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NEEDS ASSESSMENT REPORT

**Kitchener - Waterloo - Cambridge - Guelph (KWCG)
Region**

Date: December 19, 2018

Prepared by: KWCG Region Study Team



Disclaimer

This Needs Assessment Report was prepared for the purpose of identifying potential needs in the KWCG Region and to recommend which need may require further assessment and/or regional coordination to develop a preferred plan. The results reported in this Needs Assessment are based on the input and information provided by the Study Team.

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Executive Summary

REGION	Kitchener - Waterloo - Cambridge - Guelph (KWCG) Region		
LEAD	Hydro One Networks Inc. (“HONI”)		
START DATE	September 17, 2018	END DATE	December 19, 2018

1. INTRODUCTION

The first cycle of the Regional Planning process for the KWCG Region an Integrated Regional Resource Plan (“IRRP”) was published in April 2015 which identified a number of near- and mid-term needs in the KWCG region. The planning process was completed in December 2015 with the publication of the Regional Infrastructure Plan (“RIP”) which provided a description of needs and recommendations of preferred wires plans to address near-term needs. The RIP also identified some near- and mid-term needs that will be reviewed during this Regional Planning cycle.

The purpose of this Needs Assessment (“NA”) is to identify any new needs and to reaffirm needs identified in the previous KWCG Regional Planning cycle.

2. REGIONAL ISSUE/TRIGGER

In accordance with the Regional Planning process, the regional planning cycle should be triggered at least every five years. In light of the timing of the needs identified in the previous Integrated Regional Resource Plan (“IRRP”) and RIP reports as well as new replacement/ refurbishment needs in the KWCG Region, the 2nd Regional Planning cycle was triggered for this Region.

3. SCOPE OF NEEDS ASSESSMENT

The scope of this NA includes:

- Review and reaffirm needs/plans identified in the previous RIP; and
- Identification and assessment of system capacity, reliability, operation, and aging infrastructure needs.

The Study Team may also identify additional needs during the next phases of the planning process, namely Scoping Assessment (“SA”), IRRP and RIP, based on updated information available at that time.

4. INPUTS/DATA

The Study Team representatives from Local Distribution Companies (“LDC”), the Independent Electricity System Operator (“IESO”), and Hydro One provided input and relevant information for the KWCG Region regarding capacity needs, reliability needs, operational issues, and major assets/facilities approaching end-of-life (“EOL”). In addition, community energy plans in the region have also been scanned and reviewed.

5. ASSESSMENT METHODOLOGY

The assessment’s primary objective is to identify the electrical infrastructure needs, recommend further mitigation or action plan(s) to address these needs, and determine whether further regional coordination or broader study would be beneficial.

The assessment reviewed available information including load forecasts, conservation and demand management (“CDM”) and distributed generation (“DG”) forecasts, reliability needs, operational issues, and major high

voltage equipment identified to be at or near the end of their useful life and requiring replacement/refurbishment.

A technical assessment of needs was undertaken based on:

- Current and future station capacity and transmission adequacy;
- Reliability needs and operational concerns; and
- Any major high voltage equipment reaching the end of its useful life.

6. NEEDS

I. Station & Transmission Supply Capacity

- Campbell TS (T3/T4) DESN Overloading is forecasted in the 2021-2022.
- Future need for Waterloo North Hydro MTS #4
- Future need for Energy+ MTS #2

A contingency analysis was performed and due to reduced forecasts no issues were found.

II. System Reliability & Operation

- D10H 115 kV line reliability and restoration of Elmira TS loads.

III. Aging Infrastructure – Transformer Replacements and line Section Refurbishment

- Projects in execution:
 - i. Campbell TS – T1 (2018)
 - ii. Detweiler TS -Auto T2 &T4 (2021-2022)
 - iii. 115 kV B5C/ B6C Circuits (2019-2020)¹
- New projects:
 - i. 115 kV D7F/ D9F Circuits (2019-2020)²
 - ii. 230 kV D6V/ D7V Circuits (2019- 2020)³
 - iii. Hanlon TS - T1 & T2 (2023-2024)
 - iv. Kitchener MTS #5 - T9 & T10 (2023-2024)
 - v. Cedar TS - T7 & T8 (2024-2025)
 - vi. Scheifele MTS - T1 & T2 (2024-2026)
 - vii. Preston TS - T3 & T4 (2025-2026)

IV. Other Planning Considerations

The local municipalities in the region are extremely engaged and actively pursuing innovative ways to manage and/or reduce their energy needs over the next 10-20 Years. For example, several community energy plans have been developed in the region.

¹ Burlington TS to a CTS Line Section

² Tower 157 to Freeport Switching Station Line Section

³ Guelph North Junction to Fergus TS Line Section

7. RECOMMENDATIONS

The Study Team's recommendations for the above identified needs are as follows:

- a) The replacement of EOL station supply transformers at Campbell TS, Hanlon TS, Cedar TS, Kitchener MTS #5 and Preston TS along with the EOL auto transformers at Detweiler to proceed. Hydro One and the concerned LDCs will coordinate replacement of above equipment and develop replacement plans.
- b) The refurbishment of EOL line sections 115 kV B5C/ B6C, D7F/ D9F and 230 kV D6V/ D7V to proceed. Hydro One will coordinate refurbishment of these line sections with affected LDCs/ Customer.
- c) Hydro One will continue to work with Waterloo North Hydro Inc. to address the supply reliability issue at Elmira TS.
- d) The Study Team has recommended that Hydro One Transmission and the Guelph Hydro Electric System Inc. to closely monitor the loading at the T3/T4 Campbell TS DESN and to balance the loads between these DESNs when required.
- e) The Study Team recommends that the supply capacity needs with regards to Energy + MTS #2 and WNH MTS #4 be further assessed for optimization in the SA phase of regional planning. Once the optimization options are complete, Waterloo North Hydro and Energy+ shall conduct a technical and economic assessment in consultation with Hydro One.
- f) The Study Team has recommended that community energy plans will be further considered in the SA phase of the regional planning process.

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1 INTRODUCTION

The first cycle of the Regional Planning process for the KWCG Region was completed in December 2015 with the publication of the Regional Infrastructure Plan (“RIP”). The RIP provided a description of needs and recommendations of preferred wires plans to address near- and medium-term needs. Waterloo North Hydro MTS #4 was the only need to be reviewed in this planning cycle.

The purpose of this Needs Assessment (“NA”) is to identify new needs and to reconfirm needs identified in the previous KWCG regional planning cycle. Since the previous regional planning cycle, some new needs in the region have been identified.

This report was prepared by the KWCG Region Study Team (“Study Team”), led by Hydro One Networks Inc. Participants of the Study Team are listed below in Table 1. The report presents the results of the assessment based on information provided by the Hydro One, the Local Distribution Companies (“LDC”) and the Independent Electricity System Operator (“IESO”).

Table 1: KWCG Region Study Team Participants

Company
Centre Wellington Hydro
Energy+
Guelph Hydro Electric System Inc.
Halton Hills Hydro
Hydro One Networks Inc. (Lead Transmitter)
Hydro One Networks Inc. (Distribution)
Independent Electricity System Operator (“IESO”)
Kitchener Wilmot Hydro Inc.
Milton Hydro
Waterloo North Hydro Inc.
Wellington North Power Inc.

2 REGIONAL ISSUE/TRIGGER

In accordance with the Regional Planning process, the Regional Planning cycle should be triggered at least every five years. In light of the timing of the needs identified in the previous IRRP and RIP reports as well as new replacement/ refurbishment identified needs in the KWCG Region, the 2nd Regional Planning cycle was triggered for the KWCG region.

3 SCOPE OF NEEDS ASSESSMENT

The scope of this NA covers the KWCG Region and includes:

- Identification of new needs based on latest information provided by the Study Team; and,
- Confirmation/updates of existing needs and/or plans identified in the previous planning cycle.

The Study Team may identify additional needs during the next phases of the regional planning process, namely Scoping Assessment (“SA”), Local Planning (“LP”), IRRP, and/or RIP.

4 REGIONAL DESCRIPTION AND CONNECTION CONFIGURATION

The KWCG Region covers the cities of Kitchener, Waterloo, Cambridge and Guelph, portions of Oxford and Wellington counties and the townships of North Dumfries, Puslinch, Woolwich, Wellesley and Wilmot. Electrical supply to the Region is provided from eleven 230 kV and thirteen 115 kV step-down transformer stations. The summer 2018 non-coincident regional loads were about 1390 MW. The approximate boundaries of the KWCG Region are shown below in Figure 1.

