124L Deficiencies

Deficiency Category	**Number of Structures**
Insulators	7
Crossarms Deteriorated/Damaged	4
Crossbraces Deteriorated/Damaged	1
Structures Deteriorated/Damaged	9

Based on the advanced age and overall deteriorated conditions observed, it is recommended that a 5 kilometre section of line be rebuilt to current CSA Severe Weather Loading Standards in 2012 at an estimated cost of $802,000.

3.0 Concluding

In 2012, the Company will rebuild transmission line 21L and sections of 110L and 124L. These transmission lines range in age from 47 to 59 years old. Their structures have experienced deterioration of poles, crossarms, hardware, and conductor. Recent inspections have determined the transmission lines have reached a point where continued maintenance is no longer feasible and they have to be rebuilt to continue providing safe, reliable electrical service.

This project is justified based on the need to replace deteriorated transmission line infrastructure in order to ensure the continued provision of safe, reliable electrical service.

[4] This section of 124L has 2 particularly long spans, one that is 1,283 feet and another 1,502 feet in length.

Appendix A

Transmission Line Rebuild Strategy Schedule

Transmission Line Rebuilds
2012-2016
($000)

Line	Year	Replacement Age (Years)	2012	2013	2014	2015	2016
012L KBR-MUN	1950	63		350	300		
013L SJM-SLA	1962	52			605		
014L SLA-MUN	1950	66					220
015L SLA-MOL	1958	57				133	
018L GOU-GDL	1951	63			790		
021L 20L-HCP	1952	60	822				
030L RRD-KBR	1959	56				450	440
032L OXP-RRD	1959	56				353	
400L BBK-WHE	1967	48				1,940	2,000
057L BRB - HGR	1958	58					1,600
068L HGR-CAR	1951	63			881		
069L KEN-SLA	1951	64				830	
110L CLV-LOK	1958	54	1,853	2,868			
124L CLV-GAM	1964	48	802				
Average Age at Replacement	**Total**	**58**	**$3,477**	**$3,218**	**$2,576**	**$3,706**	**$4,260**

Transmission Line Rebuilds
2017-2023
($000)

Line	Year	Replacement Age (Years)	2017	2018	2019	2020	2021	2022	2023
041L CAR-HCT	1958	59	2,557						
049L HWD-CHA	1966	55					584		
057L BRB-HGR	1958	58	1,655						
100L SUN-CLV	1964	57					2,148	2,886	2,065
101L GFS-RBK	1957	61		1,850	4,023				
102L GAN-RBK	1958	61			2,012	6,444	4,296		
124L CLV-GAM	1964	58						3,634	3,441
146L GAN-GAM	1964	59							2,524
302L SPO-LAU	1959	58	1,508	3,602					
403L TAP-ROB	1960	62						890	
Average Age at Replacement	**Total**	**59**	**$5,720**	**$5,452**	**$6,035**	**$6,444**	**$7,028**	**$7,410**	**$8,030**

