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CONNECTION ASSESSMENT & APPROVAL PROCESS

PRELIMINARY ASSESSMENT REPORT

For the Proposed Increase in Load at the Musselwhite Mine
by Placer Dome (Canada) Ltd.

CAA ID No. 2002-083

Consistent Information Set Department, and
Long Term Forecasts & Assessments Department

FINAL Version

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Preliminary Assessment Report

For the Proposed Increase in Load at the Musselwhite Mine

Acknowledgement

The IMO wishes to acknowledge the assistance of Hydro One in completing some of the studies for this assessment.

Disclaimers

IMO

This report has been prepared solely for the purpose of assessing whether the connection applicant's proposed connection with the IMO-controlled grid would have an adverse impact on the reliability of the integrated power system and whether the IMO should issue a notice of approval or disapproval of the proposed connection under Chapter 4, Section 6 of the Market Rules.

Approval of the proposed connection is based on information provided to the IMO by the connection applicant and the transmitter(s) at the time the assessment was carried out. The IMO assumes no responsibility for the accuracy or completeness of such information, including the results of studies carried out by the transmitter(s) at the request of the IMO. Furthermore, the connection approval is subject to further consideration due to changes to this information, or to additional information that may become available after the approval has been granted. Approval of the proposed connection means that there are no significant reliability issues or concerns that would prevent connection of the proposed facility to the IMO-controlled grid. However, connection approval does not ensure that a project will meet all connection requirements. In addition, further issues or concerns may be identified by the transmitter(s) during the detailed design phase that may require changes to equipment characteristics and/or configuration to ensure compliance with physical or equipment limitations, or with the Transmission System Code, before connection can be made.

This report has not been prepared for any other purpose and should not be used or relied upon by any person for another purpose. This report has been prepared solely for use by the connection applicant and the IMO in accordance with Chapter 4, Section 6 of the Market Rules. The IMO assumes no responsibility to any third party for any use, which it makes of this report. Any liability that the IMO may have to the connection applicant in respect of this report is governed by Chapter 1, Section 13 of the Market Rules. The IMO reserves the right to revise this report at any time, at its sole discretion, without notice to the connection applicant. Although the IMO will use its best efforts to advise the connection applicant of such changes, it is the responsibility of the connection applicant to ensure that the most recent version of this report is being used.

Hydro One

Special Notes and Limitations of Study Results

The results reported in this preliminary assessment are based on the information available to Hydro One, at the time of the study, suitable for a preliminary assessment of a new generation or load connection proposal.

The ampacity ratings of Hydro One facilities are established based on assumptions used in Hydro One for power system planning studies. The actual ampacity ratings during operations may be determined in real-time and are based on actual system conditions, including ambient temperature, wind speed and facility loading, and may be higher or lower than those stated in this study.

The additional facilities or upgrades, which are required to incorporate the proposed connection, have been identified to the extent permitted by a preliminary assessment. Additional facility studies may be necessary to confirm constructability and the time required for construction. System impact or further studies at more advanced stages of the project development may identify additional facilities that need to be provided or that require upgrading.

PRELIMINARY ASSESSMENT REPORT

For the Proposed Increase in Load at the Placer Dome - Musselwhite Mine

1. Introduction

The Placer Dome - Musselwhite Mine in north-western Ontario is supplied via the following series of radially connected 115kV circuits originating from Dryden TS:

- Circuit E4D Dryden TS to Ear Falls SS 98.4km
- Circuit E1C Ear Falls SS to Crow River DS 260.3km
- Circuit M1M Crow River DS to Placer Dome - Musselwhite Mine 185km

Voltage support in the Ear Falls area is provided by the hydroelectric generating stations of Ear Falls GS (20MVA) and Manitou Falls GS (80MVA), with the latter station being connected into Ear Falls SS by an 18.8km radial circuit, M3E.

The existing transmission facilities between Ear Falls SS and the Musselwhite Mine are shown in Diagram 1.

Existing Loads

The following Table summarises the peak loads in the area that are supplied from circuits E1C & M1M and which have been used in the subsequent analysis:

Location	*Peak Load*
Slate Falls DS	0.4MW
Cat Lake TS	1.0MW
Crow River DS	2.4MW
Placer Dome - Musselwhite Mine	12.5MW

Proposed Increase in Load at the Musselwhite Mine

Placer Dome is seeking an increase in the maximum load permitted at their Musselwhite Mine to 16MW, with possible further increases in the future.

2. North Caribou Lake First Nations Supply

An application to connect a new 85km 115kV line, to supply the North Caribou Lake First Nations community, to the Placer Dome circuit M1M has been approved by the IMO subject to agreement with Placer Dome.

The projected peak load at the North Caribou Lake First Nations (NCLFN) community is 2MW, and this load was used in the assessment.

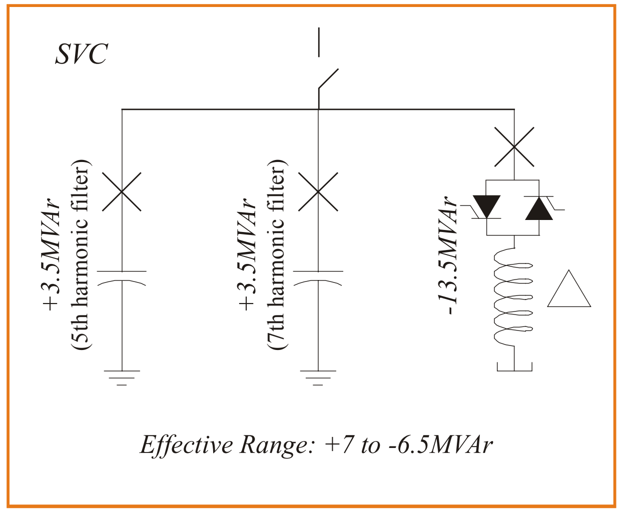
Diagram 2 shows the proposed facilities for the new NCLFN connection.

These new facilities would consist of a 115kV circuit breaker/circuit-switcher series-connected combination at the junction point of the new line on to circuit M1M. Two -1.22MVAr (rated at 118kV) shunt reactors would be connected on the line side of the circuit breaker/circuit switcher combination at the Musselwhite terminal (NCLFN Junction). A further -1.22MVAr shunt reactor would be connected at the NCLFN remote terminal. Each shunt reactor would be switched via an individual 115kV circuit-switcher. This arrangement, with the three shunt reactors directly connected to the line, was selected to ensure that the reactors and the line would be switched as a single entity, either into or out-of-service.

The reactors were sized to achieve approximately zero reactive power flows at the NCLFN Junction for a nominal load of 1MW at the NCLFN community.

Configuration of the SVCs at the Musselwhite Mine

The two static VAr compensators that are presently in-service at the Musselwhite Mine, are configured as shown in the Diagram to the right.



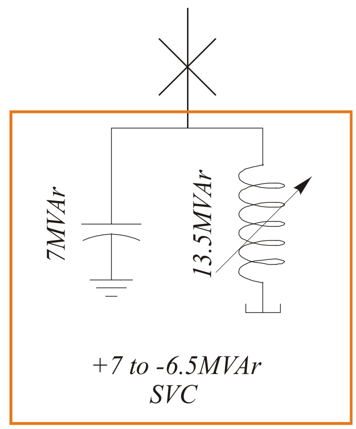
Two, individually-switched +3.5MVAr shunt capacitor banks, that act as filters for the 5th and 7th harmonic currents respectively, are connected in parallel with a -13.5MVAr thyristor-controlled shunt reactor.

The effective reactance of the shunt reactor portion of each SVC is varied by controlling the current through the reactor using thyristor switching to provide a variable reactance of 0MVAr to -13.5MVAr.

This results in an effective operating range for each SVC from +7MVAr (with 0MVAr from the reactor) to -6.5MVAr (with -13.5MVAr from the reactor).

The thyristor-controlled reactor portion of the SVC is connected in delta to minimise third harmonic currents.

The Diagram to the right shows the simplified representation that has been used in the Diagrams



The two SVCs are connected directly to the 4.16kV busbar at the Musselwhite Mine.

Upon initial connection, the inductor portion of the SVC is energised first, followed by the switching of the 5th harmonic & 7th harmonic capacitor banks, in succession.

Assumptions Regarding the Status of the SVCs at the Musselwhite Mine

In the original assessment for the proposed NCLFN connection it was assumed that the SVCs at the Musselwhite Mine would be available to control the voltage within an acceptable range at the NCLFN Junction. However, subsequent communication with representatives of the Mine has indicated that the SVCs may not always be available, possibly because of outages and/or maintenance activities at the Mine, and that operation of the NCLFN line should therefore be independent of the status of the SVCs.

This assessment has therefore examined the potential effect that the unavailability of both SVCs at the Mine would have on the supply to the NCLFN community.

3. Rating of existing transmission facilities

The following Table summarises the ratings that were used in the assessment:

Circuit	*Conductor*	*Maximum Conductor Operating Temperature*	*Thermal Rating at 30^{o}C ambient & 4km/hr wind*	
E1C	167.8kcmil	60^{o}C	220A	47MVA at 124kV
M1M	336.4kcmil	93^{o}C	500A	107MVA at 124kV
NCLFN Line	336.4kcmil	93^{o}C	500A	107MVA at 124kV

Since circuit E1C is equipped with very small, 167.8kcmil conductors that have a low maximum conductor operating temperature, its continuous rating is only 47MVA. Furthermore, because of its considerable length (~260km), achieving any marked increase in its thermal rating would be extremely difficult. It therefore represents the critical transmission element in the supply to the Musselwhite Mine.