The main sources of electricity into the KWCG Region are from five Hydro One stations: Middleport TS, Buchanan TS, Detweiler TS, Orangeville TS and Burlington TS. At these stations electricity is transformed from 500 kV and 230 kV to 230 kV and 115 kV levels, respectively. Electricity is then delivered to the end users of LDCs and directly-connected industrial customers through 26 (TS/ MTS/ CTS) step-down transformer stations. Figure 2 illustrates these stations as well as the four major regional sub-systems: Waterloo-Guelph 230 kV sub-system, Cambridge-Kitchener 230 kV sub-system, Kitchener-Guelph 115 kV sub-system and South-Central Guelph 115 kV sub-system.

The summer non-coincident regional load forecast is provided as Appendix A. Appendix B lists all step-down transformer stations, Appendix C transmission circuits and Appendix D LDCs in the KWCG Region.

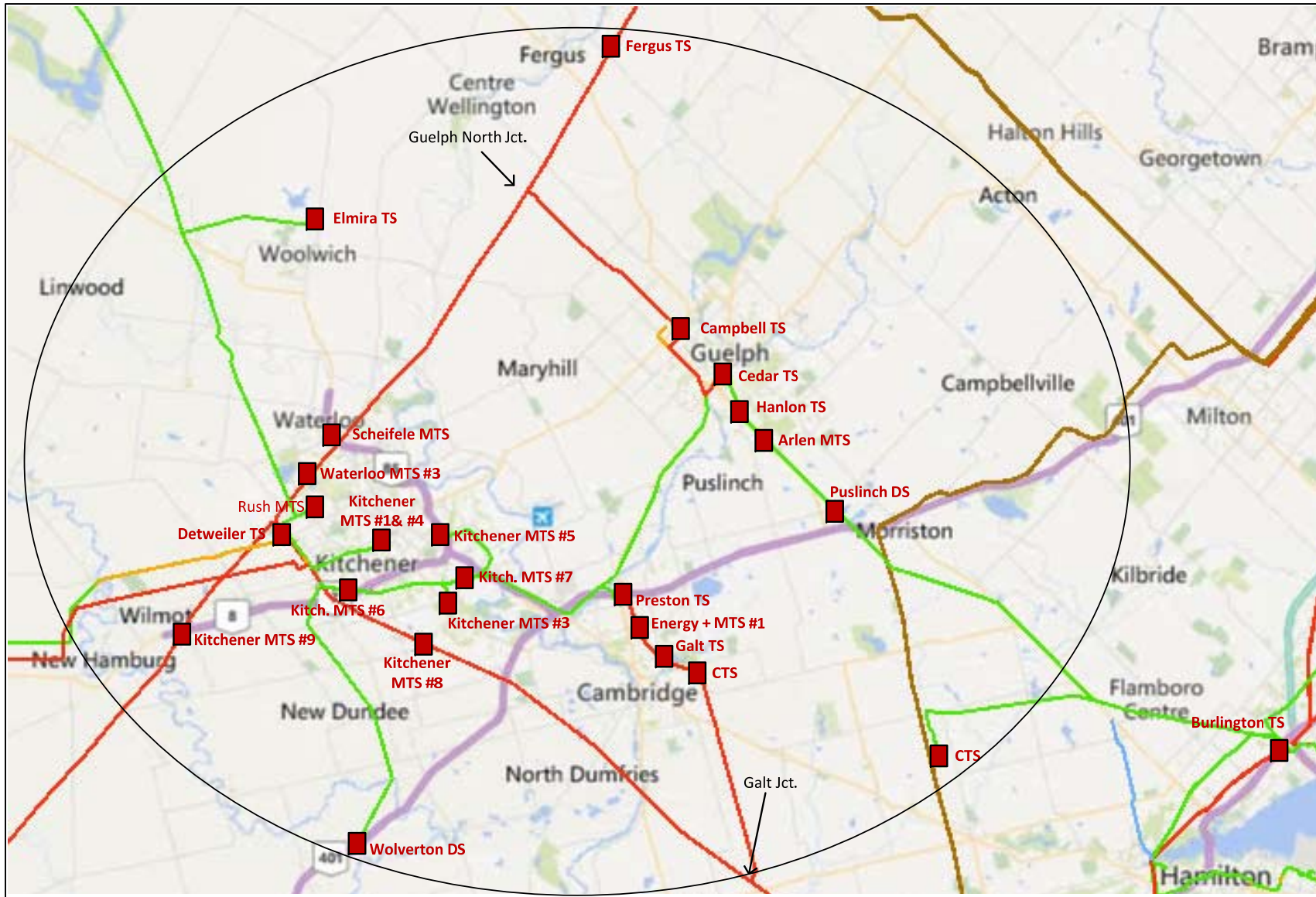


Figure 1: Geographical Area of the KWCG Region with Electrical Layout

An electrical single line diagram for the KWCG Region facilities is shown below in Figure 2.

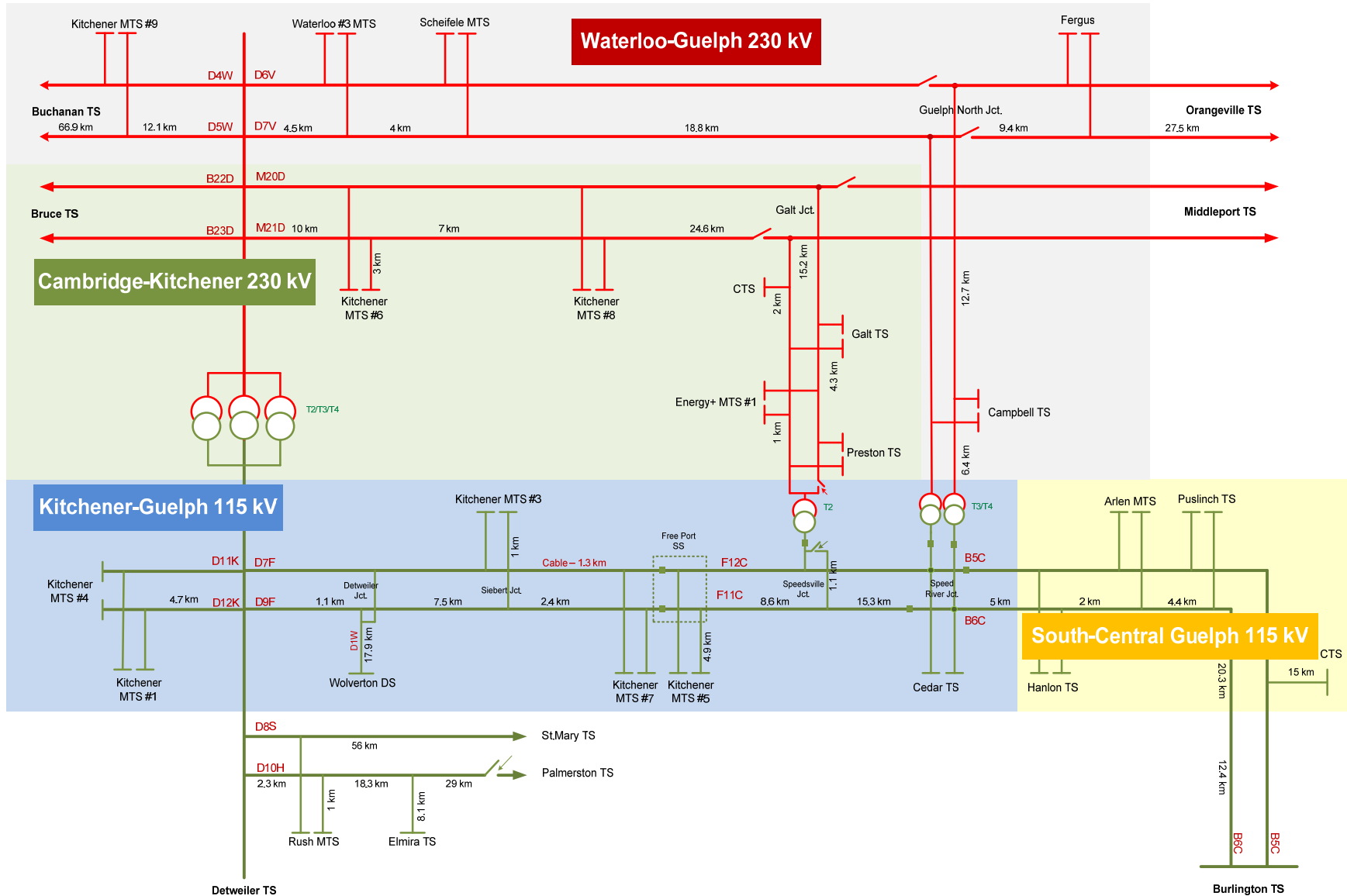


Figure 2: KWCG Region (Single Line Diagram)

5 INPUTS AND DATA

Study Team participants, including representatives from LDCs, IESO, and Hydro One provided information and input for the KWCG Region NA. The information provided includes the following:

- KWCG Load Forecast for all supply stations;
- Known capacity and reliability needs, operating issues, and/or major assets approaching the end of their useful life (“EOL”); and
- Planned/foreseen transmission and distribution investments that are relevant to regional planning for the KWCG Region.