Appendix B

Topographic Maps of Transmission Lines 110L, 21L and 124L

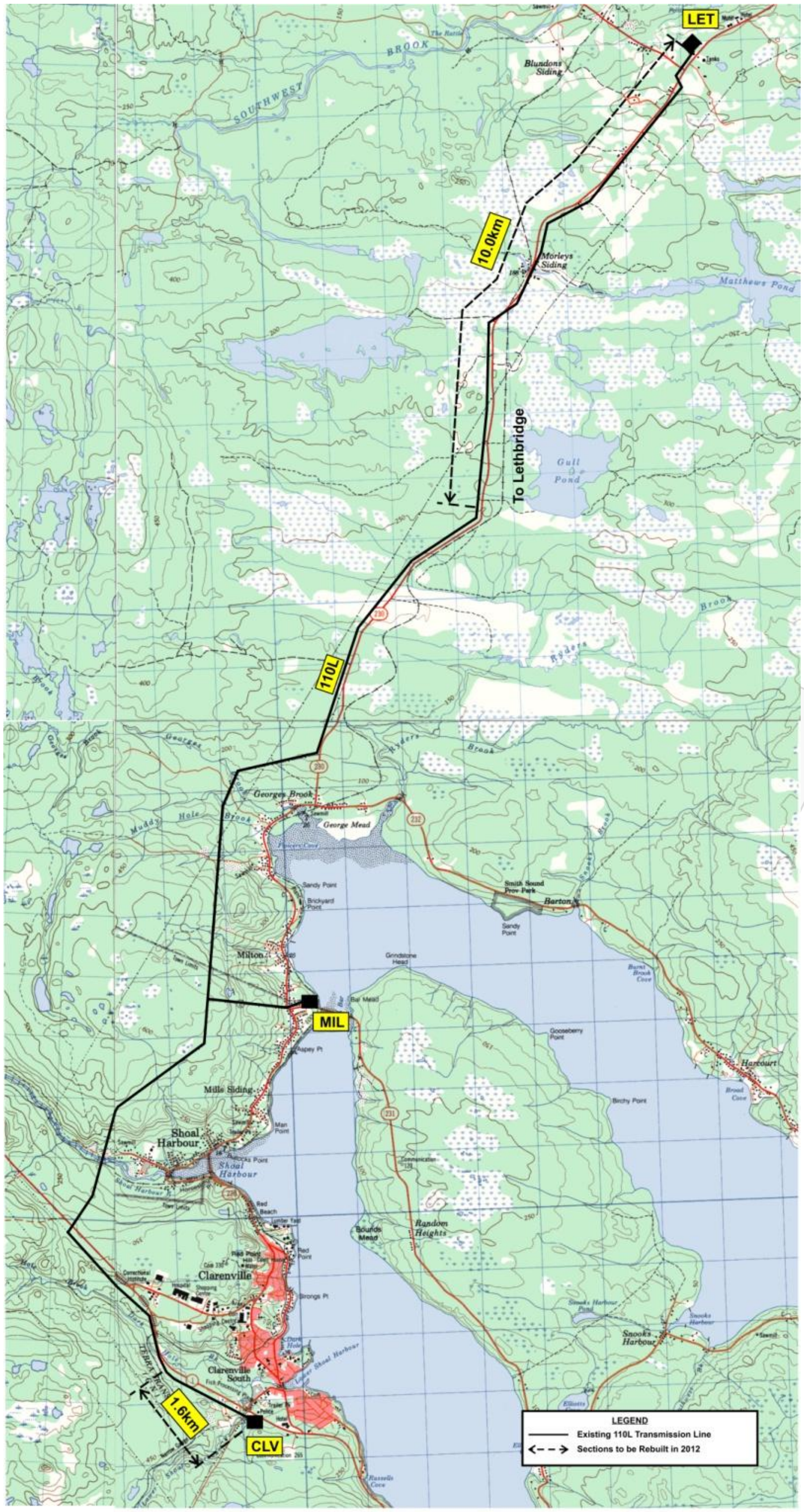

Figure 1 – Topographic Map 110L

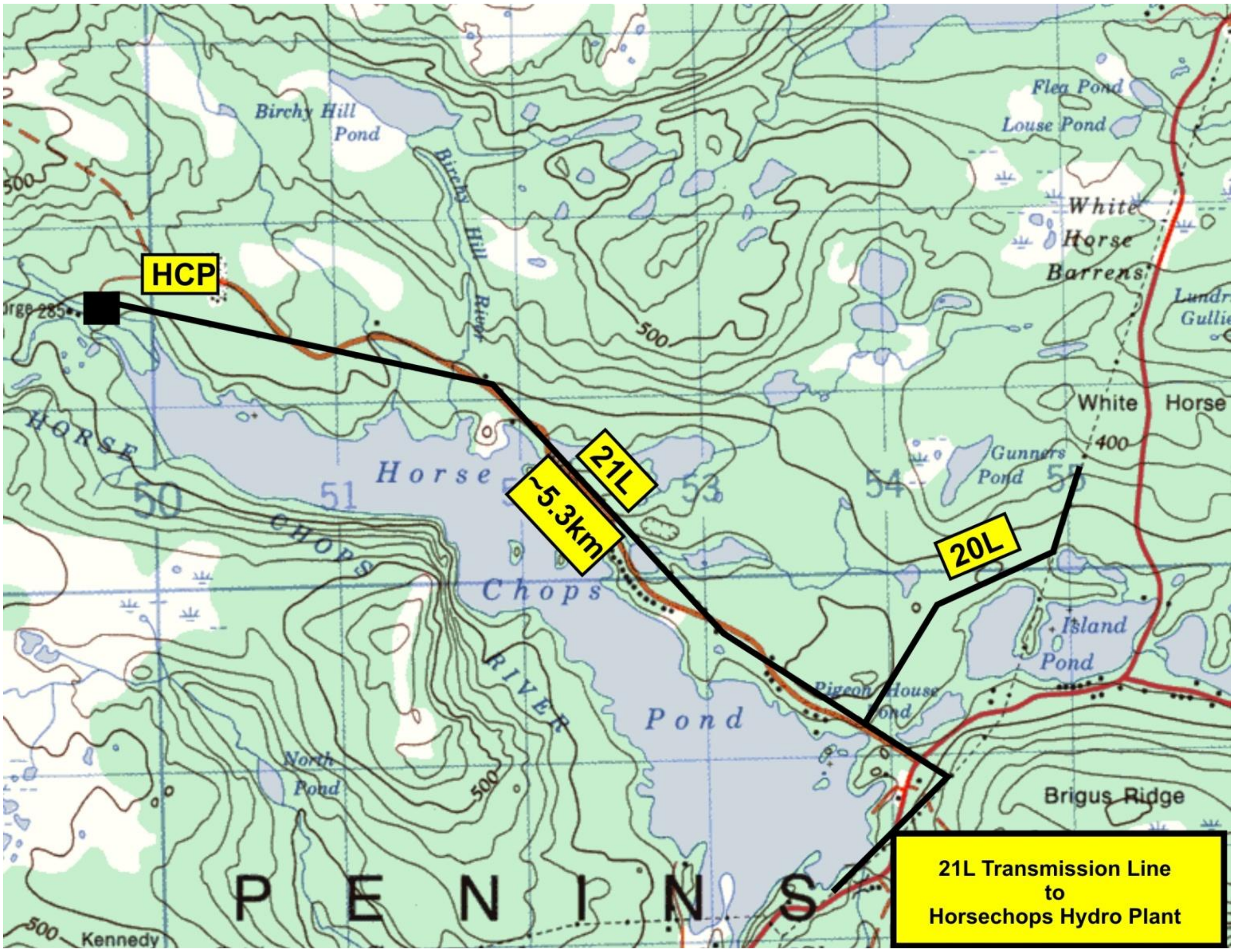

Figure 2 – Topographic Map 21L

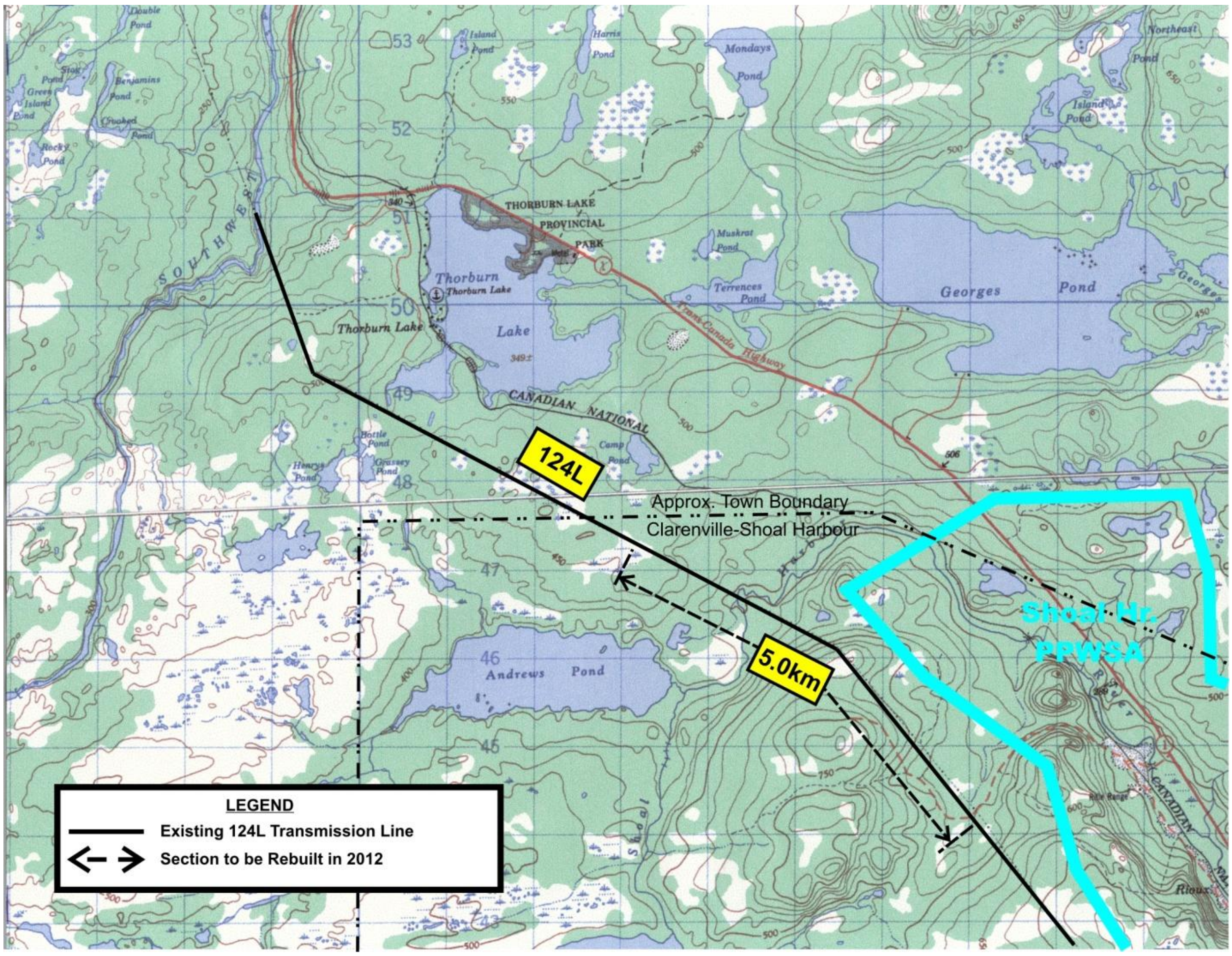

Figure 3 – Topographic Map 124L

Appendix C

Photographs of Transmission Lines 110L, 21L and 124L

Transmission Line 110L

Figure 1 – Split Crossarm 110L

Figure 2 – Deteriorated Pole on 110L

Figure 3 – Twisted Crossarm 110L

Figure 4 – Woodpecker Holes 110L

Figure 5 – Split Pole Top 110L

Figure 6 – Split Pole 110L

Transmission Line 21L

Figure 7 – Split Crossbrace 21L

Figure 8 – Pole requiring temporary support 21L

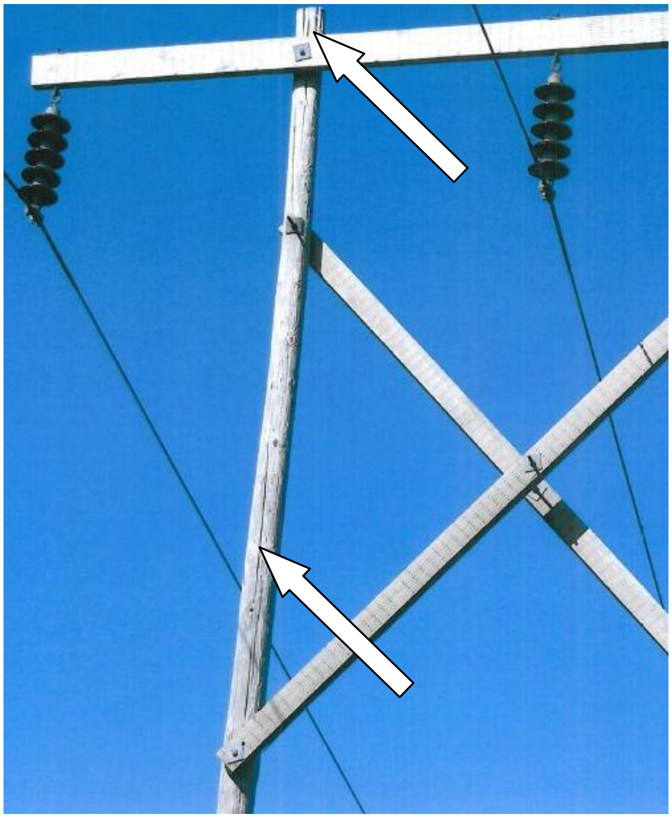

Figure 9 – Badly deteriorated pole 21L

Figure 10 – Woodpecker Hole 21L

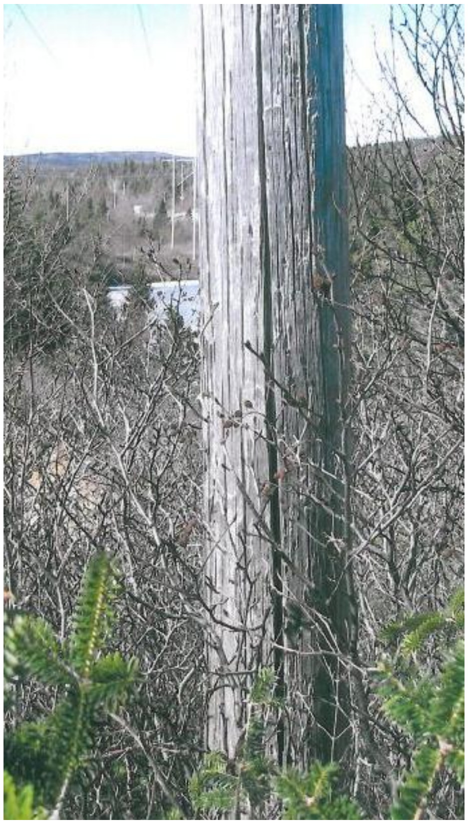

Figure 11 – Deteriorated pole 21L

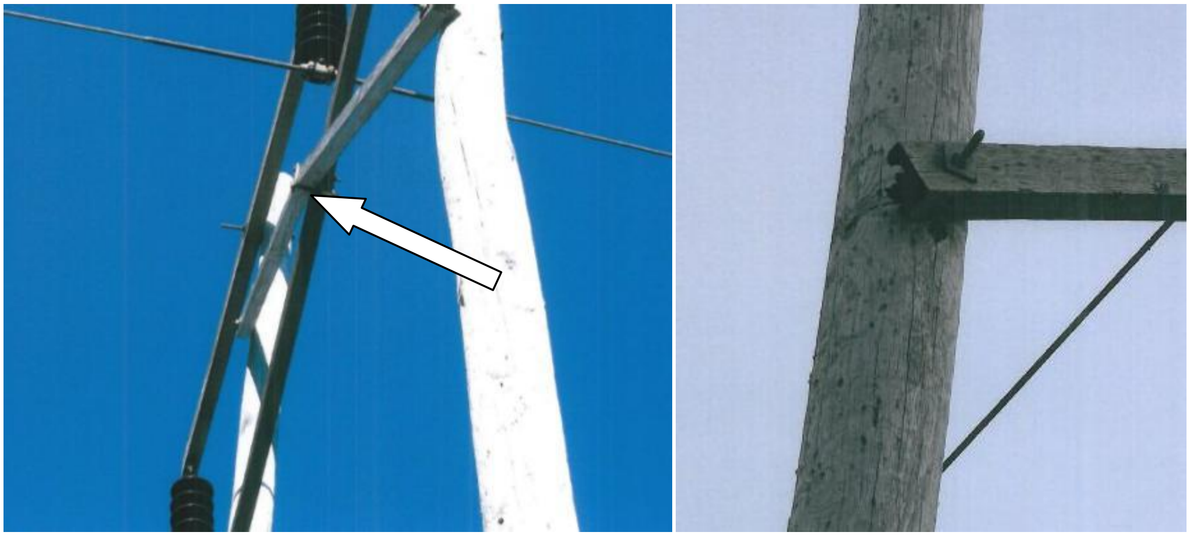

Figure 12 – Broken and Deteriorated Crossbraces 21L

Figure 13 – Deteriorated Pole and Crossarm 21L

<u>Transmission Line 124L</u>

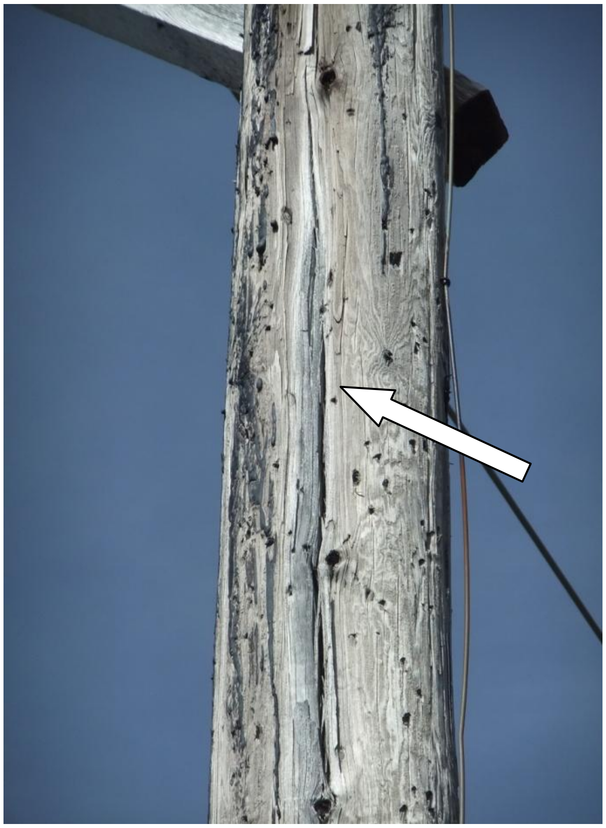

Figure 14 – Check in Pole 124L

Figure 15 – Woodpecker Holes 124L

Figure 16 – Armour Rod to Repair Wire Damage 124L

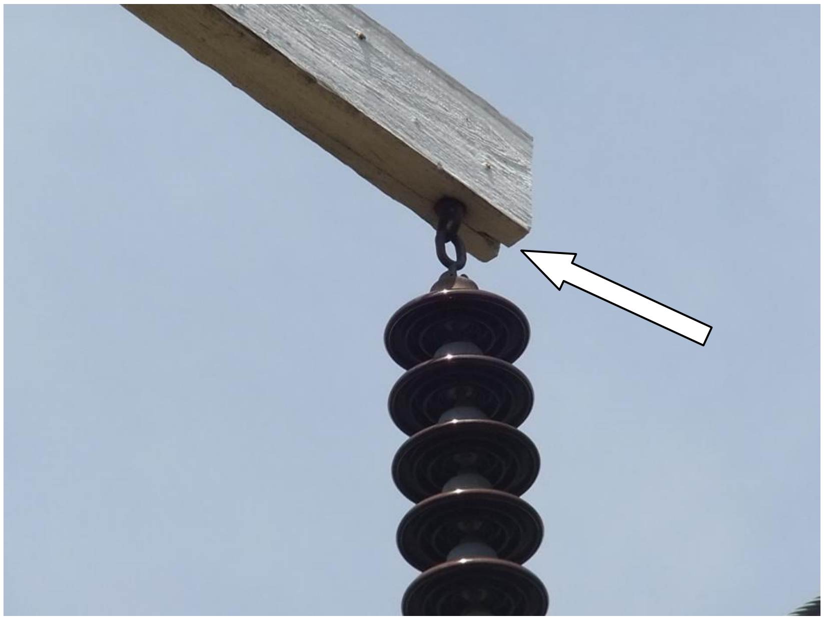

Figure 17 – Check in Crossarm 124L

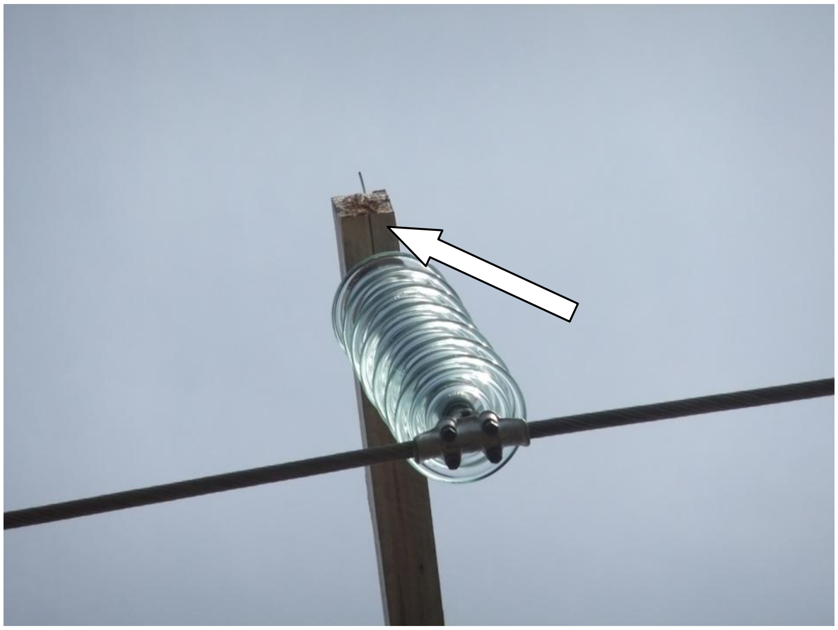

Figure 18 – Check in Crossarm 124L

Figure 19 – Location with Reduced Ground Clearance 124L

2011 Transmission Line Rebuild
June 2010

Transmission Line Rebuild

June 2010

Prepared by:

M. R. Murphy, B.Sc, E.I.T.

Michael Comerford, P. Eng.

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2.3 Transmission Line 25L……… 3

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Appendix A: Transmission Line Rebuild Strategy Schedule
Appendix B: Topographic Maps of Transmission Lines 16L, 21L, and 25L
Appendix C: Photographs of Transmission Lines 16L, 21L, and 25L

1.0 Transmission Line Rebuild Strategy

Transmission lines are the bulk transmitter of electricity providing service to customers. Transmission lines operate at higher voltages, either 66 kV or 138 kV and are often located across country away from road rights of way.

In 2006, Newfoundland Power ("The Company") submitted its *Transmission Line Rebuild Strategy* outlining a 10-year plan to rebuild aging transmission lines. This plan prioritized the investment in rebuild projects based on physical condition, risk of failure, and potential customer impact in the event of a failure.

The *Transmission Line Rebuild Strategy* is regularly updated to ensure it reflects the latest reliability data, inspection information, and condition assessments.

Appendix A contains the updated Transmission Line Rebuild Strategy Schedule.

2.0 Transmission Line Rebuild Projects Planned for 2011

In 2011, the Company plans to rebuild transmission lines 16L, 21L and 25L. Appendix B contains topographic views of each of the lines to be rebuilt. Appendix C contains photographs of the existing lines.

These lines are each more than 55 years old; and there is deterioration of the poles, crossarms, hardware, and conductor. This makes the lines vulnerable to large scale damage when exposed to heavy wind, ice, and snow loading, thus increasing the risk of power outages. Inspections have identified evidence of decaying wood, worn hardware and damage to insulators.

2.1 Transmission Line 16L ($730,000)

16L is a 66 kV transmission line running between King's Bridge Substation and Pepperell Substation. The line is 1.98 kilometres in length and is single pole construction with 1/0 Copper conductor. Constructed in 1950, it is located near Quidi Vidi Lake and runs alongside the Boulevard and King's Bridge Rd.

The line consists of 50 structures, 43 of which have distribution underbuilt on the poles, and many of which provide street lighting to the Boulevard. Most of these structures are directly adjacent to the road in the face of the curb and are prone to damage by passing snowploughs and other vehicles.