The surge impedance for the 167.8kcmil conductors that are installed on circuit E1C, calculates as approximately 423Ω, which would give a surge impedance loading of approximately 36MW at 124kV. For transfers of less than 36MW circuit E1C would be expected to be a net generator of MVAr, while for transfers greater than 36MW, the line would become a net absorber of reactive power.

4. Power System Analysis

The power system analysis that was performed for this assessment consisted of the following two components:

- an examination of the effect of line energisation for both the existing 115kV circuit M1M, and the proposed NCLFN line, and
- an assessment of the load supply capability of the existing and the proposed transmission facilities.

4.1 Line Energisation Studies for Circuit M1M

Table 1 shows that energising the 115kV circuit M1M to the Musselwhite Mine with both SVCs out-of-service would result in excessively high voltages at the Musselwhite Mine terminal (146.4kV).

Energising the line with just the -13.5MVAr shunt reactor portion of one of the SVCs in-service would limit the terminal voltage to just 117.4kV.

[Energising the line with both SVCs in-service, and with each shunt reactor at full output so that each SVC would represent a net output of -6.5MVAr (+7MVAr capacitive & -13.5MVAr inductive) would be expected to yield similar results since the combined output would be -13MVAr.]

If circuit M1M were to be energised with only one of the SVCs in-service, the results show that the subsequent switching of the first +3.5MVAr shunt capacitor, once the inductive portion of the SVC is at its full reactive output of -13.5MVAr, would result in a voltage change of +3.8% at Crow River DS. Since this would be less than the 4% limit specified in the Market Rules this would be acceptable.

The corresponding voltage change at the Musselwhite Mine would be +5.8% on the 115kV busbar and +7.0% on the LV busbar, and while this would normally be considered high, it is assumed that this would not be a concern since no loads would yet have been connected at the Mine.

The results also show that switching the second +3.5MVAr capacitor bank of the SVC into service would result in a voltage change of only +3.0% at Crow River DS. The corresponding voltage change at the Musselwhite Mine would be +5.1% on the 115kV busbar and +6.6% on the LV busbar. As before, it has been assumed that these would not be a concern.

If only a single SVC were to be available, the resulting voltages once both +3.5MVAr capacitive banks have been switched into service, i.e. with the SVC at a net output of -6.5MVA, would be high but would be considered acceptable for the short period until the line could be loaded

[Placer Dome has confirmed that the line and its associated equipment are rated for continuous operation at 138kV.]

The Table also shows the voltage changes that would be expected to occur for the subsequent switching of the second SVC as a *'complete'* unit, representing an effective shunt reactance of -6.5MVAr. However, in practice, the individual components of the SVC would be placed in-service individually, and the output of the inductive portion of the second SVC would initially be restricted to maintain the target voltage at the Musselwhite Mine. Similarly, the subsequent switching of the two shunt capacitors associated with the second SVC would be counteracted by changes in the output from the inductive portions of both SVCs. Consequently, the actual voltage changes for the various switching operations for the second SVC are expected to be relatively small.

However, these results show that with no load at the Mine and with both SVCs in-service, with their respective inductive elements at their maximum setting of -13.5MVAr, a very good voltage profile could be maintained along circuits E1C and M1M.

Since energising circuit M1M with no SVCs in-service would not be acceptable because of the excessively high voltages that would occur at the remote terminal, a study was therefore performed with two -1.22MVAr shunt reactors connected at the NCLFN Junction (identical to those proposed for the new NCLFN line) and with a further -4MVAr shunt reactor at Crow River DS. [For a total additional shunt reactance of ~ -6.5MVAr.]

The additional reactors would result in an improved voltage profile, although the voltage at the Musselwhite Mine would still be high at 134.4kV.

A further study was performed with a single -2MVAr shunt reactor at the NCLFN Junction and a -5MVAr shunt reactor at Crow River DS. [For a total additional shunt reactance of ~ -7.5MVAr.]

The revised reactor sizes were shown to result in a further improvement in the voltage profile, with a voltage of 133.0kV at the Musselwhite Mine terminal.

4.2 Line Energisation Studies for the new NCLFN line

Table 2 summarises the results for energising the proposed NCLFN line.

With no SVCs in-service at the Musselwhite Mine, the voltage at the remote terminal would be unacceptably high at 147.8kV. However, it is worth noting that the increase in voltage over the entire length of the line from the NCLFN Junction to the remote terminal at the NCLFN community would be only 0.4kV. This demonstrates that the shunt reactors that have been proposed would meet the requirement to make the line approximately 'reactive-neutral'.

Energising the NCLFN line with both SVCs at the Musselwhite Mine in-service at their full inductive output (-6.5MVAr per SVC) would limit the terminal voltage at the NCLFN community to just 119.6kV. This could be increased by reducing the inductive component of the two SVCs at the Musselwhite Mine. As before, it is worth noting that the voltage increase over the length of the NCLFN line is just 0.2kV.

The final study is with an assumed -10MVAr of additional shunt reactors connected at the NCLFN Junction, and with both SVCs at the Musselwhite Mine out-of-service. The resulting voltage profile, under no-load conditions, is very good. This study therefore indicates that if the NCLFN line is to be successfully energised whenever the LV facilities (including both SVCs) at the Musselwhite Mine are out-of-service, that additional shunt reactors totalling between -7.5MVAr & -10MVAr would need to be installed at the NCLFN Junction.

[It should be noted that while it has been shown that a single SVC with a net reactive output of -6.5MVAr would be marginally adequate to allow circuit M1M to be energised, it has been assumed that the relatively high voltages would be reduced once load is added at the Mine. With no load at the Mine, the amount of shunt reactance required to compensate for the absence of both SVCs would therefore be higher.]

Alternatively, additional shunt reactors could be installed at Crow River DS to reduce the shunt reactor capacity required at the NCLFN Junction. The combined capacity at the two locations would however still need to total between -7.5MVAr and -10MVAr.

Installing an SVC at Crow River DS

Should it be decided to install additional shunt reactors at the NCLFN Junction to ensure that the NCLFN line can be successfully placed in-service whenever both SVCs at the Musselwhite Mine are unavailable, then the rating of each reactor would need to be limited to approximately -3MVAr in order to ensure that the voltage change upon switching is less than 4%.

For the -7.5MVAr to -10MVAr of shunt reactors that have been shown to be required, this would translate into three, or possibly four, separately-switched units. Together with the two -1.22MVAr shunt reactors that are to be connected directly to the NCLFN line at NCLFN Junction, this is considered to be an excessive number of reactors and circuit-switches at a single location.

Consideration was therefore given to the installation of a new SVC at Crow River DS to try and reduce the amount of shunt reactance that would be required at NCLFN Junction in order to limit voltage increases during line energisation.

Furthermore, by substituting a single SVC for a number of shunt reactors, it would be expected to simplify the switching scheme required for controlling the reactors.

The existing arrangement at Crow River DS consists of two pairs of series-connected step-down transformers. Each pair is comprised an 8MVA 115/28kV step-down transformer connected to a 7.5MVA 28/25kV step-down transformer. However, because of the relative phase configurations and the different impedances of the respective transformer-pairs, it is understood that the transformers cannot be operated in parallel.

The rating of any SVC that is to be installed at Crow River DS would therefore be restricted by the 7.5MVA rating of the 28/25kV transformers.

It was therefore decided to limit the *maximum* output of the SVC to +/-6MVAr. With the SVC comprised a fixed shunt capacitor bank and a variable shunt reactor this would limit the maximum size of the variable reactor to -12MVAr i.e. +6MVAr capacitive & -12MVAr inductive, thereby providing an effective output range of +6MVAr to -6MVAr.

[While a single +6MVAr capacitor bank was assumed in the analysis, it is expected that two capacitor banks rated at +3MVAr will need to be installed to provide filters for the 5th and 7th harmonic currents.]

A series of line energisation studies was therefore conducted with no SVCs in-service at the Musselwhite Mine, and with the following amounts of additional reactive compensation installed at Crow River DS and at the NCLFN Junction:

Energisation of the 115kV circuit M1M & the NCLFN Line with no SVCs at the Musselwhite Mine					
	Rating of SVC at Crow River DS	*Rating of additional shunt reactors at NCLFN Junction*	*Voltages*		
			Crow River DS	Musselwhite Mine	NCLFN Community
1.	+6MVAr/-10MVAr: -4MVAr	-	136.8kV	141.1kV	141.5kV
2.	+6MVAr/-10MVAr: -4MVAr	-1.2MVAr	134.9kV	138.1kV	138.4kV
3.	+6MVAr/-11MVAr: -5MVAr	-2.0MVAr	131.8kV	134.5kV	134.7kV

The results show that, by installing a +6MVAr/-11MVAr SVC at Crow River DS, it would only be necessary to install a single shunt reactor rated at between -2.0MVAr & -2.5MVAr at the NCLFN Junction (in addition to the shunt reactors that are to be connected directly to the NCLFN line) in order to achieve acceptable, though high, voltages at Crow River DS and at the Musselwhite Mine. This assumes that all of the new equipment associated with the new NCLFN connection will be capable of continuous operation at 138kV. The detailed results are given in Table 3.

It should also be noted that these voltages would only occur if both SVCs at the Musselwhite Mine were to be out-of-service. If either of the SVCs at the Musselwhite Mine were also available, they would be able to control the voltages to lower values.