6 ASSESSMENT METHODOLOGY

The following methodology and assumptions are made in this Needs Assessment:

Information gathering included:

- i. Load forecast: The relevant LDCs provided load forecasts for all the stations supplying their loads in the KWCG region for the 10 year study period. The IESO provided a Conservation and Demand Management (“CDM”) and Distributed Generation (“DG”) forecast for the KWCG region. The region’s extreme summer non-coincident peak gross load forecast for each station were prepared by applying the LDC load forecast load growth rates to the actual 2018 summer peak extreme weather corrected loads. The extreme summer weather correction factors were provided by Hydro One. The net extreme weather summer load forecasts were produced by reducing the gross load forecasts for each station by the % age CDM and then by the amount of effective DG capacity provided by the IESO for that station. These extreme weather summer load forecast for the individual stations in the KWCG region is given in Appendix A;
- ii. Relevant information regarding system reliability and operational issues in the region; and
- iii. List of major HV transmission equipment planned and/or identified to be refurbished and/or replaced due to the end of their useful life which is relevant for regional planning purposes. This includes HV transformers, autotransformers, HV Breakers, HV underground cables and overhead lines.

A technical assessment of needs was undertaken based on:

- Current and future station capacity and transmission adequacy;
- System reliability and operational concerns; and
- Any major high voltage equipment reaching the end of its useful life.

In addition, Hydro One has reviewed the Community Energy Plans in the region. It is worth noting that there are several community energy plans in the region and some of them are meant to sustain at the

current level or reduce the community’s reliance on the provincial electric system by meeting future electricity needs with local, distributed resources and/or community-based solutions. These plans may have potential to supplement and/or defer future transmission infrastructure development needs.

7 NEEDS

This section describes emerging needs identified in the KWCG Region, and also reaffirms the near, mid, and long-term needs already identified in the previous regional planning cycle.

The recent load forecast prepared for this report is lower than that of the previous cycle of regional planning. A contingency analysis was performed for the region and due to reduced load forecasts, as expected; no new system needs were identified.

The newly identified/emerging needs pertaining to this NA will be discussed further in the following sub-sections, while the status of the previously identified needs is summarized in Table 2 below.

Table 2: Needs Identified in the Previous Regional Planning Cycle

Type of Needs identified in the previous RP cycle	Needs Details	Current Status
115kV System Supply Capacity	GATR Project Two new additional 230/115kV autotransformers at Cedar TS to reinforce supply to both 115kV sub-systems in the region.	Completed
230kV Load Restoration Needs	GATR Project Two new additional 230 kV in-line switches on D6V/D7V circuits to improve restoration capability of Waterloo-Guelph 230 kV sub-system.	Completed
	Galt Junction Two new additional 230kV in-line switches on M20D/M21D circuits to improve restoration capability of the Cambridge-Kitchener 230 kV sub-system.	Completed
Station Short Circuit Capacity	Arlen MTS Install 13.8 kV series reactors to mitigate LV bus short circuit levels.	Completed
Station Transformation Capacity	New Waterloo North Hydro: MTS #4 (2024).	Need is now expected beyond 2029.

7.1 End-Of-Life (EOL) Equipment Needs

Hydro One and LDCs have provided high voltage asset information under the following categories that have been identified at this time and are likely to be replaced over the next 10 years:

- Autotransformers
- Power transformers
- HV breakers
- Transmission line requiring refurbishment where an uprating is being considered for planning needs and require Leave to Construct (i.e., Section 92) application and approval
- HV underground cables where an uprating is being considered for planning needs and require EA and Leave to Construct (i.e., Section 92) application and approval

Accordingly, following major high voltage equipment has been identified as approaching its end of useful life over the next 10 years.

Table 3: End-of-Life Equipment – KWCG Region

EOL Asset Replacement/ Refurbishment	Replacement/ Refurbishment Timing	Details
Projects in Execution		
Campbell TS (T1/T2 DESN): T1 Supply Transformer	2018	These Project are discussed further in Section 7.1.1
Detweiler TS: 230/ 115 kV T2/ T4 Auto-transformers	2021-2022	
115 kV B5C/ B6C: Burlington TS to Westover CTS Line Sections	2019-2020	
New Identified Projects		
115 kV D7F/ D9F : Tower #157 to Freeport SS Line Section	2019-2020	These Project are discussed further in Section 7.1.2
230 kV D6V/ D7V: Guelph North Jct. to Fergus Jct. Line Section	2019-2020	
Kitchener MTS #5^[1]: T9/T10 Supply Transformers	2023-2024	
Hanlon TS: T1/T2 Supply Transformers	2023-2024	
Cedar TS: T7/T8 Supply Transformers	2024-2025	
Scheifele MTS^[1]- T1/T2 Supply Transformers	2024-2026	
Preston TS: T3/T4 Supply Transformers	2025-2026	

[¹] LDC owned assets

The end-of-life assessment for the above high voltage equipment typically included consideration of the following options:

1. Maintaining the status quo;
2. Replacing equipment with similar equipment of lower ratings and built to current standards;
3. Replacing equipment with lower ratings and built to current standards by transferring some load to other existing facilities;
4. Eliminating equipment by transferring all of the load to other existing facilities;
5. Replacing equipment with similar equipment and built to current standards (i.e., “like-for-like” replacement);
6. Replacing equipment with higher ratings and built to current standards; and
7. Station reconfiguration

Maintaining status quo is not an option for any of the above EOL autotransformer, station transformer or line sections due to risk of equipment failure, would result in increased maintenance cost and customer outages. Replacing “Like-for-Like” with nonstandard transformers would result in complexity with failures and difficulty in getting similar spare equipment along with their installation. Nonstandard equipment also poses serious safety risk for employees under normal and emergency situations.

No other lines or HV station equipment in the KWCG region have been identified for major replacement/refurbishment at this time. If and when new and/or additional information is available, it will be provided during the next planning phase underway at the time.

7.1.1 Projects in Execution

The following end-of-life refurbishment needs are under execution. This region was deemed to be in transition and NA for this region was deemed complete. Hence, following projects were not listed or discussed in the first cycle of regional planning and are currently in execution:

Campbell TS – T1 Transformer

Campbell TS is located in the city of Guelph supplying Guelph Hydro Electric System Inc. loads. Campbell TS has two 230/ 13.8 kV DESNs T1/T2 and T3/T4 of 75 MVA transformers with an LTR of 105 MVA (94 MW @ 0.9 PF) and 63 MVA (56 MW @ 0.9 PF) respectively. The loads on these two DESNs are currently forecasted to be about 87 MW and 66 MW respectively by the end of study period.

The 75 MVA T1/T2 DESN transformer T2 failed in 2017 and was replaced with a new standard 100 MVA unit and transformer T1 is also being replaced with a similar unit. In 2021-2022, Hydro One in addition plans to replace the secondary equipment limiting the station LTR. This will result in sufficient LTR of about 130 MVA for T1/T2 DESN, over the study period.

The replacement of T1 transformer is currently in execution and expected to be completed by the end of year 2018.

Detweiler TS - T2 & T4 Autotransformers

Detweiler TS is a Bulk System, major switching and autotransformer station located in the city of Kitchener. Detweiler TS facilities include a 230 kV switchyard, three 230/115 kV autotransformers (T2/T3/T4) and a 115 kV switchyard.

The Detweiler TS autotransformers T2/T3/ T4 were built in 1959, 2004 and 1963 respectively. The condition assessment has identified T2 and T4 autotransformers as EOL requiring replacement. At this time none of other HV equipment at this station has been identified as approaching EOL over the next 5-10 years.

Not replacing these auto transformers would increase risk of failure due to asset condition, maintenance expenses and reduce supply reliability to the customers. The replacement of both the EOL Detweiler TS T2 and T4 autotransformers with similar units is in execution expected to be completed in 2021-22. This will address the 230/ 115 kV transformation needs at Detweiler TS and maintain station's operability and reliability of supply.

Any Detweiler TS 230 kV system reconfiguration needs will be studied under bulk system planning expected to commence in early 2019.

115 kV B5C/ B6C Line Sections

The 115 kV B5C/B6C circuits consist of about 45 km of double circuit line and 15 km of single circuit line supplying South-Central Guelph 115 kV loads. About 12 km of double circuit line section from Burlington TS to Harper's Jct. and about 15 km B5C 115 kV line tap from Harper's Jct. to a Westover Jct. requires refurbishment.