Inspections have identified deterioration due to decay and vehicular damage, splits and checks in the poles, substandard crossarms and other hardware deficiencies. Many of these components are in advanced stages of deterioration and require replacement. Much of the structure guying on 16L is insufficient by today's standards and has resulted in a number of leaning or bent poles.

Recent inspections have determined the transmission line has reached a point where continued maintenance is no longer feasible and it has to be rebuilt to continue its safe, reliable operation.

The most recent 2010 inspection of 16L noted the following deficiencies:

Table 1
16L Deficiencies

Deficiency Category	Number of Structures[1]
Insulators	4
Deteriorated/Damaged Crossarms	28
Grounding	6
Pole Leaning	5
Pole Deteriorated/Damaged	21

Based on the overall deteriorated condition of the line, it is recommended the line be rebuilt in 2011 at an estimated cost of $730,000.

2.2 Transmission Line 21L ($822,000)

21L is a 66 kV H-Frame transmission line running between the Horse Chops Hydroelectric Plant and transmission line 20L.[2] 21L connects the Horse Chops plant to the main electricity grid.[3] It is 5.73 kilometres in length and was originally constructed in 1952. The line consists of 36 two and three-pole H-Frame structures using non-standard 266.8 ACSR conductors with a number of road crossing spans along the route.

Inspections have identified substantial deterioration due to decay, woodpecker holes, and splits and checks in the poles, crossarms and crossbraces. Many of these wooden components are in advanced stages of deterioration and require replacement. Transmission line 25L also contains insulators manufactured by Canadian Ohio Brass (COB). These insulators are identified as deficiencies due to a history of premature failure caused by cement growth. As the cement in these insulators expands, cracks in the porcelain insulators occur making the insulators more susceptible to flashovers.

The poles, crossarms and crossbraces have had their strength compromised due to the extent of deterioration. Long span lengths combined with the physical condition, make the line susceptible to damage should it become exposed to wind, ice or snow loading.

---

1 16L has a total of 50 structures.

2 21L terminates at the intersection of Horse Chops Road and the Southern Shore Highway near Cape Broyle. At its termination, 21L connects with transmission line 20L.

3 Horse Chops plant produces 43 GWH of electricity annually, or 10.1% of Newfoundland Power's annual hydroelectric production.

Recent inspections have determined the transmission line has reached a point where continued maintenance is no longer feasible and it has to be rebuilt to continue its safe, reliable operation.

The most recent 2010 inspection of 21L noted the following deficiencies:

Table 2
21L Deficiencies

Deficiency Category	Number of Structures[4]
Insulators	25
Crossarms Deteriorated/Damaged	7
Crossbraces Deteriorated/Damaged	17
Pole Deteriorated/Damaged	11

Based on the advanced age and overall deteriorated condition of the line, it is recommended the line be rebuilt in 2011 at an estimated cost of $822,000.

2.3 Transmission Line 25L ($1,443,000)

25L is a 66 kV H-Frame transmission line running between the Goulds substation on Main Road in the Goulds and St. John's Main substation on Southside Rd. This line is 9.25 kilometres in length and was originally constructed in 1954.

The line consists of 51 two and three-pole H-Frame structures and two steel towers using non-standard 477 ACSR conductor. Inspections have identified substantial deterioration including numerous instances of rot in the poles and timbers, as well as rusting guys and worn hardware. Corrosion is evident on the steel towers and the line contains insulators manufactured by Canadian Ohio Brass (COB) which have been identified as deficiencies due to a history of premature failure caused by cement growth.

The poles and timbers, in many cases, are now moss-covered which indicates advanced decay and, therefore, have compromised strength. In a number of instances, temporary bracing has been used in cases where the poles are visibly unable to support the line.[5]

[4] 21L has a total of 36 structures.
[5] Photographs of some temporary braces are included in figure 14 of Appendix C.