Summary of the Line Energisation Studies

The results of the line energisation studies can be summarised as follows:

For the existing system configuration -

- In order to maintain acceptable voltages at the stations supplied from circuit E1C, at least one of the SVCs at the Musselwhite Mine must be in-service when circuit M1M is energised. Furthermore, the SVC must be at its full inductive value of -13.5MVAr so as to provide a net value of -6.5MVAr.

For the arrangement with the NCLFN line connected to circuit M1M

- If both SVCs at the Musselwhite Mine were to be out-of-service, energisation of circuit M1M and the proposed NCLFN line would only be possible if the facilities identified in either of the following options were to be available:

    i. With shunt reactance of between -7.5MVAr & -10MVAr capacity installed at the NCLFN Junction and Crow River DS (in individually switched banks that are rated at -3MVAr or less)

    OR

    ii. With a +6MVAr/-11MVAr SVC at Crow River DS *AND* with a shunt reactor rated at between -2MVAr and -2.5MVAr at the NCLFN Junction.

The transmission facilities associated with the new NCLFN connection would need to be suitable for continuous operation at 138kV.

Diagram 3 shows the proposed arrangement with a new SVC installed at Crow River DS, together with a -2MVAr shunt reactor at the NCLFN Junction.

4.3 Load Supply Capability

The line energisation studies have shown that, if the existing SVCs at the Musselwhite Mine were unavailable, it would only be possible to operate the proposed NCLFN line if shunt reactors having a combined capacity of between -7.5MVAr & -10MVAr were to be installed at the NCLFN Junction and Crow River DS. Since the size of each individual reactor would need to be limited to respect the maximum voltage change that is permitted upon switching, a total of three or four separately-switched shunt reactors that would need to be installed. Consequently, the installation of an SVC at Crow River DS has been recommended. This would reduce the amount of shunt reactance required at the NCLFN Junction to between -2MVAr and -2.5MVAr and this could be installed as a single switchable reactor.

Furthermore, the capacitive component of the new SVC would provide voltage support at Crow River DS and this would allow additional load beyond the proposed 2MW to be supplied at the North Caribou Lake community.

Studies were therefore performed for the arrangement shown in Diagram 3 with the load at the Musselwhite Mine at an assumed power factor of 0.90 and 0.94, respectively.

Table 4 summarises the results with the load at the Musselwhite Mine at a power factor of 0.90.

It should be noted that no attempt was made in the studies to optimise the tap position on the transformers at Crow River DS and at the Musselwhite Mine to achieve the optimal LV voltage at these locations.

These results show that the SVCs at the Musselwhite Mine become limiting for a load at the Mine of approximately 15MW, while the SVC at Crow River DS becomes limiting for a load of approximately 17MW at the Musselwhite Mine. At 15MW, the SVCs at the Musselwhite Mine are still able to maintain voltages of 119.5kV & 4.2kV at the HV and LV busbars, respectively. At 16MW, because there is no additional support available from the shunt capacitor portions of the SVCs, the voltages begin to decline. However, at Crow River DS, the shunt reactance portion of the SVC is not reduced to 0.0MVAr until the load at the Musselwhite Mine is increased to 17MW.

It should also be noted that for loads of 14MW and higher, the -2.0MVAr shunt reactor that it has been proposed should be installed at the NCLFN Junction, has been switched out-of-service.

The results in Table 4 for the condition with a 14MW load at the Mine and with a 2MW supply to the NCLFN community, with the -2MVAr shunt reactor at the NCLFN Junction out-of-service, effectively correspond to the maximum load supply capability of the ***existing*** *transmission facilities. At this combined load level of 16MW, the SVC that has been assumed at Crow River DS is contributing only -0.2MVAr and therefore, is essentially out-of-service, while the two SVCs at the Mine are at their maximum capacitive output (+16.0MVAr). [If the LV voltage at the Musselwhite Mine were to be controlled to around 4.16kV, the output from the capacitor banks would decline and this would adversely affect the voltage profile on the 115kV system.]*

Consequently, the existing transmission facilities are ***only*** *capable of supplying a load of just 16MW at the Musselwhite Mine.*

Table 4A shows the results for a repeat study for loads of 16MW at the Musselwhite Mine and 2MW at the NCLFN community, with the tap-changers on the step-down transformers at the Musselwhite Mine and at Crow River DS adjusted to maintain a better HV profile, while allowing the SVCs to maintain their respective LV voltages.

These results confirm that with the load at the Musselwhite Mine at a power factor of 0.90, and *with a 2MW load at the NCLFN community*, the maximum load that could be supplied at the Mine, assuming a new +6MVAr/-11MVAr SVC is installed at Crow River DS, would be between 16MW & 17MW.

Table 5 shows the results for two contingency conditions that were examined, with a maximum load of 17MW at the Musselwhite Mine:

- *Contingency 1* The loss of the NCLFN line, and
- *Contingency 2* The loss of one of the SVCs at the Musselwhite Mine.

Tripping the NCLFN line would result in an immediate voltage increase at the Mine of 10% at the HV busbar & 11% at LV busbar, respectively. However, it is expected that these over-voltages would be moderated relatively quickly by the two SVCs at the Mine. Alternatively, the voltage rise could be avoided by simultaneous auto-switching (into service) of the -2.0MVAr shunt reactor at the NCLFN Junction to coincide with the tripping of the NCLFN line.

For the loss of one of the SVCs, load rejection at the Musselwhite Mine would need to be initiated to avoid voltage collapse. In order to obtain a converged solution for the load flow study, it was necessary to convert the loads to a voltage dependent type. This resulted in an effective reduction of 1.1MW in the load at the Musselwhite Mine and 0.1MW at the NCLFN community, in response to the reduced voltages that were obtained at these two locations.

Table 6 summarises the results with the load at the Musselwhite Mine at a power factor of 0.94.

As before, no attempt was made in the studies to optimise the tap position on the transformers at Crow River DS and at the Musselwhite Mine to achieve the optimal LV voltage at these locations.

These results show that an improvement in the power factor of the Mine load from 0.90 to 0.94 would increase the maximum load that could be supplied at the Mine by between 1MW and 2MW.

These studies also show the SVCs at the Musselwhite Mine would become limiting before the SVC at Crow River DS. At 16MW the inductive portion of the SVCs at the Musselwhite Mine are at 0.0MVAr, although the LV voltage is still high at 4.41kV, indicating that additional load could be supplied before the voltage would decline below the nominal value of 4.16kV. At Crow River DS, the SVC would still have approximately +4MVAr of capacitive support still available at a load level of 16MW. It has therefore been concluded that with the Mine load at a power factor of 0.94 and with the new SVC at Crow River DS, that a load of 17MW could be supplied at the Mine, in addition to a 2MW load at the NCLFN community.

Table 7 shows the results for the same two contingency conditions that were examined previously, but with the load at the Musselwhite Mine at its maximum value of 18MW.

However, for the contingency involving the loss of the NCLFN line, auto-switching of the -2.0MVAr shunt reactor at the NCLFN Junction was initiated, resulting in an acceptable post-contingency voltage change of less than 4%.

For the contingency involving the loss of one of the SVCs at the Musselwhite Mine, voltage dependent loads had to be used once again, in order to obtain a converged solution to the load flow study. The resulting reduction in the load at the Mine and at the NCLFN community confirms that an automatic load rejection scheme would be required to maintain acceptable post-contingency voltages in the event that one of the SVCs were tripped.

Increase in the Rating of the SVCs at the Musselwhite Mine

Since the studies have shown that the SVCs at the Musselwhite Mine would become limiting before the new SVC that has been proposed at Crow River DS, further studies were conducted with the capacitive portion of the Musselwhite SVCs increased from +7MVAr to +9MVAr.

The results are summarised in Table 8. For these studies a power factor of 0.94 was assumed for the load at the Musselwhite Mine, while for all the other loads the power factor was maintained at 0.90.

These studies show that the enhanced system arrangement would be capable of supplying a peak load at the Musselwhite Mine of 19MW, together with the 2MW load that has been assumed at the NCLFN community.

It should be also noted from a comparison of the results in Tables 4 & 6, with those in Table 8, that the differential between the voltage at Cat Lake TS/Golden Junction and that at Crow River DS has been eroded. Furthermore, the analysis that was conducted with a load of 20MW at the Musselwhite Mine indicated that the reduced voltage at Cat Lake TS/Golden Junction was becoming a problem and this prevented a converged solution from being obtained. This would suggest that the lower voltages that were occurring further away along circuit E1C were adversely reducing the reactive power generation of the line. Therefore, in order to compensate for the reactive power loss, additional reactive support would need to be installed at Cat Lake TS/Golden Junction.

It must also be stressed that any increase in the rating of the capacitive portion of the SVCs would need to be separately switched for the following reasons:

- *to ensure that the voltage change that would occur when the capacitor banks are switched would remain within the 4% limit specified in the Market Rules. Increasing the rating of each of the existing capacitor banks from +3.5MVAr to +4.5MVAr would result in a voltage change greater than 4%.*
- *to ensure that with both +3.5MVAr capacitor filters of one of the SVCs in-service, a net reactance of -6.5MVAr is maintained from the SVC, should only a single SVC be available for service.*

Effectively, this means that it would be preferable to provide the additional shunt capacitance through a separate capacitor bank rather than by increasing the rating of the existing SVCs.

System Losses

As a result of the very small conductor on circuit E1C, the losses at the higher load levels would become a significant factor, affecting the load-meeting capability of the existing transmission facilities. These have been tabulated in Table 9 for load levels of 16MW, 18MW & 19MW at the Musselwhite Mine.