Not refurbishing these line sections would increase risk of failure due to asset condition, maintenance expenses and reduce supply reliability to the customers.

The refurbishment of this 27 km long 115 kV B5C/B6C line sections from Burlington TS to a CTS is currently under execution and the work is planned to be completed by the end of year 2019.

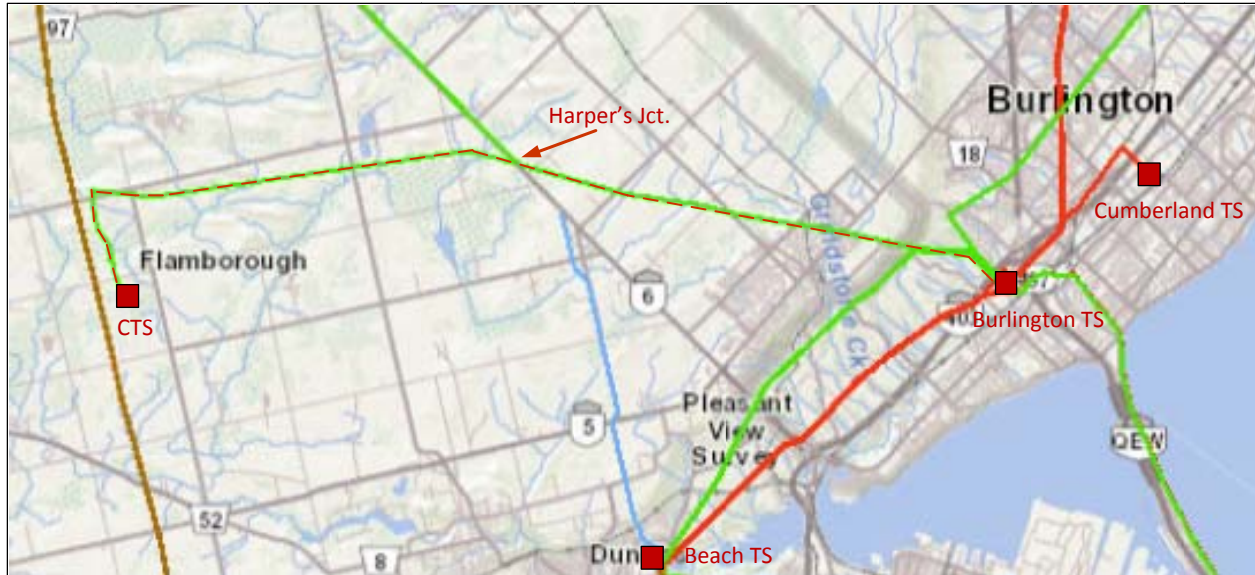


Figure 3: Burlington TS to Harper's Jct. to CTS B5C/ B6C Line Sections

7.1.2 New Needs

The following end-of-life refurbishment needs have been identified in this regional planning cycle:

115 kV D7F/D9F Line Section

The 115 kV D7F/ D9F double circuit line is about 12 km long supplying Kitchener- Guelph 115 kV loads. The 115 kV D7F/ D9F double circuit 450 meter line section from Tower 157 to Freeport Switching Station was built in 1951. It is approaching end of life and requires refurbishment.

Not refurbishing this line section would increase risk of failure due to asset condition, maintenance expenses and reduce supply reliability to the customers.

Therefore the Study Team recommends Hydro One to continue with refurbishment of the 450 meter long 115 kV D7F/ D9F end of life line section from Tower 157 to Freeport Switching Station. This project is currently under estimating and is planned to be completed by the end of year 2019.

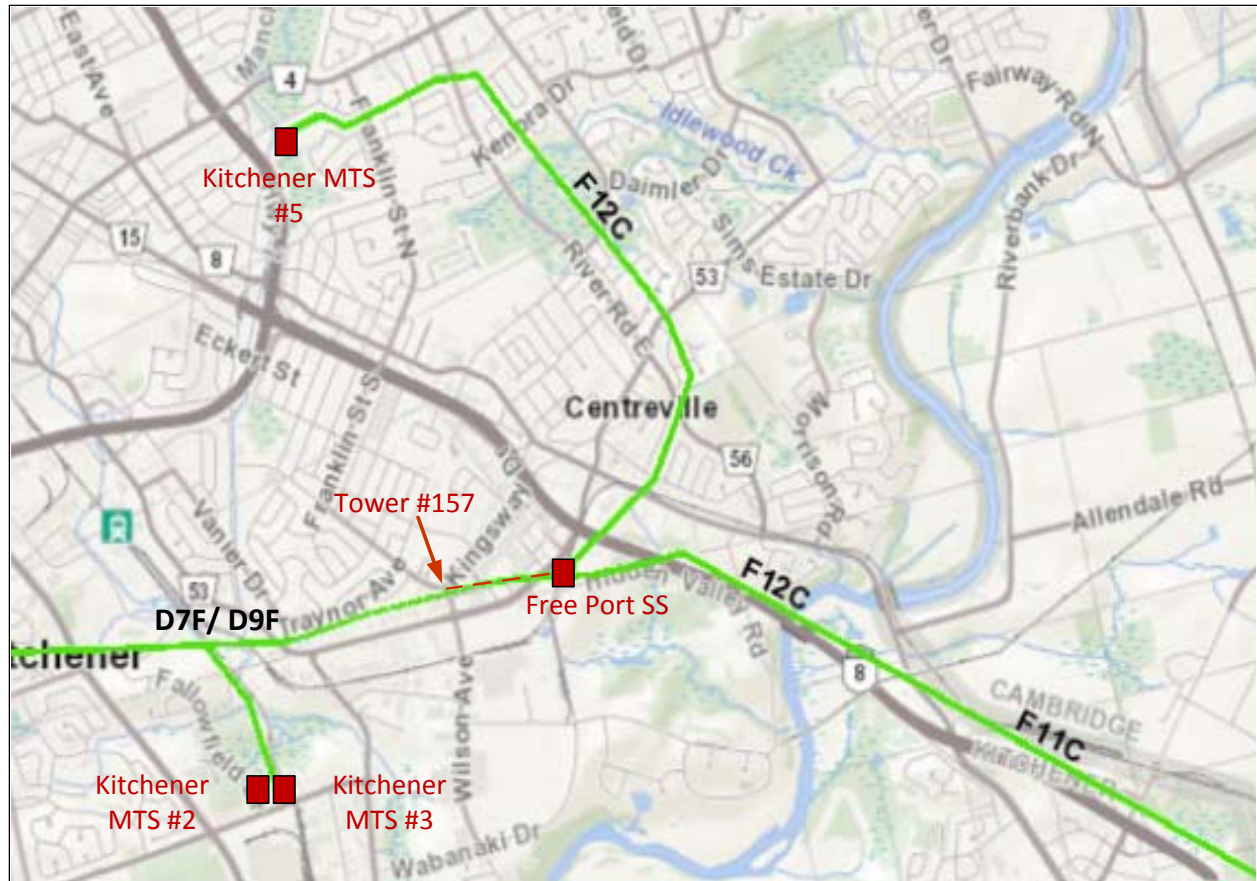


Figure 4: Tower #157 Jct. to Freeport SS F11C/ F12C Line Section

230 kV D6V/D7V Line Section

The 230 kV D6V/D7V double circuit line is about 84 km long and is part of bulk power system supplying loads in the Waterloo Guelph 230kV and South Central Guelph 115 kV loads. A 230 kV D6V/ D7V 9.5 km double circuit line section from Guelph North junction to Fergus TS was built in 1950's and its conductor is approaching end of life. It requires refurbishment.

Not refurbishing this line section would increase risk of failure due to asset condition, maintenance expenses and reduce supply reliability to the customers.

Therefore the Study Team recommends to refurbish this the 9.5 km long 230 kV D6V/D7V end of life line section from Guelph North Junction to Fergus TS. This project is currently under estimating and is planned to be completed by the end of year 2019.