Recent inspections have determined the transmission line has reached a point where continued maintenance is no longer feasible and it has to be rebuilt to continue its safe, reliable operation.

The most recent 2010 inspection of 25L noted the following deficiencies:

Table 3
25L Deficiencies

Deficiency Category	Number of Structures[6]
Insulators	43
Crossarms Deteriorated/Damaged	15
Crossbraces Deteriorated/Damaged	27
Pole Deteriorated/Damaged	30

Based on the advanced age and overall deteriorated condition of the line, it is recommended the line be rebuilt in 2011 at an estimated cost of $1,443,000.

3.0 Concluding

In 2011, the Company will rebuild transmission lines 16L, 21L and 25L. Each of these transmission lines is more than 55 years old; with structures experiencing deterioration of the poles, crossarms, hardware, and conductor. Recent inspections have determined the transmission lines have reached a point where continued maintenance is no longer feasible and they have to be rebuilt to continue providing safe, reliable electrical service.

This project is justified based on the need to replace deteriorated transmission line infrastructure in order to ensure the continued provision of safe, reliable electrical service.

[6] 25L has a total of 51 structures.

Appendix A

Transmission Line Rebuild Strategy Schedule

Transmission Line Rebuilds 2011-2015 ($000)						
Line	**Year**	**2011**	**2012**	**2013**	**2014**	**2015**
012L KBR-MUN	1950		595			
013L SJM-SLA	1962				605	
014L SLA-MUN	1950			237		
015L SLA-MOL	1958					133
016L PEP-KBR	1950	730				
018L GOU-GDL	1951					766
021L 20L-HCP	1952	822				
025L GOU-SJM	1954	1,443				
030L RRD-KBR	1959					825
032L OXP-RRD	1959					353
035L OXP-KEN	1963					929
068L HGR-CAR	1951				881	
069L KEN-SLA	1951				802	
110L CLV-LOK	1958		1,653	2,868		
124L CLV-GAM	1964		802			
	Total	**$2,995**	**$3,050**	**$3,105**	**$2,288**	**$3,006**

Transmission Line Rebuilds 2016-2022 ($000)								
Line	**Year**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
041L CAR-HCT	1958	695	2,830					
049L HWD-CHA	1966						595	
057L BRB-HGR	1958	3,228						
100L SUN-CLV	1964						2,203	2,978
101L GFS-RBK	1957			1,863	4,076			
102L GAN-RBK	1958				2,038	6,568	4,406	
124L CLV-GAM	1964							3,750
301L SPO-GRH	1959		208					
302L SPO-LAU	1959		1,509	3,627				
403L TAP-ROB	1960							919
	Total	**$3,923**	**$4,547**	**5,490**	**$6,114**	**$6,568**	**$7,204**	**$7,647**