In addition to the actual load at the Musselwhite Mine and the 2MW supply to the NCLFN community, circuit E1C is required to supply approximately 4MW of load that is tapped off circuit E1C at Slate Falls DS, Cat Lake TS and Crow River DS.

Consequently, for a 19MW load at the Musselwhite Mine, the flow on circuit E1C at Ear Falls SS would total ***38MW*** [19MW (mine load) + 2MW (NCLFN load) + 4MW (E1C-connected load) + 13MW (losses)]. Since this would exceed the surge impedance loading of approximately 36MW for circuit E1C, increasing amounts of reactive compensation would need to be installed to maintain an acceptable voltage profile at the higher load levels.

Furthermore, since the reactive power flow recorded on circuit E1C for a 19MW load at the Musselwhite Mine was 20MVAr, the effective flow on this circuit would be approximately 44MVA. This is approaching the continuous rating of 47MVA for this circuit under summertime conditions at an ambient temperature of 30^{o}C.

Since the losses would increase disproportionately at higher load levels, and since increasing amounts of reactive compensation would be required along the entire length of the radial system in order to maintain an acceptable voltage profile, it has therefore been concluded that the maximum load that it would be possible to supply at the Musselwhite Mine would be limited to around 20MW (in addition to the 4MW of existing load supplied directly from circuit E1C and the proposed 2MW at the NCLFN community).

Any further increases in load beyond the 26MW identified above would therefore be expected to require the construction of additional transmission capacity.

Effect of Power Factor on the Load Meeting Capability of the Existing System

Table 10 shows the effect of an improvement in the power factor of the load at the Musselwhite Mine upon the maximum load that could be supplied with only the existing transmission facilities (without the NCLFN line).

With the load at the Mine maintained at a power factor of 0.94, the SVCs at the Musselwhite Mine would become limiting (i.e. the shunt reactor portions of the SVCs would be at 0MVAr) at a load level of 17MW. At this load level, the voltage at Crow River DS would begin to decline and at 18MW it would fall below the minimum permitted under the Market Rules.

Consequently, improving the power factor of the load at the Musselwhite Mine from 0.90 to 0.94 would increase the maximum load that it would be possible to supply with only the existing transmission facilities in-service, from 16MW to 17MW.

5. Conclusions from the Analysis

The following conclusions can be drawn from the preceding analysis:

5.1 North Caribou Lake First Nations Line

Energisation of the 85km NCLFN line whenever the two SVCs at the Musselwhite Mine are unavailable would only be possible if additional shunt reactors totalling between -7.5MVAr & -10MVAr were to be installed at the NCLFN Junction. Alternatively, if an additional +6MVAr/-11MVAr SVC were to be installed at Crow River DS, then only a single shunt reactor rated between -2MVAr & -2.5MVAr would need to be installed at the NCLFN Junction.

However, since the existing transmission facilities have been shown to be adequate to supply only a load of 16MW at the Musselwhite Mine, and since the installation of an SVC at Crow River DS would also allow a supply of 2MW to be provided to the NCLFN community (all loads at 0.90 power factor), it is therefore recommended that the latter option be adopted.

Furthermore, if the power factor of the loads were to be maintained above 0.94, then the maximum, combined load that could be supplied at the Mine and the NCLFN community would increase to approximately 19MW.

The installation of an SVC at Crow River DS would also assist in controlling the terminal voltage on circuit E1C when it is being energised.

It is therefore proposed to revise the IMO's requirements for the connection of the NCLFN line to the Placer Dome circuit M1M to reflect the findings of this assessment. **Connection of the NCLFN line to the Placer Dome circuit M1M will still be subject to the approval of Placer Dome.**

Furthermore, all facilities associated with the NCLFN line must be suitable for continuous operation at 138kV.

Facilities are also required to permit auto-switching (into service) of the -2MVAr shunt reactor at the NCLFN Junction in response to a contingency involving the NCLFN line, so as to limit the immediate post-contingency voltage rise at Crow River DS and at the Musselwhite Mine. These facilities are to include the capability to remotely select (pre-arm) this auto-switching operation.

Diagram 4 shows the facilities required for the connection of the NCLFN line.

5.2 Placer Dome - Musselwhite Mine

For the existing system, energisation of circuit M1M with no SVCs in-service has been shown to result in excessively high voltages at the Musselwhite Mine and at the stations supplied from circuit E1C.

Energising circuit M1M with only a single SVC in-service, with a net reactive output of -6.5MVAr, has been shown to result in relatively high voltages at Crow River DS and at the Musselwhite Mine. However, since these voltages would be reduced once load is added at the Mine, they are considered to be acceptable for the limited period involved.

If both SVCs at the Musselwhite Mine were to be unavailable, then in order for circuit M1M to be energised and a supply provided to the NCLFN community, the connection of the NCLFN line would need to be accompanied by the installation of a -2.0MVAr shunt reactor at the NCLFN Junction and a new SVC at Crow River TS.

Furthermore, with these new facilities installed to complement the connection of the new NCLFN line to circuit M1M (as shown in Diagram 4), it would be possible to provide the required supply of 2MW to the NCLFN community, in addition to supplying a load of 16MW at the Musselwhite Mine at a power factor of 0.90.

Improving the power factor of the Mine load to 0.94 would enable an additional 1MW of load to be supplied, either at the Mine or at the NCLFN community, for a total combined load of 19MW.

Increasing the total shunt capacitance at the Musselwhite Mine from +14MVAr (from the two +3.5MVAr capacitor banks associated with each SVC) to +18MVAr would allow a further increase in the load meeting capability of 2MW, for a total combined load of 21MW.

This compares with the maximum load of 17MW, at a power factor of 0.94MW that could be supplied at the Musselwhite Mine with only the existing transmission facilities i.e. without the NCLFN line and the additional SVC installed at Crow River DS.

Summary of the Load Supply Capability

The following Table summarises the load meeting capability of the various system arrangements.

	System Conditions	Power Factor of Mine Load	*Max. Load that could be supplied*		
			At the Musselwhite Mine	*At the NCLFN community*	*Additional Load*
1.	Existing System	0.90	16MW	-	-
2.		0.94	16MW	-	*+1MW*
3.	With the NCLFN line & a new +6/-11MVAr SVC at Crow River DS	0.90	16MW	2MW	-
4.		0.94	16MW	2MW	*+1MW*
5.	With the NCLFN line & a new SVC at Crow River DS, *AND* with the shunt capacitance at the Mine increased from +14MVAr to +18MVAr	0.94	16MW	2MW	*+3MW*

It is worth noting by comparing the results in the following rows of above Table, that while the installation of the proposed SVC at Crow River DS associated with the connection of the NCLFN line to circuit M1M, would increase the supply capability of the *existing* transmission facilities, the increase would only be sufficient to provide a 2MW supply to the NCLFN community. It would have no net effect on the supply capability to the Musselwhite Mine that is presently available from the existing facilities:

- compare Row 1 (total load: 16MW) with Row 3 (total load: 18MW) - for a mine load power factor of 0.90, and
- compare Row 2 (total load: 17MW) with Row 4 (total load: 19MW) - for a mine load power factor of 0.94.

6. IMO Requirements for connection to the IMO-controlled grid

For the existing system configuration, without the North Caribou Lake First Nation Line connected

Since the ***existing*** transmission facilities would allow the requested maximum load of 16MW, at a power factor of 0.90, to be supplied at the Musselwhite Mine, there are no additional IMO requirements.

However, it is recommended that Placer Dome install facilities to initiate automatic load rejection at the mine site in the event of a contingency involving either of the SVCs.

Currently, should an excessive reduction in voltage occur at the mine site, the approach that has been adopted involves the tripping of circuit M1M at Crow River DS. While this would be acceptable to the IMO, since it would only affect Placer Dome, there would be considerable merit in adopting an approach that would avoid the tripping, and the subsequent need to re-energise circuit M1M.

Furthermore, should the NCLFN community proceed with their proposed connection on to circuit M1M, then the tripping of circuit M1M to resolve local problems at the mine site would no longer be acceptable.

In addition, there have been occasions when only a single SVC has been available at the Mine, and high voltages have been experienced at the Crow River terminal following initial energisation of circuit M1M and these have resulted in the circuit being tripped. Since the analysis has indicated that a single SVC should be adequate to maintain the voltages within an acceptable range, the IMO recommends that the response of the SVC be reviewed to ensure that it will achieve its full inductive rating within 80 milliseconds.

The IMO therefore recommends that Placer Dome review the performance of the two SVCs at their Musselwhite Mine to ensure that the shunt reactor portion of each SVC (in isolation) is able to achieve its full reactive capacity within 80 milliseconds of circuit M1M being energised.

For the revised system configuration, with the North Caribou Lake First Nation Line connected to circuit M1M

Once the new facilities associated with the NCLFN line are in-service, the enhanced system arrangement would be capable of providing a 2MW supply to the NCLFN community, in addition to the required 16MW at the Musselwhite Mine (at a power factor of 0.90), for a combined total load of 18MW.

If the power factor of the Mine load were to be maintained above 0.94 then this would allow the maximum load that could be supplied at either the Mine or the NCLFN community to be increased by a further 1MW, for a combined total load of 19MW.

Consequently, for the subsequent connection of the NCLFN line and its associated facilities, no further changes would be required to allow the Musselwhite Mine to maintain its 16MW supply.