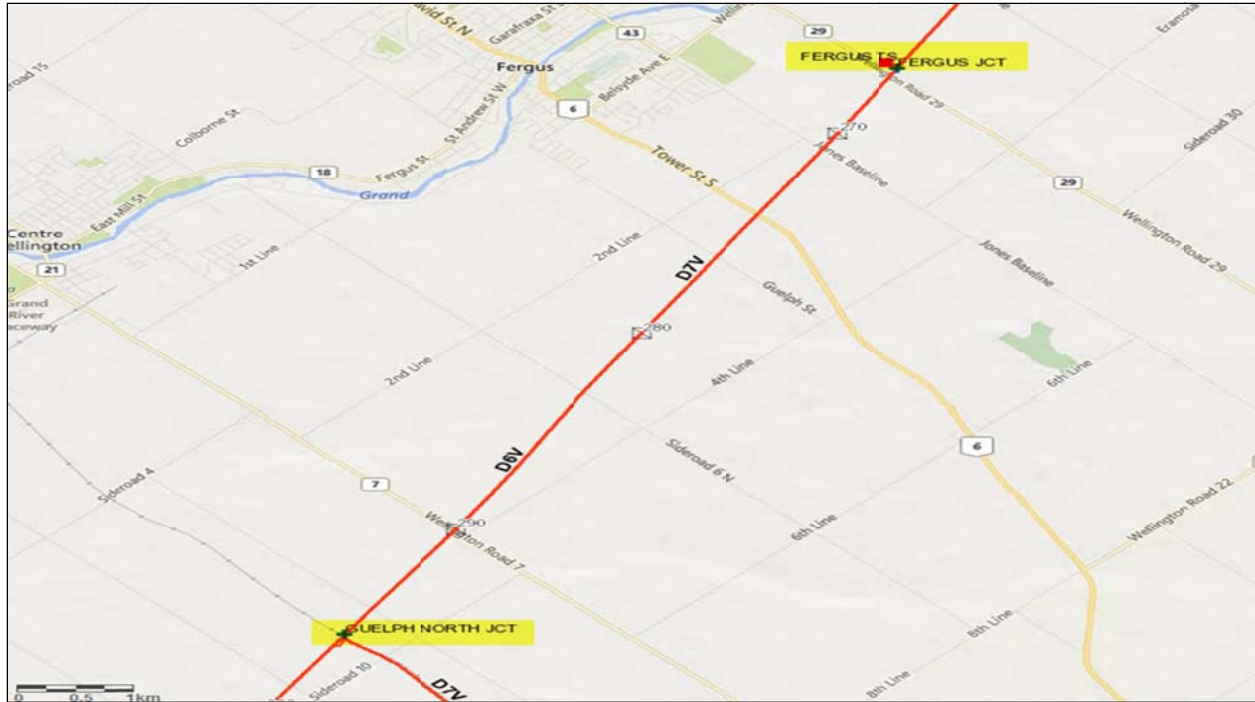


Figure 5: Guelph North Jct. to Fergus TS D6V/ D7V Line Section

Kitchener MTS #5 T9/T10 Transformers

Kitchener MTS #5 is located in the city of Kitchener supplying Kitchener-Wilmot Hydro Inc. loads. Kitchener MTS #5 is a 115/ 13.8 kV single T9/T10 DESN station of 83 MVA nonstandard transformers having a LTR of 89 MVA (80 MW @ 0.9 PF), currently supplying 67 MW of peak load. The loads at Kitchener MTS #5 are currently forecasted to remain flat over the entire study period. The supply capacity of this station is therefore expected to be sufficient over and beyond the study period.

Both the T9/T10 transformers at this station have been identified as approaching end of life requiring replacement. At this time none of other HV/LV equipment at this station has been identified as approaching EOL over the next 5-10 years.

The station cannot be downsized or eliminated because there is no nearby supply station/s to Kitchener MTS #5 having surplus capacity where this station's loads can be transferred. The Study Team recommends replacing the T9/T10 nonstandard transformers with standard units of similar size is the preferred option. Kitchener-Wilmot Hydro Inc. and Hydro One will coordinate the replacement plan of these transformers. The replacement of the EOL equipment is expected to be completed by 2023-2024.

Hanlon TS T1/T2 Transformer

Hanlon TS is located south of the city of Guelph supplying Guelph Hydro Electric System Inc. loads. Hanlon TS is a single T1/T2 DESN station of 33 MVA nonstandard transformers having a LTR of 48

MVA (43 MW @ 0.9 PF). This station is currently supplying about 27 MW of peak load. The loads at Hanlon TS are currently forecasted to remain flat over the entire study period. The supply capacity of this station is therefore expected to be sufficient over and beyond the study period.

The T1/T2 transformers are of 1955/ 56 built and have been identified as EOL requiring replacement. At this time none of other HV/LV equipment at this station has been identified as approaching EOL over the next 5-10 years.

There is no nearby supply station/s to Hanlon TS having surplus capacity where this station's loads can be transferred therefore Hydro One plans to replace these EOL transformers with standard size units of 42 MVA in 2023-2024.

Cedar TS – T7/ T8 Transformers

Cedar TS is located in the city of Guelph supplying Guelph Hydro Electric System Inc. loads. Cedar TS has two 115/ 13.8 kV DESN units T1/T2 and T7/T8 of 75 MVA with a LTR of 115 MVA (103 MW @ 0.9 PF) and 37 MVA with a LTR of 44 MVA (40 MW @ 0.9 PF), currently supplying 67 MW and 36 MW of peak loads respectively. The loads at both Cedar TS DESNs are currently forecasted to remain almost flat over the entire study period. The supply capacity of this station is therefore expected to be sufficient over and beyond the study period.

The T7/T8 DESN 38 MVA nonstandard transformers are of 1958 built have been identified for replacement. The T1/T2 transformers are relatively newer and were built in early 1990s. At this time none of other HV/LV equipment at this station has been identified as approaching EOL over the next 5-10 years.

The station cannot be downsized or eliminated because there is no nearby supply station/s to Cedar TS having surplus capacity where this station's loads can be transferred therefore Hydro One plans to replace these EOL transformers with standard size units of 42 MVA in 2024-2025 timeframe.

Cedar TS and Hanlon TS Optimization with Neighbouring Stations

After performing an analysis of the current distribution situation, it was determined that there are not enough spare feeder positions at HONI and GHESI stations to reallocate DESN loads in the sub-system without significant distribution system and neighboring station upgrades.

Over loading of Campbell DESN T3/T4 will be effectively managed by load transfer to DESN T1/T2 after 2021/22. Following that there will be no additional capacity at these two DESNs.

Secondly, Hanlon TS DESN has eight (8) feeders with three (3) being dedicated underground infrastructure to existing customers, two (2) feeders supplying the industrial load in the Hanlon Industrial Park, two (2) feeder circuits supplying residential load north of Hanlon TS and one (1) feeder to be utilized for planned future load growth at Gordon/ Clair. In addition, due to technical limitations at 13.8 kV distribution voltage and density of load on certain feeders sections, it is not possible to supply existing

loads from any other station without significant transmission and distribution investments. Therefore there are little or no significant optimization opportunity is present at this point in time. Option considered for load transfer will require significant new investment; for example:

- The two residential distribution feeders supplying loads north of Hanlon TS could be transferred to existing feeders out of Cedar TS. These load transfers will result in increased line losses and reduced capacity (due to voltage drop)
- Another option could be transferring remaining Hanlon TS load to Arlen MTS. This load transfer will require an additional DESN and underground infrastructure at Arlen MTS.

Hence, the Study Team recommends that Hydro One undertakes replacement of Cedar TS T7/T8 and Hanlon TS T1/T2 transformers with 42 MVA standard size units, being technically and economical most suitable solution. The replacement of EOL equipment is expected to be completed by 2023-2025 timeframe for both stations.

Scheifele MTS – T1/ T2 Transformers

Scheifele MTS is located in the city of Waterloo supplying Waterloo North Hydro Inc. loads. Scheifele MTS has four 230/ 13.8 kV transformers T1 and T2 of 67 MVA, and T3 and T4 of 83 MVA currently supplying 145 MW of peak loads. The load at this station is forecasted to remain almost flat over the entire study period. The total supply capacity of Scheifele MTS is 161 MW expected to be sufficient over the study period.

The T1/T2 transformers based on their age have been identified by Waterloo North Hydro Inc. as approaching end of life potentially requiring replacement in the 2024- 2026 timeframe. Waterloo North Hydro will be monitoring the condition of these transformers to assess their replacement need. At this time none of other HV/LV equipment at this station has been identified as approaching EOL over the next 5-10 years.

The station cannot be downsized or eliminated because there is no nearby supply station/s to Scheifele MTS having surplus capacity where this station's loads can be transferred. The Study Team recommends that Waterloo North Hydro continue monitoring the condition of these T1/T2 transformers at Scheifele MTS and this need to be reassessed in the next regional planning cycle.

Preston TS T3/T4 Transformers

Preston TS (DESN) is located in the city of Cambridge supplying Energy+ loads. Preston TS is a single T3/T4 DESN station of 125 MVA transformers with no additional LTR capability available i.e. 125 MVA (113 MW @ 0.9 PF). This station is currently supplying about 92 MW of peak load. The loads at Preston TS are currently forecasted to peak at about 102 MW during the study period.