Appendix B

Topographic Maps of Transmission Lines 16L, 21L, and 25L

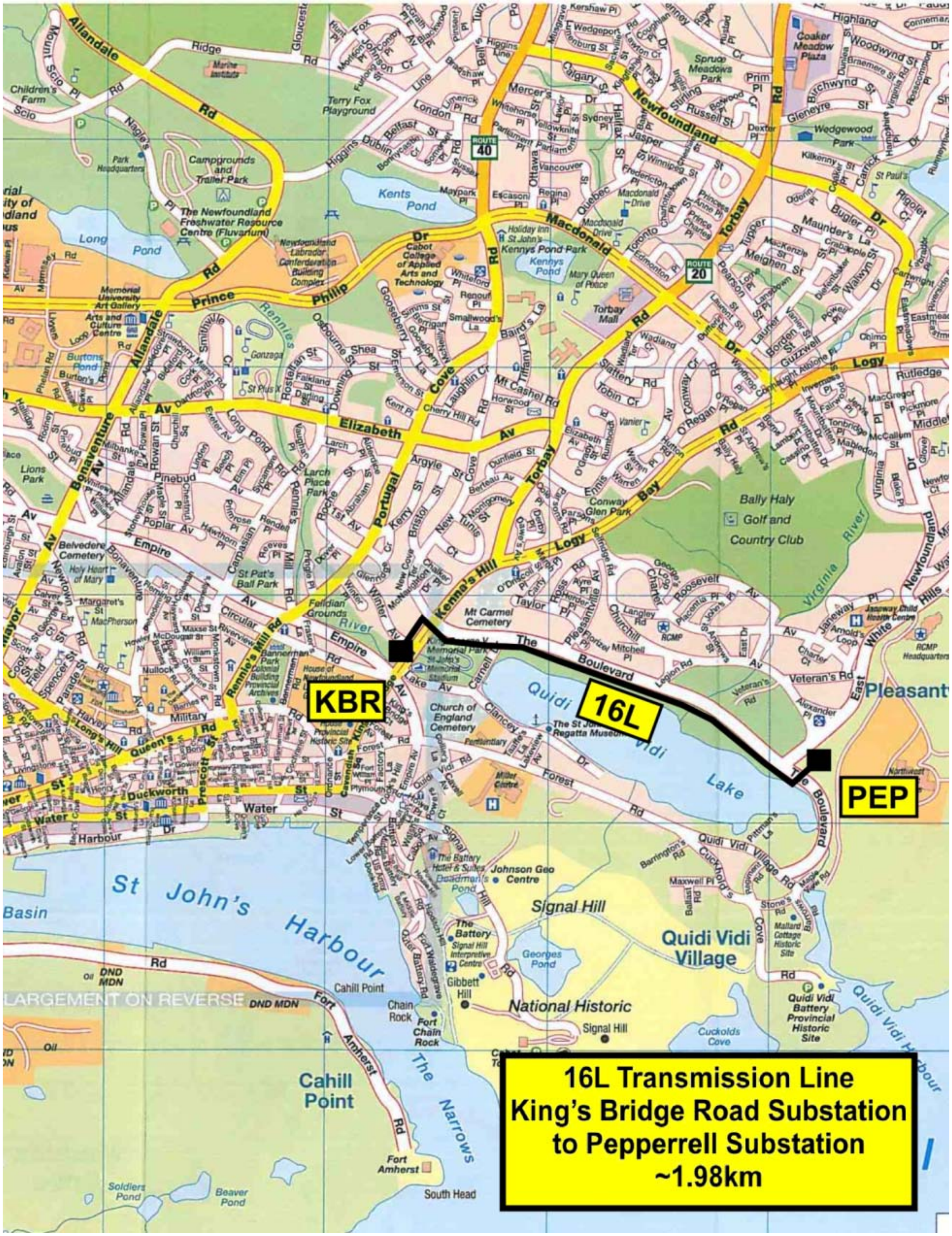

Figure 1 – Road Map 16L

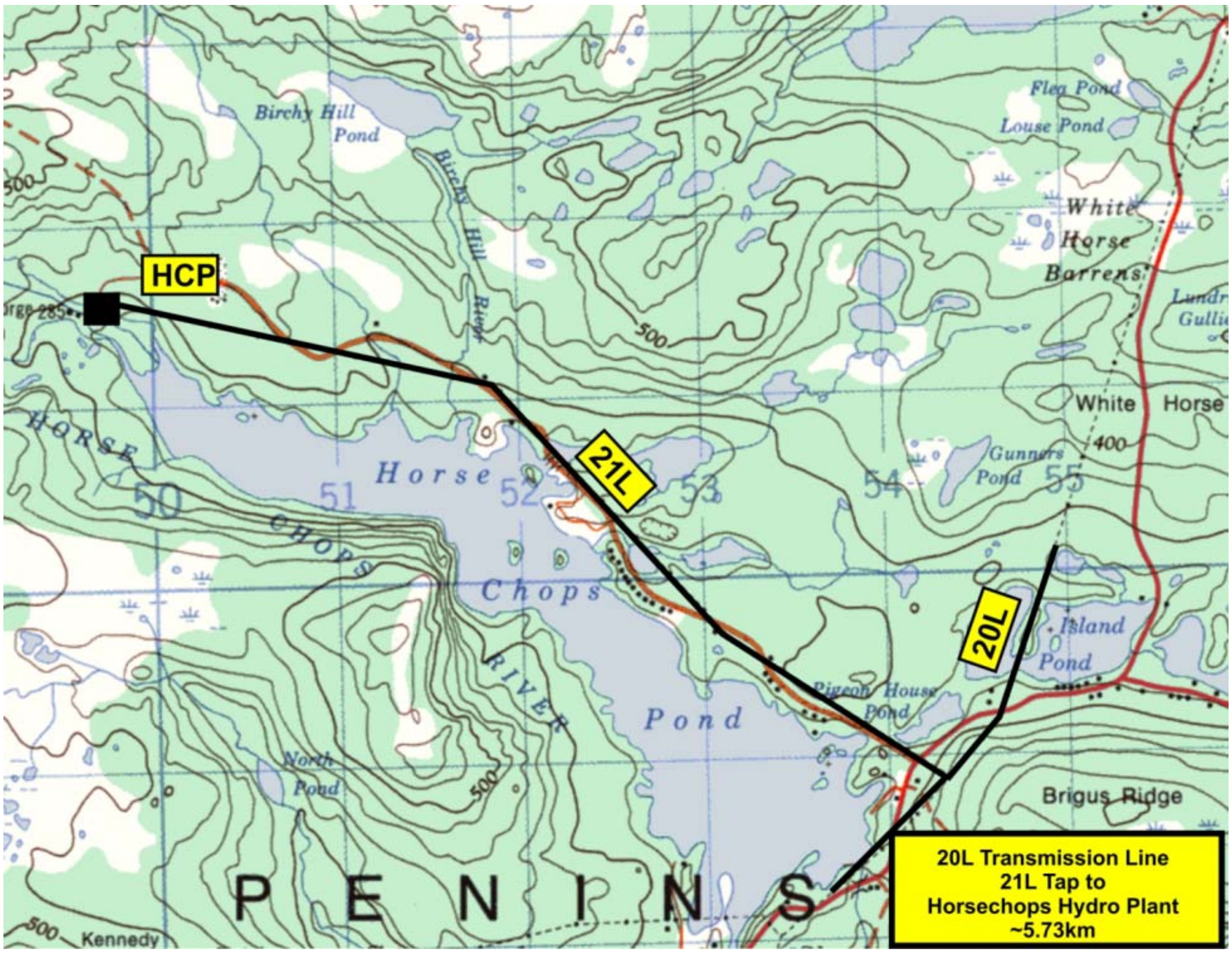

Figure 2 – Topographic Map 21L

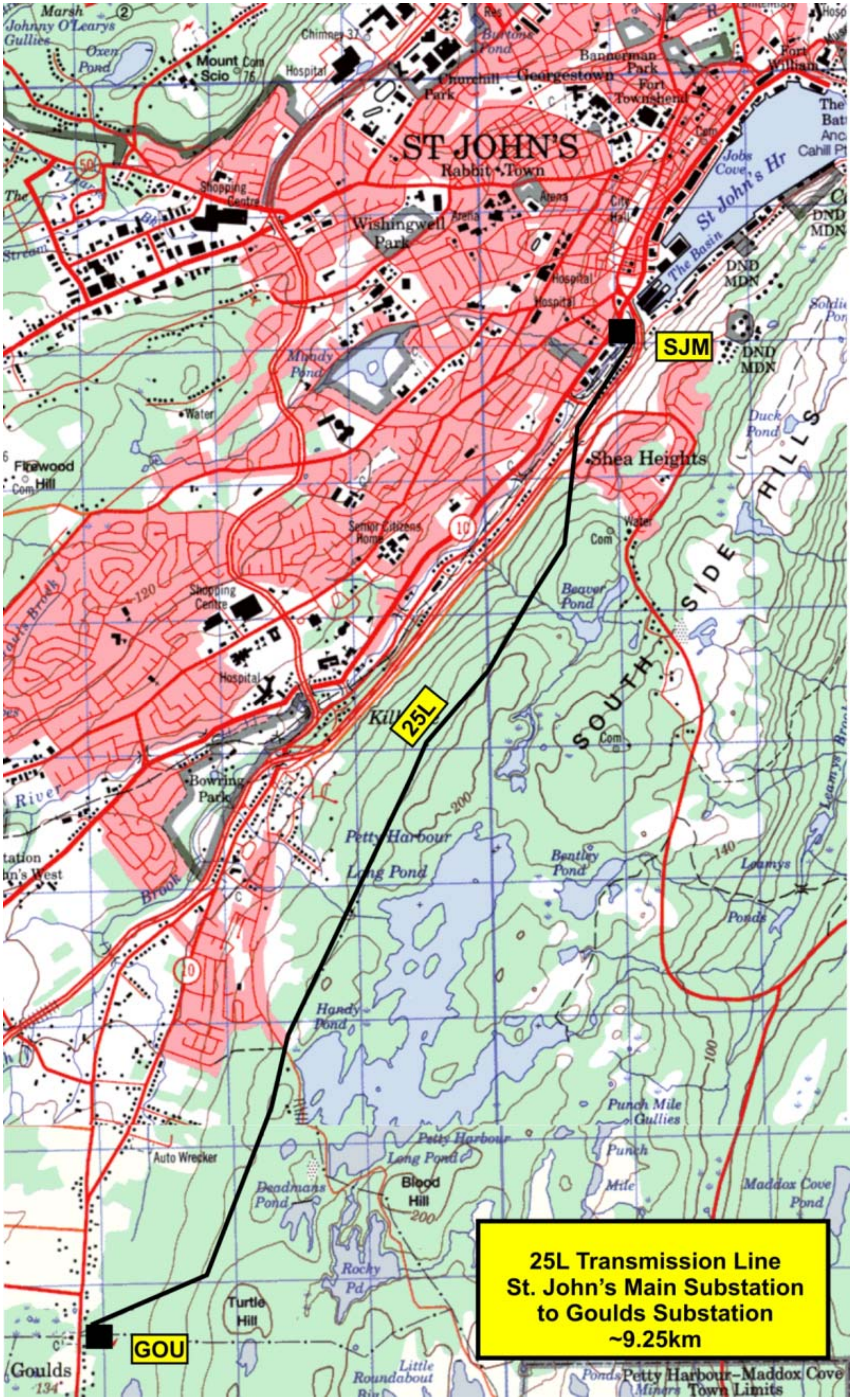

Figure 3 – Topographic Map 25L

Appendix C

Photographs of Transmission Lines 16L, 21L, and 25L

Transmission Line 16L

Figure 1 – Pole damaged by vehicle 16L

Figure 2 – Poles leaning along the Boulevard 16L

Figure 3 – Deteriorated poles 16L

Figure 4 – Split Crossarm 16L

<u>Transmission Line 21L</u>

Figure 5 – Split crossbrace 21L

Figure 6 – Pole requiring temporary support 21L

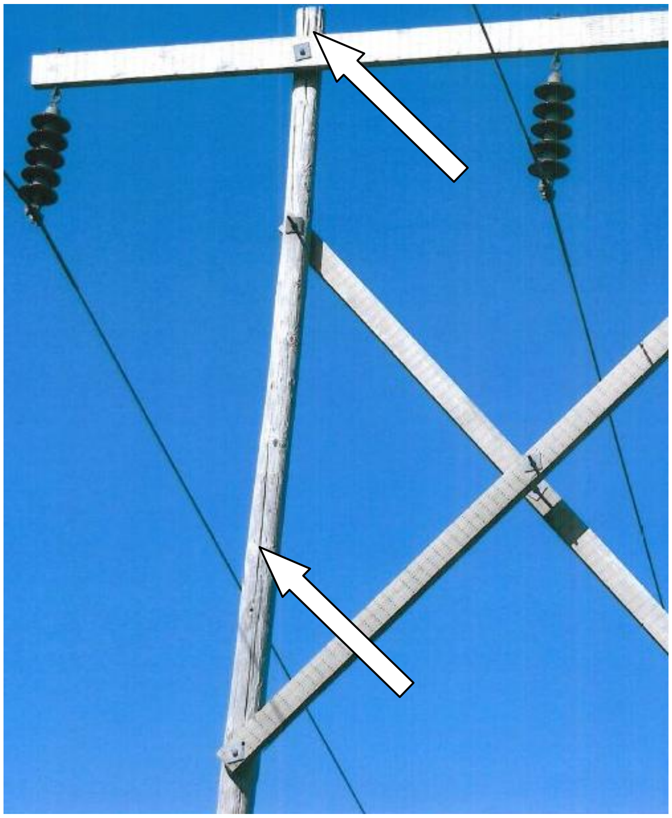

Figure 7 – Badly deteriorated pole 21L

Figure 8 – Woodpecker hole 21L

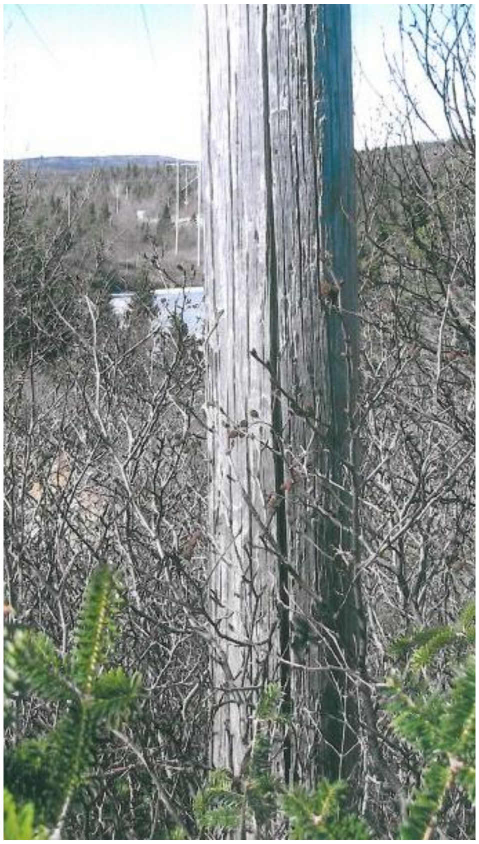

Figure 9 – Deteriorated pole 21L

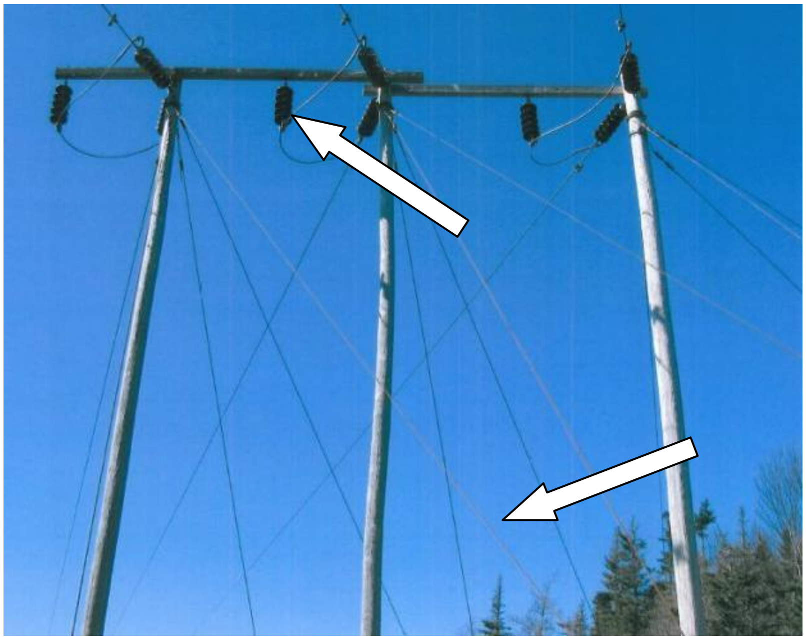

Figure 10 – Rusted guys and old vintage COB insulators 21L

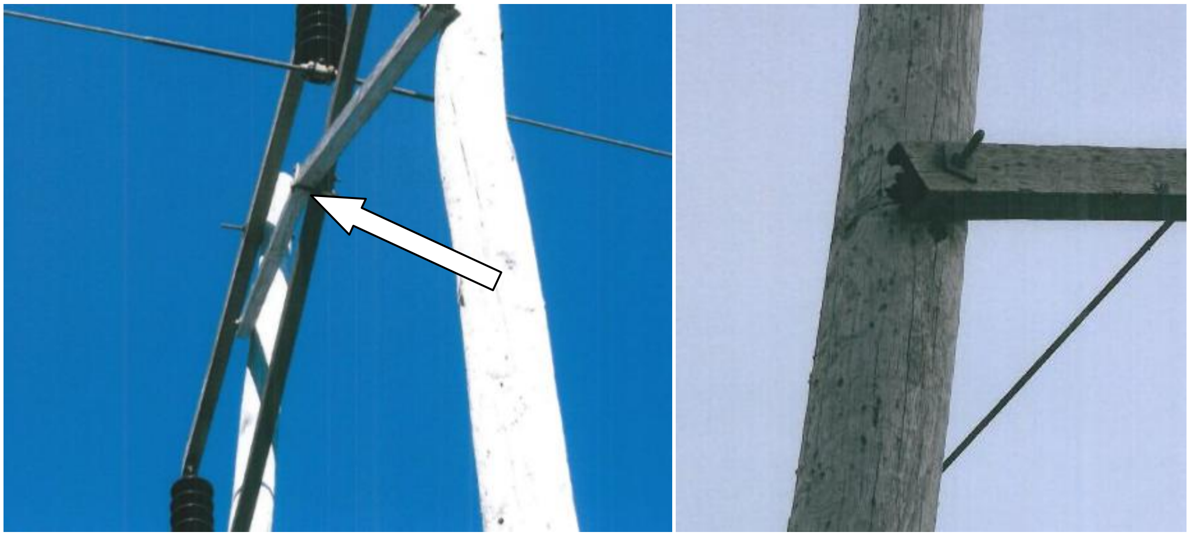

Figure 11 – Broken and deteriorated crossbraces 21L

Figure 12 – Deteriorated pole and crossarm 21L

<u>Transmission Line 25L</u>

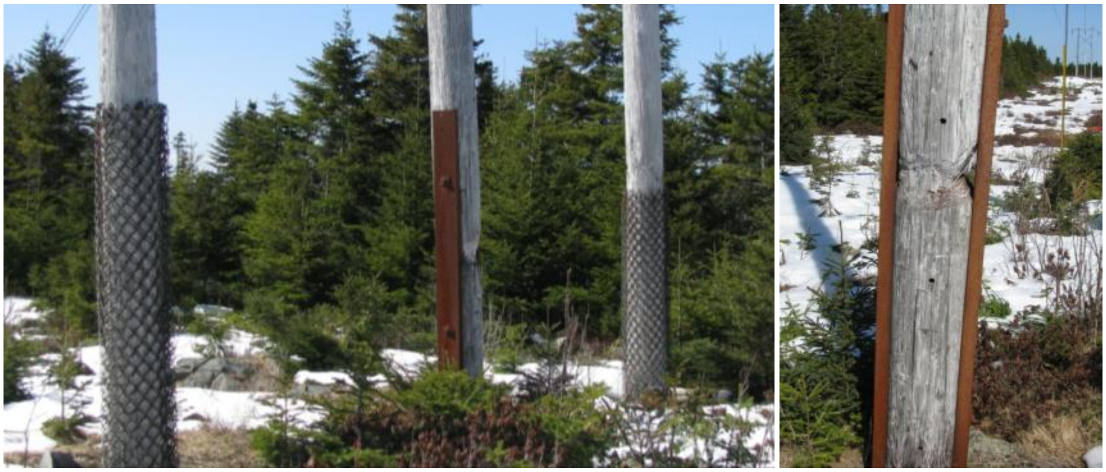

Figure 13 – Damaged pole requiring external support 25L

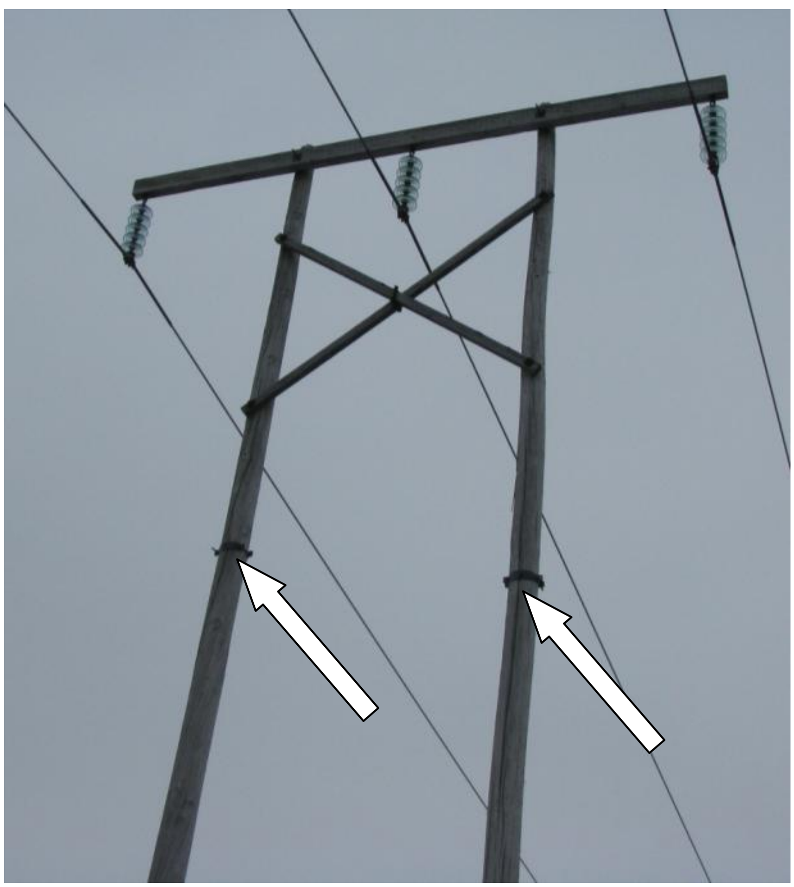

Figure 14 – Pole bands bracing damaged poles 25L

Figure 15 – Rotten poles 25L

Figure 16 – Rusted guys and hardware 25L

Figure 17 – Split crossarm 25L

Figure 18 – Deteriorated poles, crossarms and hardware 25L

2010 Transmission Line Rebuild
June 2009

Transmission Line Rebuild

June 2009

Prepared by:

Trina L. Troke, P.Eng.

REGISTERED PROFESSIONAL ENGINEER
TRINA L. TROKE
SIGNATURE
June 16, 2009
DATE
NEWFOUNDLAND & LABRADOR

NEWFOUNDLAND POWER
A FORTIS COMPANY

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Appendix A: Transmission Line Rebuild Strategy Schedule
Appendix B: Topographic Maps of Transmission Lines 23L, 24L, and 110L
Appendix C: Photographs of Transmission Lines 23L, 24L, and 110L

1.0 Transmission Line Rebuild Strategy

Transmission lines play a critical role in providing reliable electrical service to customers. The Company ensures that transmission lines are maintained in a manner consistent with their critical role in service delivery.

In 2006, Newfoundland Power ("The Company") submitted its *Transmission Line Rebuild Strategy* outlining a 10-year plan to rebuild aging transmission lines. This plan prioritized the investment in rebuild projects based on physical condition, risk of failure, and potential customer impact in the event of a failure.

The *Transmission Line Rebuild Strategy* is regularly updated to ensure that it reflects the latest reliability data, inspection information, and condition assessments.

Appendix A contains the updated Transmission Line Rebuild Strategy Schedule.

2.0 Transmission Line Rebuild Projects Planned for 2010

In 2010, the Company plans to rebuild transmission line 23L and sections of transmission lines 24L and 110L. Appendix B contains topographic views of each of the lines to be rebuilt. Appendix C contains photographs of the existing lines.

These lines are each more than 45 years old and there is deterioration of the poles, crossarms, hardware, and conductor. This makes the lines vulnerable to large scale damage when exposed to heavy wind, ice, and snow loading, thus increasing the risk of power outages. Inspections have identified evidence of decaying wood, worn hardware and damage to insulators. In addition, the steel core of the 110L conductor shows evidence of corrosion which reduces the physical strength and electrical current carrying capacity of the conductor.

2.1 Transmission Line 23L ($826,000)