North Caribou Lake First Nation Line

Although not strictly a part of this assessment, the IMO's requirements for the connection of the NCLFN line to the Placer Dome 115kV circuit M1M have been detailed below, since these facilities must be installed to ensure that the required 16MW supply (at a power factor of 0.90) can be maintained to the Musselwhite Mine.

The IMO's requirements for connecting the North Caribou Lake First Nation Line to the Placer Dome's 115kV circuit M1M are therefore as follows:

- Install a 115kV circuit breaker and circuit switcher in series at the connection point on to circuit M1M.
- Install a -2MVAr (rated at 118kV) shunt reactor, switched via a 115kV circuit switcher, at the connection point on to circuit M1M, and connected directly to circuit M1M.
- Install two -1.22MVAr shunt reactors, each switched via its own circuit switcher, at the connection point on to circuit M1M, but connected to the NCLFN line.
- Install a single -1.22MVAr shunt reactor, switched via its own circuit switcher, connected at the remote terminal of the NCLFN line.
- Install a +6MVAr/-11MVAr SVC at Crow River DS. The SVC must be capable of delivering its full inductive capability upon energisation so that, for the proposed rating of +6MVAr capacitive and -11MVAr inductive, the device would appear to have a net value of -5MVAr inductive. Once the SVC has been energised the thyristors could then start to adjust the current to vary the inductive portion of the SVC.
- Install an auto-close scheme for automatically switching the -2MVAr shunt reactor at the NCLFN Junction into service for a contingency involving the NCLFN line.

7. Approximate Cost Estimates

Since all of the work entailed in implementing the IMO's requirements (installation of a load rejection scheme and verification of the response of the existing two SVCs) would be internal to the Placer Dome facilities at the Musselwhite Mine, no attempt has been made to estimate the cost.

8. Identification of 'Sole Beneficiary'

Section 9.2.5 of the Transmission System Code states:

> *Modifications and upgrades to specific network facilities or installation of new network facilities that are triggered by a load customer and are for its sole benefit shall be borne by that customer.*

For the proposed increase in load at the Musselwhite Mine

Since the existing transmission facilities are capable of supplying the required increase in load at the Musselwhite Mine without any further *'modifications and upgrades to specific network facilities or the installation of new network facilities',* the 'sole beneficiary' designation is not applicable.

For the proposed connection of the NCLFN line to circuit M1M

This will be addressed in the PA Report for this Project.

9. Customer Impact Assessment

Hydro One Networks Inc. has informed the IMO that a formal Customer Impact Assessment will not be required for the requested increase in the maximum load at the Musselwhite Mine.

10. System Impact Assessment

All of the analysis required to determine the potential impact that this Project would be expected to have on the IMO-controlled grid has been completed in this assessment.

A separate System Impact Assessment will therefore not be required for this Project.

11. Notification of Approval of the Connection Proposal

It is therefore recommended that a Notification of Approval for the revised connection be issued.

TABLES

Line Energisation Studies

TABLE 1	Conditions:	Energisation of the 115kV circuit M1M: Placer Junction to the Musselwhite Mine					
System Condition		*Voltages*					
		Ear Falls GS	*Slate Falls Junction*	*Cat Lake/ Golden Jct.*	*Crow River*	*Musselwhite Mine*	
						115kV	*4.16kV*
Without the North Caribou Lake First Nation Line Connected							
1.	With no SVCs at the Musselwhite Mine	124.9kV	134.8kV	138.5kV	142.3kV	146.4kV	5.03kV
2.	With -13.5MVAr reactor at the Musselwhite Mine	123.9kV	125.3kV	124.9kV	123.3kV	117.4kV	3.83kV
3.	With -13.5MVAr reactor in-service & 1st +3.5MVAr cap. switched	124.1kV	127.8kV	128.3kV	128.0kV	124.2kV	4.10kV
	Change in voltage	*+0.2kV* *+0.2%*	*+2.5kV* *+2.0%*	*+3.4kV* *+2.7%*	*+4.7kV* *+3.8%*	*+6.8kV* *+5.8%*	*0.23kV* *+7.0%*
4.	With -13.5MVAr reactor in-service & 2nd +3.5MVAr cap. switched	124.4kV	129.8kV	131.2kV	131.9kV	130.5kV	4.37kV
	Change in voltage	*+0.3kV* *+0.2%*	*+2.0kV* *+1.6%*	*+2.9kV* *+2.3%*	*+3.9kV* *+3.0%*	*+6.3kV* *+5.1%*	*+0.27kV* *+6.6%*
5.	Switching of the 2nd 'full' SVC (+7MVAr/-13.5MVAr)	123.9kV	125.7kV	125.5kV	124.1kV	118.4kV	3.87kV
	Change in voltage	*-0.5kV* *-0.4%*	*-4.1kV* *-3.2%*	*-5.7kV* *-4.3%*	*-7.8kV* *-5.9%*	*-12.1kV* *-9.3%*	*-0.50kV* *-11.4%*
6.	With no SVCs at the Musselwhite Mine; with a total shunt reactance of -2.4MVAr at NCLFN Junction; & with a -4.0MVAr reactor at Crow River DS	124.4kV	130.0kV	131.6kV	132.5kV	134.4kV	4.50kV
7.	With no SVCs at the Musselwhite Mine; with a -2.0MVAr shunt reactor at NCLFN Junction; & with a -5.0MVAr reactor at Crow River DS	124.3kV	129.3kV	130.6kV	131.1kV	133.0k V	4.45kV

Line Energisation Studies (Continued)

TABLE 2	***Conditions:***	***Energisation of the proposed 115kV North Caribou Lake First Nations Line: Circuit M1M assumed to be in-service***						
System Condition	***Voltages***							
	Ear Falls GS	*Slate Falls Junction*	*Cat Lake/ Golden Junction*	*Crow River*	*Musselwhite Mine*		*NCLFN Community*	
					115kV	*4.16kV*		
1. With no SVCs at the Musselwhite Mine	124.9kV	135.3kV	139.0kV	142.9kV	147.4kV	5.05kV	147.8kV	
2. With both SVCs (net -13.0MVAr) at the Musselwhite Mine	124.0kV	126.0kV	126.1kV	124.6kV	119.3kV	3.90kV	119.6kV	
3. With no SVCs at Musselwhite Mine & with an additional -10.0MVAr of shunt reactors at NCLFN Junction	124.0kV	127.3kV	127.6kV	127.0kV	123.0kV	4.02kV	123.3kV	

TABLE 3	***Conditions:***	***Energisation of the proposed 115kV North Caribou Lake First Nations Line: Circuit M1M assumed to be in-service With an SVC at Crow River DS***						
System Condition	***Voltages***							
	Ear Falls GS	*Slate Falls Junction*	*Cat Lake/ Golden Junction*	*Crow River*	*Musselwhite Mine*		*NCLFN Community*	
					115kV	*4.16kV*		
1. With no SVCs at the Musselwhite Mine & with an additional +6MVAr/-10MVAr (net -4MVAr) SVC at Crow River DS	124.6kV	132.2kV	134.7kV	136.8kV	141.1kV	4.84kV	141.5kV	
2. With no SVCs at the Musselwhite Mine & with an additional +6/-10MVAr SVC at Crow River DS & an additional -1.2MVAr reactor at NCLFN Junction	124.4kV	131.3kV	133.3kV	134.9kV	138.1kV	4.73kV	138.4kV	
3. With no SVCs at the Musselwhite Mine & with an additional +6/-11MVAr SVC at Crow River DS & an additional -2.0MVAr reactor at NCLFN Junction (-2.4 & -2.0MVAr)	124.3kV	129.7kV	131.1kV	131.8kV	134.5kV	4.50kV	134.7kV	

Load Supply Capability ***Power Factor of the Musselwhite Mine Load: 0.90***

TABLE 4	**Conditions:**	***Two SVCs at Musselwhite (+7/-13.5MVAr) & one SVC at Crow River (+6/-11MVAr); Additional -2MVAr reactor at Musselwhite Junction; and with loads at the Musselwhite Mine at 0.90 power factor***							
System Condition			***Voltages***						
			Ear Falls GS	*Slate Falls Junction*	*Cat Lake/ Golden Junction*	*Crow River*	*Musselwhite Mine*		*NCLFN Community*
							115kV	*4.16kV*	
1.	Load at the Musselwhite Mine (at 0.90 pf) & with 2MW at NCLFN (at 0.90 pf)	5MW	124.3kV *SVC Output*	126.2kV	126.3kV	125.6kV *+6.7/-9.5:= -2.8*	125.9kV	4.34kV *+15.3/-11.4:= +3.9*	125.6kV
2.		10MW	124.3kV *SVC Output*	124.3kV	124.1kV	123.1kV *+6.6/-8.1:= -1.5*	124.2kV	4.34kV *+15.3/-4.9:= +10.4*	123.9kV
3.		14MW	124.2kV *SVC Output*	122.0kV	121.1kV	119.9kV *+6.7/-5.4:= +1.3*	120.6kV	4.26kV *+14.7/-0:= +14.7*	120.3kV
4.		14MW **	124.3kV *SVC Output*	123.1kV	122.8kV	122.3kV *+6.7/-6.9:= -0.2*	125.8kV	4.45kV *+16.0/-0:= +16.0*	125.3kV
5.		15MW**	124.1kV *SVC Output*	121.1kV	119.9kV	118.4kV *+6.7/-5.4:= +1.3*	119.5kV	4.2kV *+14.3/-0:= +14.3*	119.2kV
6.		16MW**	124.1kV *SVC Output*	120.0kV	118.5kV	116.9kV *+6.6/-2.7:= +3.9*	116.3kV	4.07kV *+13.4/-0:= +13.4*	116.0kV
7.		17MW**	123.9kV *SVC Output*	117.8kV	115.6kV	113.2kV *+6.7/-0:= +6.7*	110.1kV	3.82kV *+11.9/-0:= +11.9*	109.6kV

Note: ** Indicates that the 2MVAr shunt reactor at NCLFN Junction was switched out-of-service.