The T3/T4 transformers are almost 50 years old, having been built in 1968. Condition assessment has identified that both T3/T4 transformers at their EOL requiring replacement. At this time none of other HV/LV equipment at this station has been identified as EOL over the next 5-10 years.

The station cannot be downsized or eliminated because there is no nearby supply station/s to Preston TS having spare supply capacity where this station's loads can be transferred. The Study Team recommends replacing the existing 125 MVA 230/ 27.6 kV T3/T4 transformers at Preston TS with 125 MVA standard units. This will also result in an increased supplying capacity at Preston TS required to meet the future Energy+ needs in the Cambridge distribution area. The replacement plan for the equipment will be developed by Hydro One and coordinated with the affected LDC and/or customers and it is expected to be completed by 2025-2026.

7.2 Supply Reliability Needs

Supply reliability of Elmira TS –D10H 115 kV Line

The 115 kV D10H circuit between Detweiler TS and Hanover TS supplies loads at Rush MTS, Elmira TS and Palmerston TS. The D10H circuit has a normally open point just south of Palmerston TS through a motorized disconnect switch. The northern section of D10H is supplied from Hanover TS radially supplying Palmerston TS loads. The southern section of D10H supplied from Detweiler TS radially supplies Waterloo North Hydro's 34 MW Elmira TS peak loads. D10H also supplies Rush MTS which is also supplied by 115 kV D8S circuit from Detweiler TS.

The normally open motorized switch near Palmerston TS helps restore the loads at Elmira TS from Hanover TS in-case supply from Detweiler TS is interrupted and similarly helps restoring Palmerston TS loads from Detweiler if supply from Hanover is interrupted.

In last three years, supply to Elmira TS from Detweiler TS resulted in 3 outages due to faults on the D10H line section between Elmira TS tap and Detweiler TS. The Elmira TS load restoration from Hanover TS is slower due to manually operated disconnect switches at Elmira TS tap location.

Hydro One is currently assessing the condition of line and will continue to work with Waterloo North Hydro to address the supply reliability at Elmira TS. The developed mitigation plan to improve supply reliability of Elmira TS loads will be included in the final RIP report.

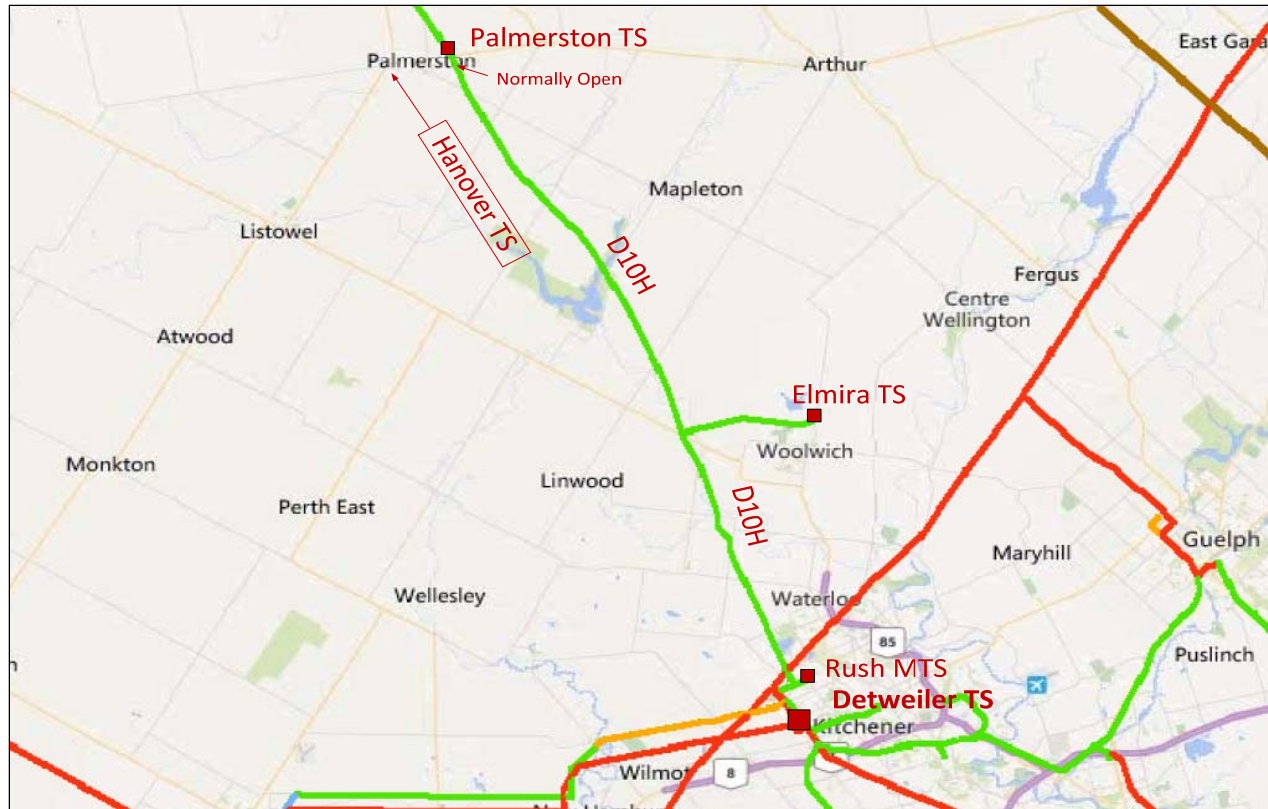


Figure 6: D10H 115 kV Line (Burlington TS to Elmira TS)

7.3 Station and Transmission Capacity Needs in the KWCG Region

The following Station and Transmission supply capacities needs have been identified in the KWCG region during the study period of 2019 to 2028.

7.3.1 Campbell TS (T3/T4) DESN Overloading

There are two DESN stations inside Campbell TS boundary. Both the T1/T2 and T3/T4 DESNs are 230 kV/ 13.8 kV having supply capacities of 94 MW and 56 MW, currently supplying 84 MW and 52 MW of loads respectively. The 75 MVA transformer T2 recently failed and was replaced with a Hydro One standard 100 MVA unit. The transformer T1 is also being replaced with a similar 100 MVA unit by the end of 2018. The load at T3/T4 DESN is forecasted to exceed its supply capacity of 56 MW in the 2021-2022 timeframe.

At Campbell TS, after replacement of T1 transformer and secondary equipment there will be sufficient spare supply capacity on T1/T2 DESN where excess T3/T4 DESN loads can be transferred. Hydro One Transmission and the Guelph Hydro Electric System Inc. will monitor the loading at the T3/T4 Campbell TS DESN and will balance the loads between the two DESNs, when required. The Study Team therefore recommends that no further action is required at this time.

7.3.2 Waterloo North Hydro MTS #4

During the last regional planning cycle a need for a new MTS #4 DESN was identified in the 2024 timeframe. The current load forecast defers this need beyond the needs assessment study period.

7.3.3 Energy+ MTS #2

Energy+ has initially identified a future need for a new DESN station (MTS #2) in the city of Cambridge near Preston TS. This station need is due to a potential new load center growth in their service territory. The additional supply capacity due to EOL transformer replacement and available new feeder positions at Preston TS, will defer this new MTS need beyond the study period of current regional planning cycle.

WNH MTS #4 and Energy+ MTS #2 Optimization

The Preston TS like-for-like transformer replacement is critical for local supply needs and will proceed according to the current plan. However, study team recommends that the supply capacity needs with regards to Energy + MTS #2 and WNH MTS #4 be further assessed for optimization in the next phases of regional planning. Once the optimization options are complete, Waterloo North Hydro and Energy+ shall conduct a technical and economic assessment in consultation with Hydro One.

7.4 Other Planning Considerations in the KWCG Region

Municipalities in KWCG region have developed their community energy plans with a primary focus to reduce their energy consumption by local initiatives over next 25 to 30 years. With respect to electricity, these communities are planning for an increased reliance on community energy sources such as distributed generation, generation behind the meters like rooftop solar systems and local battery storage systems to reduce cost and for improved reliability of electricity supply.

There are situations where behind the meter battery storage cannot be connected due to technical constraints. The LDCs in this region and Hydro One, outside the regional planning forum, can undertake the task of exploring the issue to assess technical constraints and /or other solutions that can facilitate connection of additional battery storage.

Communities are also working towards self-sufficiency by improving efficiencies of existing local energy systems i.e. reducing energy consumption and losses by means of utilizing smarter buildings, houses, efficient heating, cooling, appliances, equipment, and processes for all community needs. Ultimately, the objective of these energy plans in the region is to be a net zero carbon community.

Community energy plans may have potential to supplement and/or defer future transmission infrastructure development needs. The Study Team therefore recommends reviewing the community energy plans in the SA phase.