23L is a 33 kV radial transmission line between Pierre's Brook Plant and Mobile Substation. Constructed in 1942, it is 5.5 km in length and is Newfoundland Power's oldest transmission line connecting the Company's 4.3 MW Pierre's Brook Hydroelectric plant to the Island interconnected system. No customers are directly served by 23L.

Inspections have identified deterioration to poles and crossarms due to decay, woodpecker holes, insect damage, splits and checks, as well as corrosion and wear to hardware. Many of these components are in advanced stages of deterioration and require replacement. A number of the wooden poles are original vintage (67 years old) and have surpassed their normal life expectancy.

Many of the insulators on the line are pin-type (tie-top) and not the more robust line post (clamp-top) insulators that are have been standard for the Company's transmission lines for many years. The conductor is non-standard 3/0 copper.

The justification for conversion of 23L to 66 kV is contained in report ***2.3*** *Convert 23L to 66 kV to Reduce Losses.* The 23L transmission line requires replacement due to its deteriorated condition. It is recommended that it be rebuilt using 66 kV construction standards. This will provided added benefit from a decrease in electrical losses and an increase in energy efficiency.

Recent inspections have determined the transmission line has reached a point where it must be rebuilt to continue to provide safe, reliable operation.

Based on the overall deteriorated condition of the line, the associated safety and reliability concerns, and the energy efficiency benefits associated with this project, it is recommended that the line be rebuilt in 2010 at an estimated cost of $826,000.

2.2 Transmission Line 24L ($1,161,000)

24L is a 66kV radial transmission line between Bay Bulls Big Pond Substation and Mobile Substation. It is 20 kilometres in length and was originally constructed in 1954 and 1964. The H-Frame section constructed in 1954 was completely rebuilt in 2002, and a section of the 1964 vintage single pole section was rebuilt in 2003. Only a 7.7 kilometre section of the original wooden single pole structures remains.

Inspections have identified deterioration due to decay, splits and checks in the poles and crossarms, and corrosion and wear to other hardware. Many of these components are in advanced stages of deterioration and require replacement.

The poles, crossarms and hardware are generally deteriorated and in a weakened state. This combined with the long spans, many in excess of 100 metres, make the line more susceptible to damage and place the line at risk of large scale damage should it become exposed to wind, ice or snow loading.

24L is a critical transmission line as it connects 4,600 customers, 7 hydroelectric plants and 9 privately-owned wind generation units[1] to the Island interconnected system. The copper conductor on this 7.7 kilometre section of transmission line is small in comparison to the Company's standard transmission line conductors. As a result, the electrical losses over this section of line are significant when all generation sources are on-line.

Based on the overall condition of this section of 24L, it is recommended that the remaining 7.7 km be rebuilt in 2010 at an estimated cost of $1,161,000.

2.3 Transmission Line 110L ($2,178,000)

Constructed in 1958, 110L is a 66 kV transmission line between Clarenville Substation and Lockston Substation on the Bonavista Peninsula. The line is 79 km in length and is of single wood pole construction.

[1] This represents a combined generating capacity of approximately 69 MW.

110L serves approximately 4,300 customers on the Bonavista Peninsula between Milton and Lockston. This line also connects the Company's Lockston hydro plant to the main electrical grid.