Load Supply Capability (Continued) ***Power Factor of the Musselwhite Mine Load: 0.90*** ***Optimisation of Voltage at Crow River DS***

<table>
<tr><td>TABLE 4A</td><td>Conditions:</td><td colspan="8">Two SVCs at Musselwhite (+7/-13.5MVAr) & one SVC at Crow River (+6/-11MVAr); Additional -2MVAr reactor at Musselwhite Junction; and with loads at the Musselwhite Mine at 0.90 power factor</td></tr>
<tr><td colspan="3" rowspan="3">System Condition</td><td colspan="7">Voltages</td></tr>
<tr><td rowspan="2">Ear Falls GS</td><td rowspan="2">Slate Falls Junction</td><td rowspan="2">Cat Lake/ Golden Junction</td><td rowspan="2">Crow River</td><td colspan="2">Musselwhite Mine</td><td rowspan="2">NCLFN Community</td></tr>
<tr><td>115kV</td><td>4.16kV</td></tr>
<tr><td rowspan="2">6A.</td><td rowspan="2">Load at the Musselwhite Mine (at 0.90 pf) & with 2MW at NCLFN (at 0.90 pf)</td><td rowspan="2">16MW**</td><td>124.3kV</td><td>123.4kV</td><td>123.8kV</td><td>124.6kV</td><td>127.3kV</td><td>4.61kV</td><td>127.1kV</td></tr>
<tr><td>SVC Output</td><td></td><td></td><td>+6.0/-0:= +6.0</td><td></td><td>+17.2/-0:= +17.2</td><td></td></tr>
</table>

Note: ** Indicates that the 2MVAr shunt reactor at NCLFN Junction was switched out-of-service

Contingency Response ***Power Factor of the Musselwhite Mine Load: 0.90***

<table>
<tr><td>TABLE 5</td><td>Conditions:</td><td colspan="8">Two SVCs at Musselwhite (+7/-13.5MVAr) & one SVC at Crow River (+6/-11MVAr); Additional -2MVAr reactor at Musselwhite Junction; and with loads at the Musselwhite Mine at 0.90 power factor</td></tr>
<tr><td colspan="3" rowspan="3">Contingency Condition</td><td colspan="7">Voltages</td></tr>
<tr><td rowspan="2">Ear Falls GS</td><td rowspan="2">Slate Falls Junction</td><td rowspan="2">Cat Lake/ Golden Junction</td><td rowspan="2">Crow River</td><td colspan="2">Musselwhite Mine</td><td rowspan="2">NCLFN Community</td></tr>
<tr><td>115kV</td><td>4.16kV</td></tr>
<tr><td colspan="10">Load Supply with two SVCs at Musselwhite & one SVC at Crow River and with loads at 0.90 power factor & 2MW at NCLFN Community: With -2MVAr reactor</td></tr>
<tr><td rowspan="2" colspan="2">0. Reference: Pre-contingency</td><td rowspan="9">17MW **</td><td>123.9kV</td><td>117.8kV</td><td>115.6kV</td><td>113.2kV</td><td>110.1kV</td><td>3.82kV</td><td>109.6kV</td></tr>
<tr><td>SVC Output</td><td></td><td></td><td>+6.7/-0:= +6.7</td><td></td><td>+11.9/-0:= +11.9</td><td></td></tr>
<tr><td rowspan="2" colspan="2">1. Loss of NCLFN Line No auto-switching of -2MVAr reactor at Junction</td><td>124.2kV</td><td>121.9kV</td><td>121.1kV</td><td>120.2kV</td><td>121.2kV (+10.1%)</td><td>4.24kV (+11.0%)</td><td rowspan="2">Out-of-Service</td></tr>
<tr><td>SVC Output</td><td></td><td></td><td>+6.8/-4.1:= +2.7</td><td></td><td>+14.6/-0:= +14.6</td></tr>
<tr><td rowspan="5" colspan="2">2. Loss of a 3.5MVAr capacitor of one of the SVCs at Musselwhite Mine</td><td colspan="7">Voltage collapse with constant MVA loads</td></tr>
<tr><td colspan="7">With Voltage dependent loads</td></tr>
<tr><td>123.9kV</td><td>117.9kV</td><td>115.5kV</td><td>112.3kV</td><td>107.0kV</td><td>3.66kV</td><td>106.5kV</td></tr>
<tr><td>SVC Output</td><td></td><td></td><td>+6.6/-0:= +6.6</td><td></td><td>+8.1/-0:= +8.1</td><td></td></tr>
<tr><td>Loads</td><td></td><td></td><td>2.4MW</td><td></td><td>15.9MW</td><td>1.9MW</td></tr>
</table>

Load Supply Capability (Continued) ***Power Factor of the Musselwhite Mine Load: 0.94***

TABLE 6	***Conditions:***	***Two SVCs at Musselwhite (+7/-13.5MVAr) & one SVC at Crow River (+6/-11MVAr); Additional -2MVAr reactor at Musselwhite Junction; and with loads at the Musselwhite Mine at 0.94 power factor***

System Condition			***Voltages***						
			Ear Falls GS	*Slate Falls Junction*	*Cat Lake/ Golden Junction*	*Crow River*	*Musselwhite Mine*		*NCLFN Community*
							115kV	*4.16kV*	
1.	Load at the Musselwhite Mine (at 0.94 pf) & with 2MW at NCLFN (at 0.90 pf)	14MW	124.4kV *SVC Output*	123.9kV	123.9kV	123.8kV *+6.9/-4.2:= +2.7*	125.9kV	4.46kV *+16.0/-1.7:= +14.3*	125.6kV
2.		14MW**	124.4kV *SVC Output*	124.9kV	125.4kV	125.9kV *+6.9/-5.6:= +1.3*	130.0kV	4.62kV *+17.3/-1.9:= +15.4*	130.0kV
3.		16MW	124.2kV *SVC Output*	120.9kV	119.8kV	118.7kV *+6.7/-2.7:= +4.0*	119.0kV	4.22kV *+14.4/-0:= +14.4*	118.8kV
4.		16MW **	124.3kV *SVC Output*	122.1kV	121.6kV	121.3kV *+6.7/-4.1:= +2.6*	124.3kV	4.41kV *+15.7/-0:= +15.7*	124.0kV
5.		18MW**	124.0kV *SVC Output*	118.1kV	116.1kV	114.1kV *+6.8/-0:= +6.8*	112.6kV	3.96kV *+12.7/-0:= +12.7*	112.2kV

Note: ** Indicates that the -2MVAr shunt reactor at NCLFN Junction was switched out-of-service.

Contingency Response ***Power factor of the Musselwhite Mine Load: 0.94***

TABLE 7 ***Conditions:*** ***Two SVCs at Musselwhite (+7/-13.5MVAr) & one SVC at Crow River (+6/-11MVAr); Additional -2MVAr reactor at Musselwhite Junction; and with loads at the Musselwhite Mine at 0.94 power factor***

Contingency Condition		Voltages: *Ear Falls GS*	*Slate Falls Junction*	*Cat Lake/ Golden Junction*	*Crow River*	*Musselwhite Mine 115kV*	*Musselwhite Mine 4.16kV*	*NCLFN Community*
0. ***Reference: Pre-contingency***	18MW **	124.0kV	118.1kV	116.1kV	114.1kV	112.6kV	3.96kV	112.2kV
		SVC Output			*+6.8/-0:= +6.8*		*+12.7/-0:= +12.7*	
1. ***Loss of NCLFN Line With auto-switching of the -2MVAr reactor at Junction***		124.1kV	120.3kV	118.9kV	117.4kV	116.9kV (+3.8%)	4.11kV (+3.8%)	*Out-of-service*
		SVC Output			*+6.7/-0:= +6.7*		*+13.7/-0:= +13.7*	
2. ***Loss of a 3.5MVAr capacitor of one of the SVCs at Musselwhite Mine***		*Voltage collapse with constant MVA loads*						
		With Voltage dependent loads						
		123.9kV	118.0kV	115.8kV	113.2kV	109.4kV (-3.7%)	3.79kV	*109.0kV*
		SVC Output			*+6.7/-0:= +6.7*		*+8.7/-0:= +8.7*	
		Loads			*2.4MW*		*16.9MW*	*1.9MW*

Load Supply Capability (Continued) ***Power Factor of Musselwhite Mine Load: 0.94 & rating of SVC capacitors increased to 9MVAr from 7MVAr***

TABLE 8	***Conditions:***	***Two SVCs at Musselwhite (+9/-13.5MVAr) & one SVC at Crow River (+6/-11MVAr); Additional -2MVAr reactor at Musselwhite Junction; and with loads at the Musselwhite Mine at 0.94 power factor***							
System Condition			***Voltages***						
			Ear Falls GS	*Slate Falls Junction*	*Cat Lake/ Golden Junction*	*Crow River*	*Musselwhite Mine 115kV*	*Musselwhite Mine 4.16kV*	*NCLFN Community*
1.	Load at the Musselwhite Mine (at 0.94 pf) & with 2MW at NCLFN (at 0.90 pf)	16MW**	124.4kV *SVC Output*	122.9kV	122.8kV	123.1kV *+6.8/-2.8:= +4.0*	126.1kV	4.47kV *+20.8/-5.2:= +15.6*	125.8kV
2.		18MW**	124.3kV *SVC Output*	121.3kV	121.1kV	121.7kV *+6.6/-2.7:= +3.9*	127.4kV	4.59kV *+21.9/-0:= +21.9*	127.1kV
3.		19MW**	124.2kV *SVC Output*	119.7kV	119.1kV	119.2kV *+6.8/-0:= +6.8*	122.6kV	4.40kV *+20.1/-0:= +20.1*	122.3kV
4.		20MW**	*Unacceptable Voltages* *SVC Output*						

Note: ** Indicates that the -2MVAr shunt reactor at NCLFN Junction was switched out-of-service.