8 CONCLUSION AND RECOMMENDATIONS

Hydro One and Waterloo North Hydro Inc. will develop a supply reliability improvement plan for Elmira TS loads. The developed local plan to improve supply reliability of Elmira TS loads will be included in the final RIP report.

At Campbell TS, after replacement of T1 transformer and addressing the secondary equipment limitations there will be sufficient spare supply capacity on T1/T2 DESN to accommodate T3/T4 DESN overloading. Hydro One and the LDC will work together to balance loads between the two Campbell TS DESNs, when required.

The distribution system in the Cedar TS, Hanlon TS and Arlen MTS supply area is already optimized and there are not enough spare feeder positions at any of the stations to reallocate DESN loads without significant distribution system investments and upgrades at neighboring stations.

The Study Team's recommendations for the above identified needs are as follows:

- a) The replacement of EOL station supply transformers at Campbell TS, Hanlon TS, Cedar TS, Kitchener MTS #5 and Preston TS along with the EOL auto transformers at Detweiler to proceed. Hydro One and the concerned LDCs will coordinate replacement of above equipment and develop replacement plans.
- b) The refurbishment of EOL line sections 115 kV B5C/ B6C, D7F/ D9F and 230 kV D6V/ D7V to proceed. Hydro One will coordinate refurbishment of these line sections with affected LDCs/ Customer.
- c) Hydro One will continue to work with Waterloo North Hydro Inc. to address the supply reliability issue at Elmira TS.
- d) The Study Team has recommended that Hydro One Transmission and the Guelph Hydro Electric System Inc. to closely monitor the loading at the T3/T4 Campbell TS DESN and to balance the loads between these DESNs when required.
- e) The Study Team recommends that the supply capacity needs with regards to Energy + MTS #2 and WNH MTS #4 be further assessed for optimization in the SA phase of regional planning. Once the optimization options are complete, Waterloo North Hydro and Energy+ shall conduct a technical and economic assessment in consultation with Hydro One.
- f) The Study Team has recommended that community energy plans will be further considered in the SA phase of the regional planning process.

9 REFERENCES

- [1] [KWCG Regional Infrastructure Plan - December 2015](#)
- [2] [Planning Process Working Group Report to the Ontario Energy Board - May 2013](#)
- [3] [Ontario Resource and Transmission Assessment Criteria \(ORTAC\) – Issue 5.0 -August 2007](#)

Appendix A: KWCG Region Non-Coincident Summer Load Forecast

* LTR based on 0.9 power factor

Transformer Station		Summer 10 Day LTR*	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	
Arlen MTS	Gross	45	24.44	25.17	25.92	26.70	27.50	28.33	29.18	30.05	30.95	31.88	32.84	33.82	
	CDM		0.00	0.22	0.28	0.44	0.57	0.79	1.12	1.50	2.05	2.71	3.40	3.99	
	DG		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	Net		24.42	24.94	25.64	26.25	26.92	27.53	28.04	28.54	28.89	29.16	29.43	29.83	
Campbell TS (T1/T2)	Gross	94	83.46	84.71	85.98	87.27	88.58	89.91	91.26	92.63	94.02	95.43	96.86	98.31	
	CDM		0.00	0.72	0.91	1.44	1.83	2.50	3.51	4.63	6.22	8.11	10.03	11.59	
	DG		0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	
	Net		83.45	83.98	85.06	85.82	86.75	87.40	87.74	87.99	87.78	87.30	86.82	86.72	
Campbell TS (T3/T4)	Gross	56	51.62	53.42	55.29	57.23	59.23	61.30	63.45	65.67	67.97	70.35	72.81	75.36	
	CDM		0.00	0.46	0.59	0.94	1.22	1.70	2.44	3.28	4.50	5.98	7.54	8.88	
	DG		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	Net		51.62	52.97	54.71	56.28	58.01	59.60	61.01	62.39	63.47	64.37	65.27	66.48	
Cedar TS (T1/T2)	Gross	103	67.35	67.69	68.03	68.37	68.71	69.05	69.40	69.75	70.09	70.44	70.80	71.15	
	CDM		0.00	0.58	0.72	1.13	1.42	1.92	2.67	3.49	4.64	5.99	7.33	8.38	
	DG		0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	
	Net		67.30	67.06	67.26	67.19	67.24	67.09	66.68	66.21	65.40	64.41	63.42	62.72	
Cedar TS (T7/T8)	Gross	40	35.63	35.80	35.98	36.16	36.34	36.53	36.71	36.89	37.08	37.26	37.45	37.63	
	CDM		0.00	0.31	0.38	0.60	0.75	1.01	1.41	1.85	2.45	3.17	3.88	4.44	
	DG		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	Net		35.63	35.50	35.60	35.57	35.59	35.51	35.29	35.05	34.62	34.09	33.57	33.20	
Elmira TS	Gross	55	34.19	34.62	35.04	35.38	35.73	36.06	36.39	36.71	37.05	37.40	37.75	38.10	
	CDM		0.00	0.30	0.37	0.58	0.74	1.00	1.40	1.84	2.45	3.18	3.91	4.49	
	DG		0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	
	Net		34.17	34.31	34.65	34.78	34.98	35.04	34.97	34.86	34.58	34.20	33.83	33.60	
Energy+ MTS #1	Gross	102	84.03	84.87	85.72	86.58	87.44	88.53	89.64	90.76	91.90	93.05	94.21	95.39	
	CDM		0.00	0.73	0.91	1.43	1.80	2.46	3.45	4.54	6.08	7.91	9.75	11.24	
	DG		0.32	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	
	Net		83.71	83.65	84.31	84.65	85.15	85.58	85.70	85.73	85.32	84.64	83.96	83.65	
Fergus TS	Gross	154	87.52	88.57	89.62	90.27	90.96	91.52	92.07	92.62	93.20	93.83	94.45	95.05	
	CDM		0.00	0.76	0.95	1.49	1.87	2.54	3.54	4.63	6.17	7.98	9.78	11.20	
	DG		0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	
	Net		87.47	87.77	88.62	88.73	89.03	88.92	88.48	87.94	86.98	85.80	84.62	83.80	
Galt TS	Gross	169	113.56	114.69	115.84	117.00	118.17	119.64	121.14	122.65	124.19	125.74	127.31	128.90	
	CDM		0.00	0.98	1.23	1.93	2.44	3.32	4.66	6.14	8.22	10.69	13.18	15.19	
	DG		0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	
	Net		113.35	113.51	114.40	114.86	115.53	116.11	116.27	116.31	115.76	114.84	113.93	113.51	
Hanlon TS	Gross	43	26.85	27.25	27.66	28.08	28.50	28.93	29.36	29.80	30.25	30.70	31.16	31.63	
	CDM		0.00	0.23	0.29	0.46	0.59	0.80	1.13	1.49	2.00	2.61	3.23	3.73	
	DG		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	Net		26.85	27.02	27.37	27.62	27.91	28.12	28.23	28.31	28.25	28.09	27.94	27.90	
Kitchener MTS # 1	Gross	54	31.31	33.64	34.72	35.81	36.90	37.76	38.60	39.46	40.31	41.16	42.02	42.87	
	CDM		0.00	0.29	0.37	0.59	0.76	1.05	1.49	1.97	2.67	3.50	4.35	5.05	
	DG		0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	
	Net		31.28	33.33	34.33	35.19	36.11	36.68	37.09	37.47	37.62	37.64	37.65	37.79	
Kitchener MTS # 3	Gross	108	46.73	45.03	45.34	46.05	46.78	47.49	48.22	48.93	49.64	50.37	51.08	51.81	
	CDM		0.00	0.38	0.48	0.76	0.96	1.32	1.86	2.45	3.29	4.28	5.29	6.11	
	DG		0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	
	Net		46.71	44.63	44.83	45.27	45.79	46.15	46.34	46.46	46.34	46.06	45.77	45.68	