The conductor is damaged and deteriorated in many places and has been subjected to ice loading since its original installation. The steel core and the aluminum strands are corroded. This reduces the physical strength and the electrical capacity of the conductor. This deterioration is such that the line has been de-rated to about one-half of its original electrical current carrying capacity for safety reasons.

Since 2001, there have been several outages on this line due to wind and ice conditions which cause the conductors to slap together. This results in conductor damage and often conductor failure.

Sections of 110L have already been upgraded. Most recently, the 21 km section of line extending between the Company's Lockston plant and Summerville substation was completely rebuilt. Another 4.9 km section of the line is approved for rebuilding as part of the Company's 2009 Capital Budget Application.

Based on the condition of the remaining sections of the line, it is recommended that another 14.5 km of 110L be rebuilt in 2010 at an estimated cost of $2,178,000.

Appendix A

Transmission Line Rebuild Strategy Schedule

Transmission Line Rebuilds
2010-2014
($000)

Line	Year	2010	2011	2012	2013	2014
012L KBR-MUN	1950		590			
013L SJM-SLA	1962					605
014L SLA-MUN	1950			235		
015L SLA-MOL	1958					131
016L PEP-KBR	1950		730			
018L GOU-GDL	1951				777	
021L 20L-HCP	1952		822			
023L MOB-PBK	1942	826				
024L MOB-BIG	1964	1,161				
025L GOU-SJM	1954		1,443			
030L RRD-KBR	1959			806		
032L OXP-RRD	1959					350
035L OXP-KEN	1963					949
068L HGR-CAR	1951					900
069L KEN-SLA	1951					819
110L CLV-LOK	1958	2,178		1,668	2,910	
124L CLV-GAM	1964			810		
	Total	**$4,165**	**$3,585**	**$3,519**	**$3,687**	**$3,754**

Transmission Line Rebuilds
2015-2021
($000)

Line	Year	2015	2016	2017	2018	2019	2020	2021
041L CAR-HCT	1958		3,553					
049L HWD-CHA	1966						595	
057L BRB-HGR	1958	3,228						
100L SUN-CLV	1964							2,978
101L GFS-RBK	1957				6,012			
102L GAN-RBK	1958					6,356	6,829	
124L CLV-GAM	1964							3,750
301L SPO-GRH	1959		208					
302L SPO-LAU	1959			5,196				
403L TAP-ROB	1960							919
	Total	**$3,228**	**$3,761**	**5,196**	**$6,012**	**$6,356**	**$7,424**	**$7,647**