Line Losses

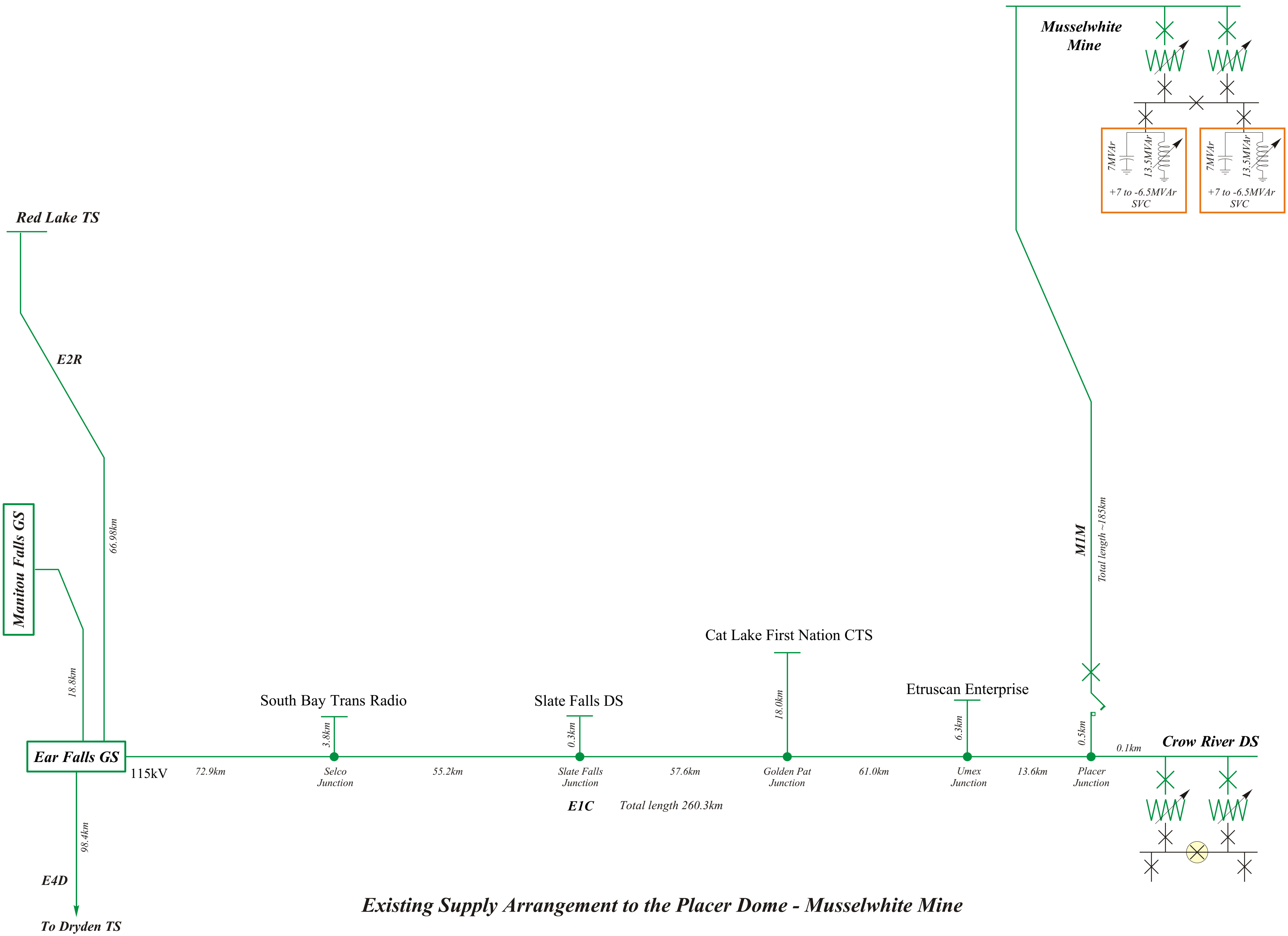
TABLE 9	***Conditions:***	***Two SVCs at Musselwhite (+9/-13.5MVAr) & one SVC at Crow River (+6/-11MVAr); Additional -2MVAr reactor at Musselwhite Junction; and with loads at the Musselwhite Mine at 0.94 power factor***			
Loads at the Musselwhite Mine	*Line Section*				*Total Losses*
	Circuit E1C: Ear Falls TS to Crow River DS			*Circuit M1M*	
	Ear Falls TS to Slate Falls Jct.	Slate Falls Jct. to Golden Pat Jct.	Golden Pat Jct. to Placer Jct.		
16MW	4.4MW	1.8MW	1.9MW	1.1MW	9.2MW
18MW	5.7MW	2.4MW	2.6MW	1.6MW	12.3MW
19MW	5.9MW	2.9MW	2.7MW	1.6MW	13.1MW

Load Supply Capability (Continued) ***Power Factor of the Musselwhite Mine Load: 0.94***

TABLE 10	***Conditions: Existing System, without the NCLFN line, and with loads at the Musselwhite Mine at 0.94 power factor***							
System Condition			***Voltages***					
			Ear Falls GS	*Slate Falls Junction*	*Cat Lake/ Golden Junction*	*Crow River*	*Musselwhite Mine*	
							115kV	*4.16kV*
1.	Load at the Musselwhite Mine (at 0.94 pf)	16MW	124.3kV *SVC Output*	123.1kV	122.8kV	122.3kV	125.5kV	4.43kV *+15.9/-1.7:= +14.2*
2.		17MW	124.2kV *SVC Output*	122.0kV	121.1kV	120.5kV	123.8kV	4.39kV *+15.6/-0:= +15.6*
3.		18MW	123.7kV *SVC Output*	116.4kV	113.2kV	109.2kV	107.6kV	3.76kV *+11.5/-0:= +11.5*

Voltages below the Market Rule minimum of 113kV for the 115kV system. (shaded cells)