Transformer Station		Summer 10 Day LTR*	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	
Kitchener MTS # 4	Gross	90	58.39	59.76	60.63	61.49	62.36	63.05	63.73	64.41	65.09	65.77	66.46	67.13	
	CDM		0.00	0.51	0.64	1.01	1.29	1.75	2.45	3.22	4.31	5.59	6.88	7.91	
	DG		0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
	Net		58.34	59.19	59.93	60.43	61.02	61.24	61.22	61.14	60.73	60.12	59.52	59.17	
Kitchener MTS #5	Gross	80	66.56	67.94	68.82	69.70	70.58	71.28	71.96	72.66	73.35	74.03	74.73	75.42	
	CDM		0.00	0.58	0.73	1.15	1.45	1.98	2.77	3.63	4.86	6.29	7.74	8.89	
	DG		0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
	Net		66.50	67.31	68.03	68.49	69.07	69.24	69.14	68.97	68.43	67.68	66.94	66.47	
Kitchener MTS #6	Gross	90	64.17	62.22	62.97	63.71	64.47	65.21	65.96	66.70	67.44	68.19	68.93	69.68	
	CDM		0.00	0.53	0.67	1.05	1.33	1.81	2.54	3.34	4.46	5.80	7.14	8.21	
	DG		0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
	Net		64.08	61.60	62.21	62.57	63.04	63.30	63.33	63.27	62.88	62.30	61.70	61.38	
Kitchener MTS #7	Gross	54	42.79	43.98	44.69	45.38	46.08	46.77	47.47	48.16	48.85	49.55	50.24	50.95	
	CDM		0.00	0.38	0.48	0.75	0.95	1.30	1.83	2.41	3.23	4.21	5.20	6.00	
	DG		0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	
	Net		42.77	43.59	44.19	44.61	45.11	45.45	45.63	45.73	45.60	45.32	45.03	44.92	
Kitchener MTS #8	Gross	54	38.68	39.94	41.18	42.44	43.70	45.62	47.53	49.45	51.38	53.30	55.21	57.13	
	CDM		0.00	0.34	0.44	0.70	0.90	1.27	1.83	2.47	3.40	4.53	5.71	6.73	
	DG		0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	
	Net		38.62	39.54	40.69	41.68	42.74	44.30	45.65	46.92	47.92	48.71	49.44	50.34	
Kitchener MTS #9	Gross	90	30.16	30.72	31.28	31.83	32.39	32.94	33.50	34.05	34.61	35.17	35.73	36.27	
	CDM		0.00	0.26	0.33	0.52	0.67	0.92	1.29	1.70	2.29	2.99	3.70	4.27	
	DG		0.23	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	
	Net		29.94	29.96	30.45	30.80	31.22	31.53	31.71	31.85	31.82	31.68	31.53	31.50	
Preston TS	Gross	113	92.38	95.15	98.00	100.94	103.97	105.27	106.59	107.92	109.27	110.63	112.02	113.42	
	CDM		0.00	0.81	1.04	1.67	2.14	2.92	4.10	5.40	7.23	9.41	11.60	13.37	
	DG		0.00	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	
	Net		92.38	94.14	96.76	99.08	101.63	102.15	102.29	102.33	101.84	101.03	100.23	99.86	
Puslinch DS	Gross	56	28.49	29.24	30.01	30.45	30.92	31.30	31.68	32.05	32.45	32.88	33.31	33.72	
	CDM		0.00	0.25	0.32	0.50	0.64	0.87	1.22	1.60	2.15	2.80	3.45	3.97	
	DG		0.02	0.02	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	
	Net		28.47	28.98	29.54	29.80	30.14	30.29	30.31	30.30	30.16	29.94	29.71	29.60	
Rush MTS	Gross	68	45.33	46.24	47.16	48.11	49.07	50.05	51.05	52.07	53.11	54.17	55.26	56.36	
	CDM		0.00	0.40	0.50	0.79	1.01	1.39	1.97	2.60	3.52	4.61	5.72	6.64	
	DG		0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	
	Net		45.30	45.81	46.63	47.28	48.03	48.63	49.06	49.44	49.57	49.54	49.51	49.69	
Scheifele MTS	Gross	161	144.78	146.96	149.16	151.39	153.67	155.98	158.32	160.69	163.11	165.55	168.04	170.56	
	CDM		0.00	1.26	1.59	2.50	3.17	4.33	6.10	8.04	10.80	14.08	17.39	20.10	
	DG		0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	
	Net		144.70	145.62	147.49	148.81	150.42	151.56	152.14	152.57	152.23	151.40	150.56	150.38	
WNH MTS #3	Gross	77	56.29	57.42	58.57	59.74	60.93	62.15	63.39	64.66	65.95	67.27	68.62	69.99	
	CDM		0.00	0.49	0.62	0.99	1.26	1.73	2.44	3.23	4.37	5.72	7.10	8.25	
	DG		0.06	0.06	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	
	Net		56.23	56.87	57.80	58.61	59.53	60.28	60.81	61.28	61.44	61.41	61.37	61.60	
Wolverton DS	Gross	54	18.42	18.73	19.05	19.19	19.35	19.47	19.59	19.71	19.83	19.98	20.12	20.25	
	CDM		0.00	0.16	0.20	0.32	0.40	0.54	0.75	0.99	1.31	1.70	2.08	2.39	
	DG		0.00	0.00	0.00	0.00	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	
	Net		18.41	18.57	18.84	18.87	18.76	18.74	18.64	18.53	18.33	18.08	17.84	17.67	
CTS	Net		9.80	9.80	9.80	9.80	9.80	9.80	9.80	9.80	9.80	9.80	9.80	9.80	

Appendix B: Lists of Step-Down Transformer Stations

Sr. No.	Transformer Stations
1.	Arlen MTS
2.	Campbell TS (T1/T2)
3.	Campbell TS (T3/T4)
4.	Cedar TS (T1/T2)
5.	Cedar TS (T7/T8)
6.	Elmira TS
7.	Energy+ MTS #1
8.	Fergus TS
9.	Galt TS
10.	Hanlon TS
11.	Kitchener MTS # 1
12.	Kitchener MTS # 3
13.	Kitchener MTS # 4
14.	Kitchener MTS #5
15.	Kitchener MTS #6
16.	Kitchener MTS #7
17.	Kitchener MTS #8
18.	Kitchener MTS #9
19.	Preston TS
20.	Puslinch DS
21.	Rush MTS
22.	Scheifele MTS
23.	Waterloo North MTS 3
24.	Wolverton DS
25.	CTS - 1
26.	CTS - 2

Appendix C: Lists of Transmission Circuits

Sr. No.	Circuit ID	From Station	To Station	Voltage (kV)
1.	D6V/ D7V	Detweiler TS	Orangeville TS	220
2.	M20D/ M21D	Detweiler TS	Middleport TS	220
3.	D4W/ D5W	Detweiler TS	Buchanan TS	220
4.	B22D/ B23D	Detweiler TS	Bruce TS	220
5.	D7F/ D9F	Detweiler TS	Free Port SS	115
6.	F11C/ F12C	Free Port SS	Cedar TS	115
7.	B5C/ B6C	Cedar TS	Burlington TS	115
8.	D11K/ D12K	Detweiler TS	Kitchener MTS #4	115
9.	D8S	Detweiler TS	St. Mary TS	115
10.	D10H	Detweiler TS	Hanover TS	115

Appendix D: Lists of LDCs in the KWCG Region

Sr. No.	Company	Connection Type (TX/DX)
1.	Centre Wellington Hydro	Dx
2.	Energy+	Tx/ Dx
3.	Guelph Hydro Electric System Inc.	Tx/ Dx
4.	Halton Hills Hydro	Dx
5.	Hydro One Networks Inc. (Distribution)	Tx/ Dx
6.	Kitchener Wilmot Hydro Inc.	Tx
7.	Milton Hydro	Dx
8.	Waterloo North Hydro Inc.	Tx/ Dx
9.	Wellington North Power Inc.	Dx

Appendix E: Acronyms

Acronym	Description
A	Ampere
BES	Bulk Electric System
BPS	Bulk Power System
CDM	Conservation and Demand Management
CIA	Customer Impact Assessment
CGS	Customer Generating Station
CSS	Customer Switching Station
CTS	Customer Transformer Station
DESN	Dual Element Spot Network
DG	Distributed Generation
DS	Distribution Station
GS	Generating Station
HV	High Voltage
IESO	Independent Electricity System Operator
IRRP	Integrated Regional Resource Plan
kV	Kilovolt
LDC	Local Distribution Company
LP	Local Plan
LTE	Long Term Emergency
LTR	Limited Time Rating
LV	Low Voltage
MTS	Municipal Transformer Station
MW	Megawatt
MVA	Mega Volt-Ampere
MVAR	Mega Volt-Ampere Reactive
NA	Needs Assessment
NERC	North American Electric Reliability Corporation
NGS	Nuclear Generating Station
NPCC	Northeast Power Coordinating Council Inc.
NUG	Non-Utility Generator
OEB	Ontario Energy Board
OPA	Ontario Power Authority
ORTAC	Ontario Resource and Transmission Assessment Criteria
PF	Power Factor
PPWG	Planning Process Working Group
RIP	Regional Infrastructure Plan
SA	Scoping Assessment
SIA	System Impact Assessment
SPS	Special Protection Scheme
SS	Switching Station
STG	Steam Turbine Generator
TS	Transformer Station