Appendix B

Topographic Maps of
Transmission Lines 23L, 24L, and 110L

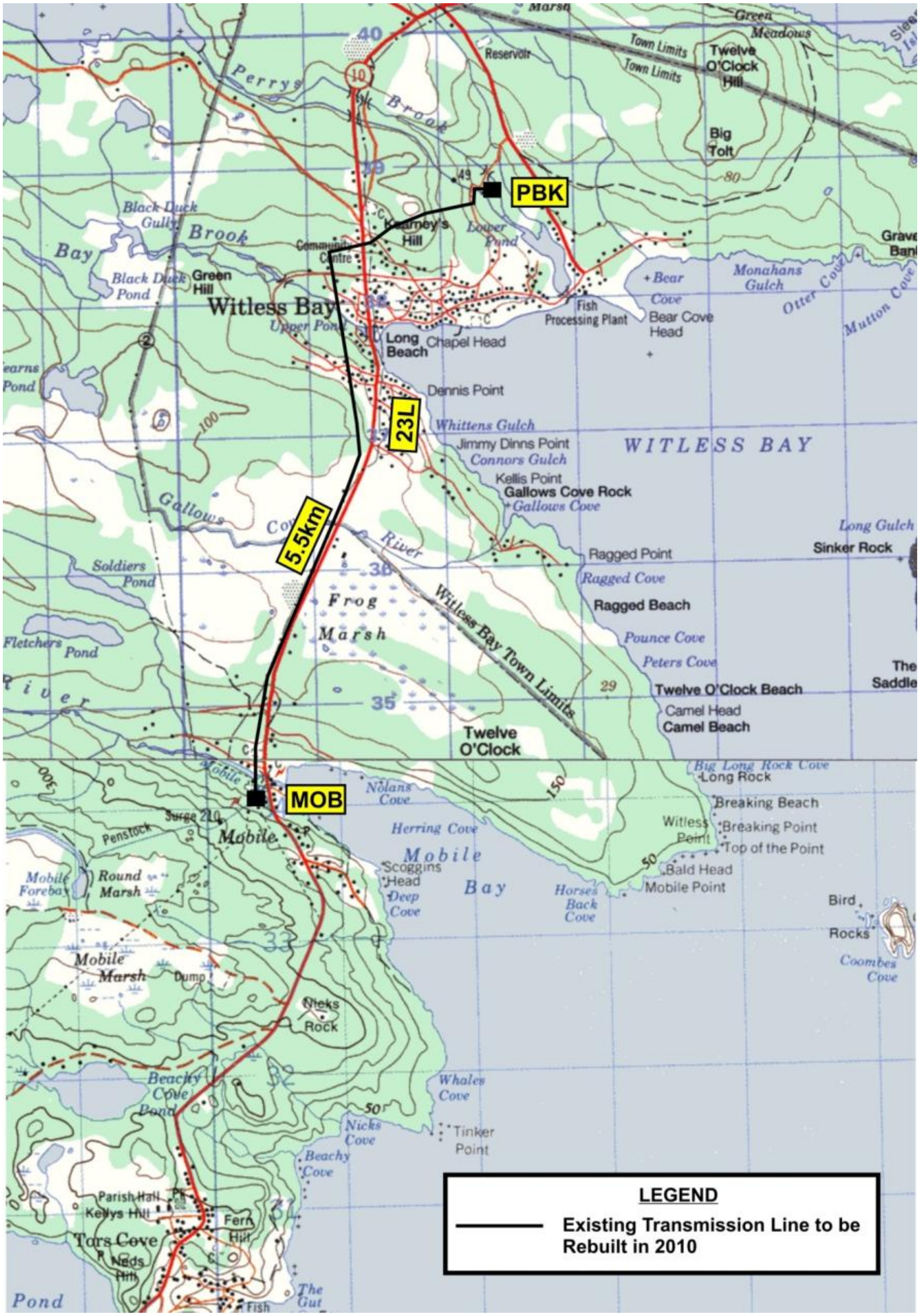


Figure 1 – Topographic Map 23L

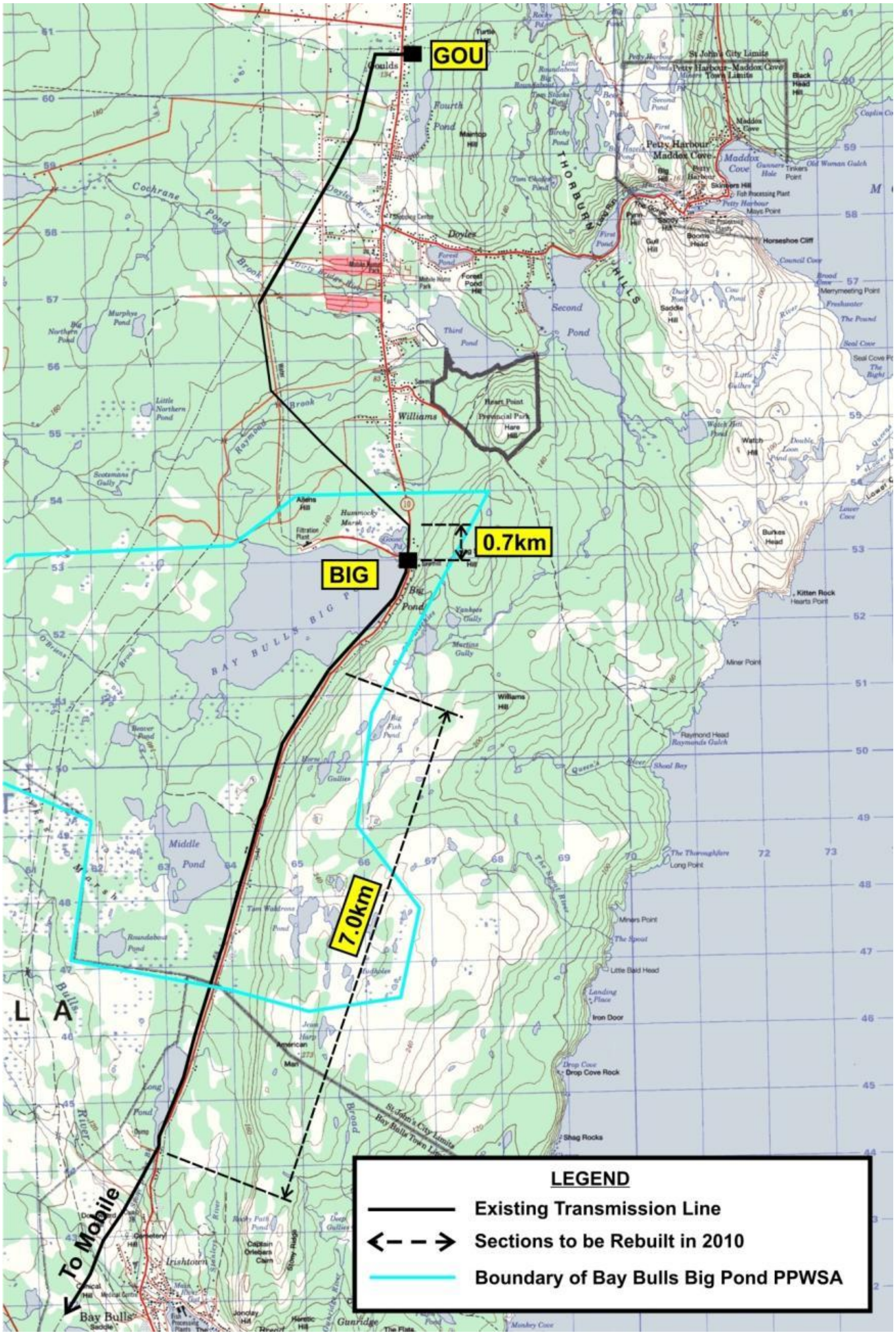


Figure 2 – Topographic Map 24L

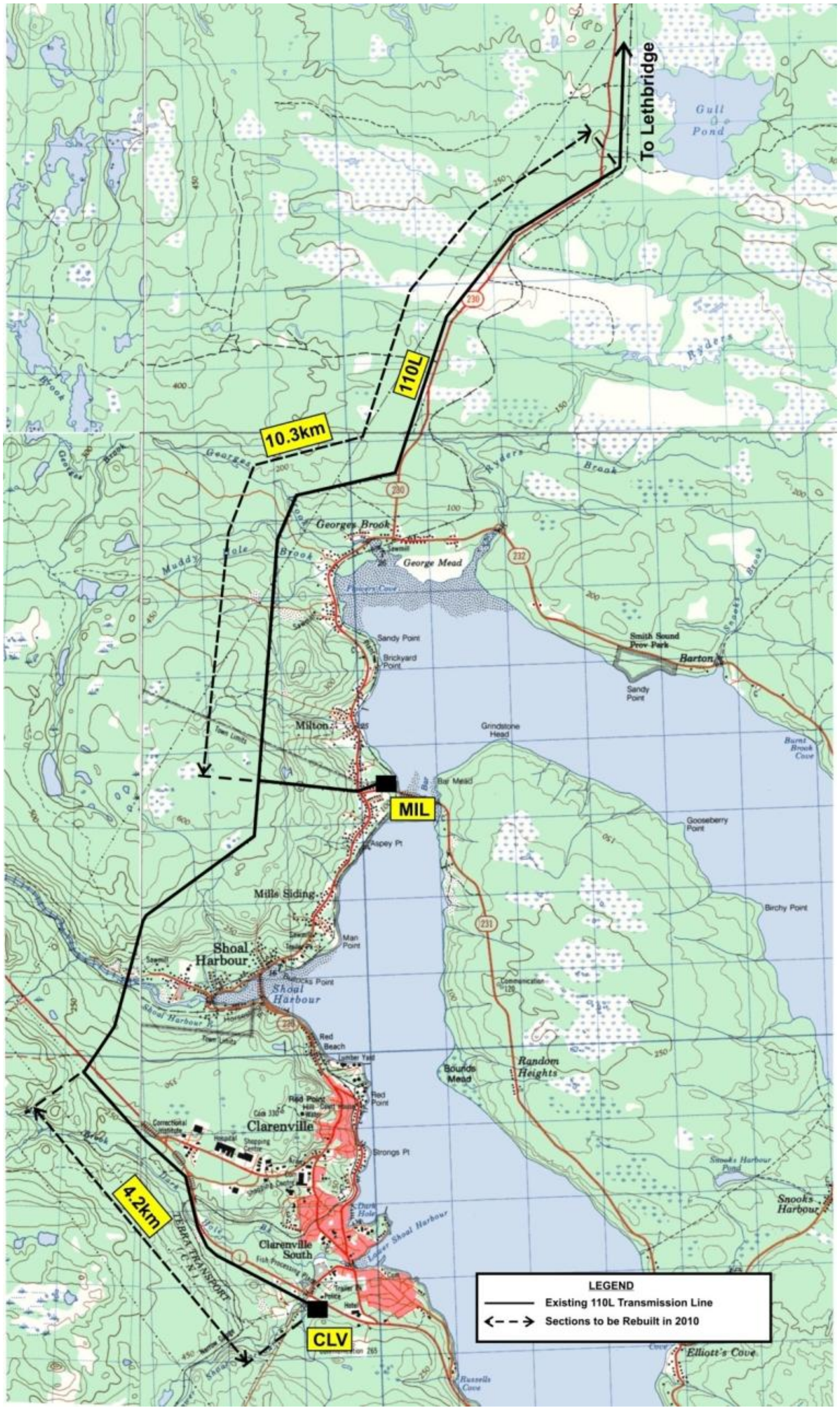
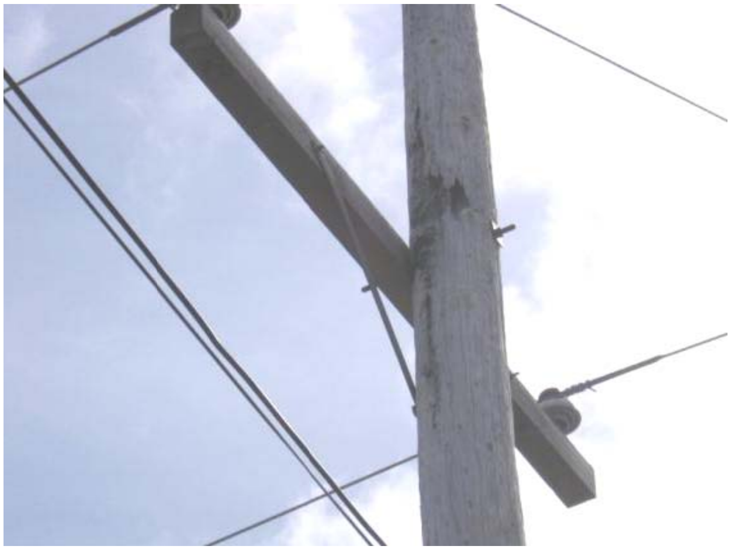


Figure 3 – Topographic Map 110L

Appendix C

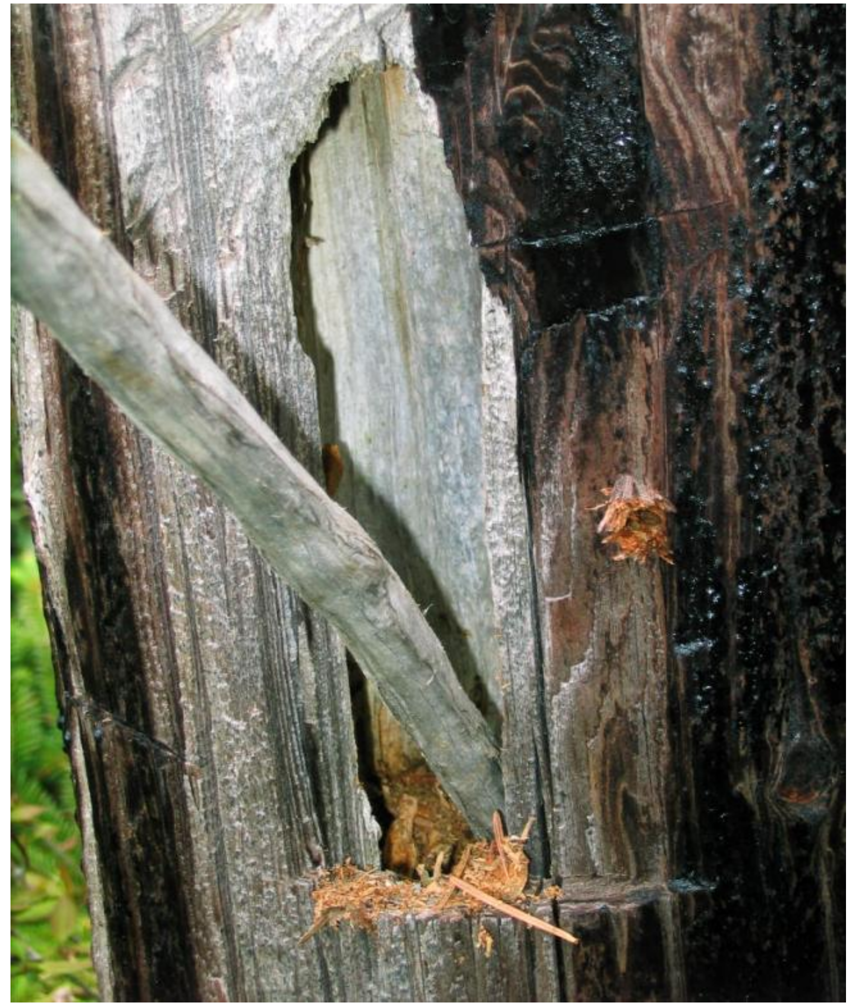
Photographs of Transmission Lines 23L, 24L, and 110L

Transmission Line 23L



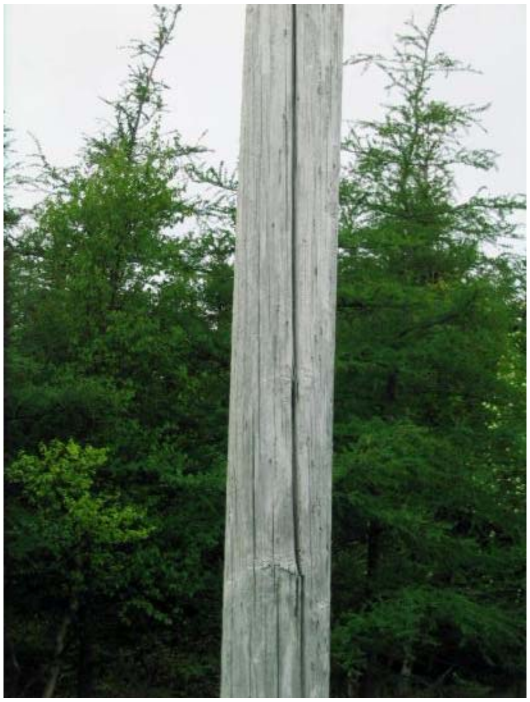
Burn Marks on Pole Caused by Flashover

Woodpecker Hole in Pole



Hole and Rot in Pole

Transmission Line 24L



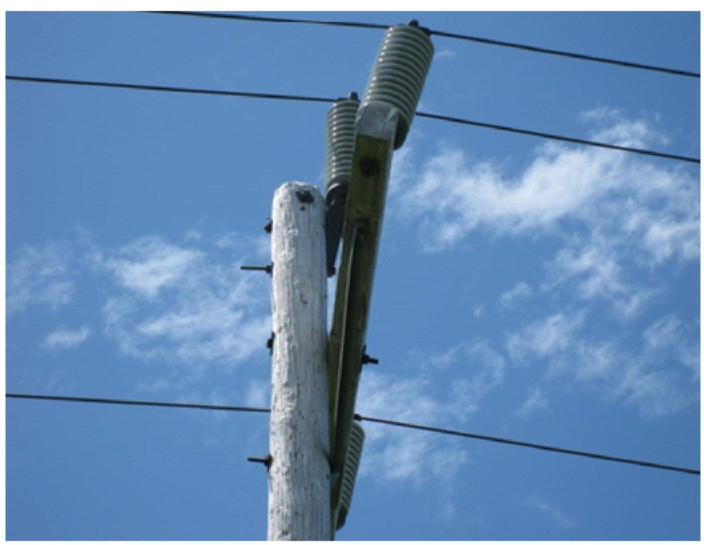
Deteriorated Pole

Deteriorated Crossarm

Deteriorated Crossarm

Deteriorated Pole

Pole Crack between Bolts



Leaning Insulator

Deteriorated Crossarm

Split Pole

<u>Transmission Line 110L</u>

110L Ice Storm Damage December 2003

110L Broken Conductor - Ice Build Up December, 2003

Deteriorated Pole 110L

Deteriorated Pole 110L