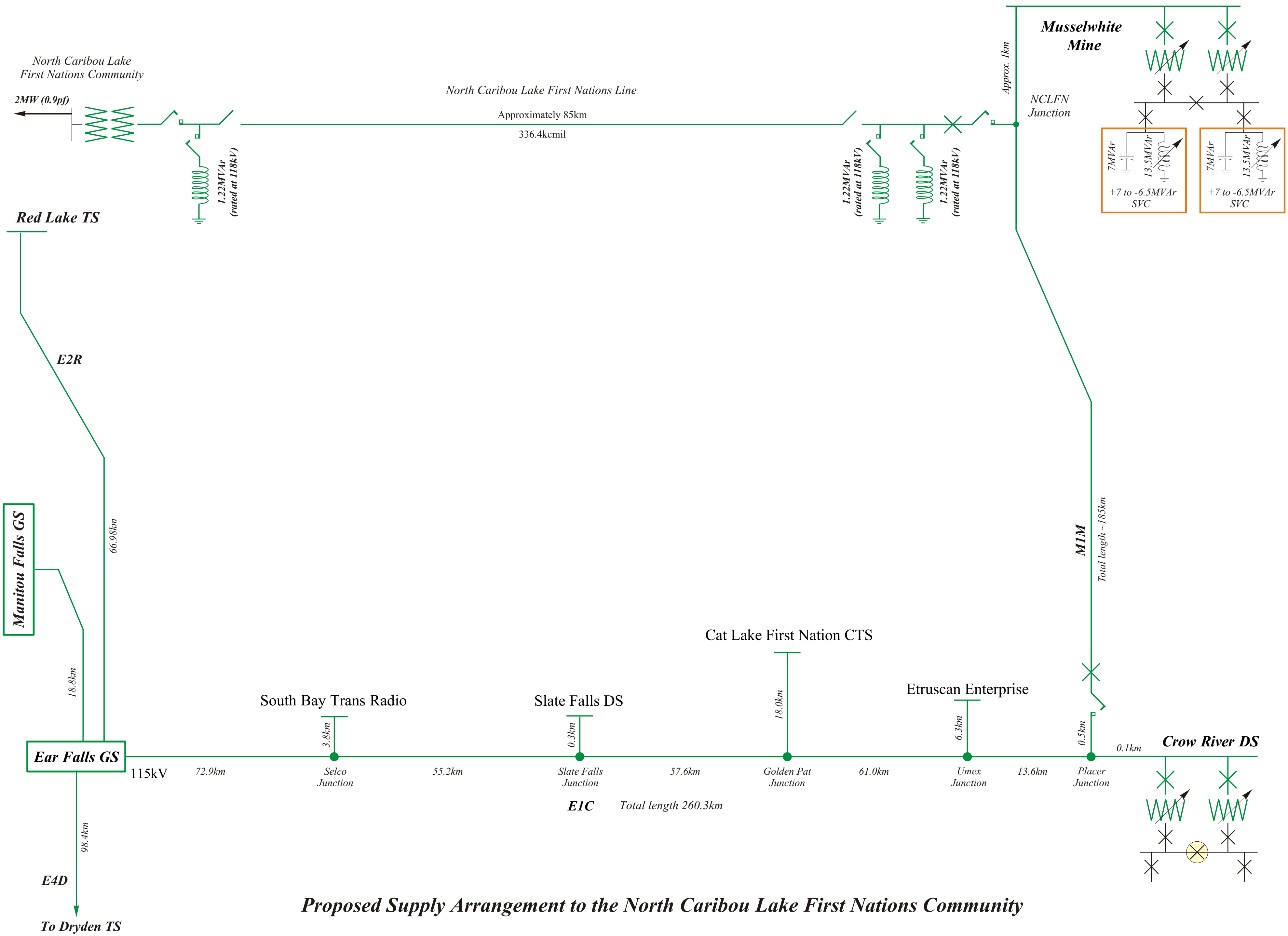
DIAGRAMS



Existing Supply Arrangement to the Placer Dome - Musselwhite Mine

DIAGRAM 1

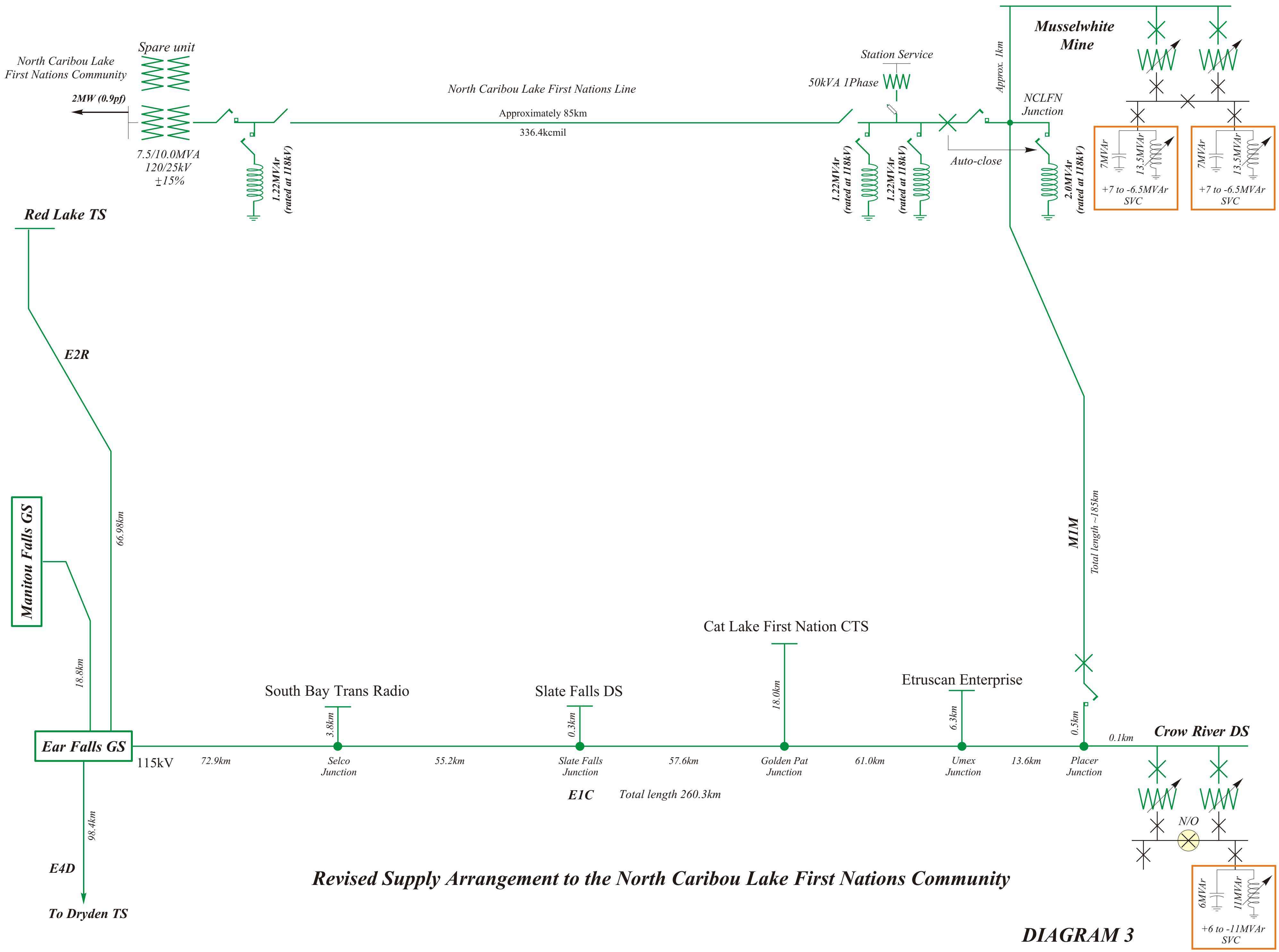
10th May 2003



Proposed Supply Arrangement to the North Caribou Lake First Nations Community

DIAGRAM 2

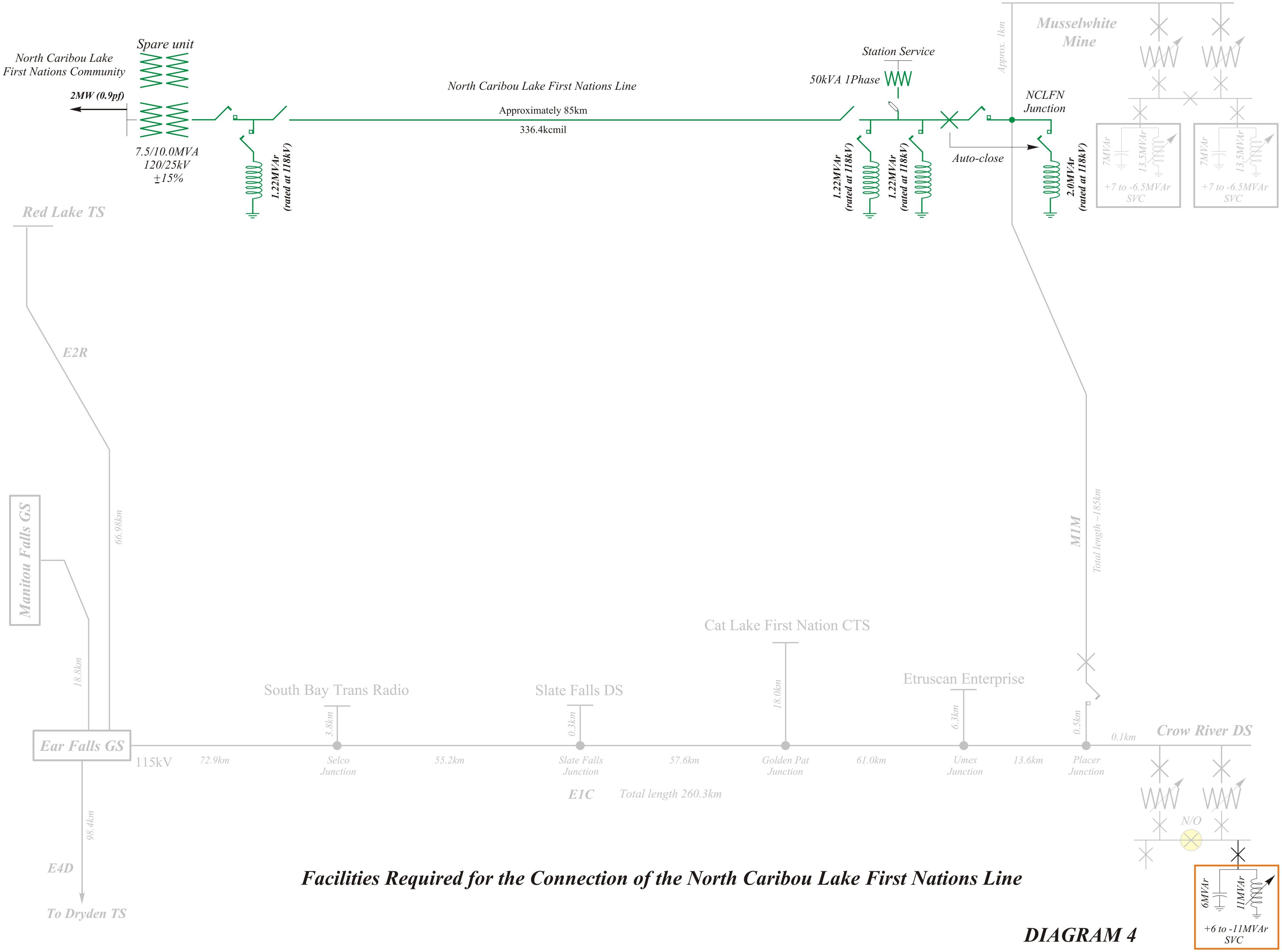
10th May 2003



Revised Supply Arrangement to the North Caribou Lake First Nations Community

DIAGRAM 3

20th May 2003



Facilities Required for the Connection of the North Caribou Lake First Nations Line

DIAGRAM 4

19th May 2003