NIAGARA

REGIONAL INFRASTRUCTURE PLAN

July 12, 2023

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Lead Transmitter:

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Prepared by:

Niagara Technical Working Group

DISCLAIMER

This Regional Infrastructure Plan (RIP) Report was prepared for the purpose of developing an electricity infrastructure plan to address electrical supply needs identified in previous planning phases and also any additional needs identified based on new and/or updated information provided by the RIP Technical Working Group (TWG).

The preferred solution(s) that have been identified in this report may be reevaluated based on the findings of further analysis. The load forecast and results reported in this RIP report are based on the information provided and assumptions made by the participants of the RIP Technical Working Group.

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EXECUTIVE SUMMARY

THIS REGIONAL INFRASTRUCTURE PLAN ("RIP") WAS PREPARED BY HYDRO ONE WITH SUPPORT FROM THE TECHNICAL WORKING GROUP IN ACCORDANCE WITH THE ONTARIO TRANSMISSION SYSTEM CODE REQUIREMENTS. IT IDENTIFIES INVESTMENTS IN TRANSMISSION FACILITIES, DISTRIBUTION FACILITIES, OR BOTH, THAT SHOULD BE DEVELOPED AND IMPLEMENTED TO MEET THE ELECTRICITY INFRASTRUCTURE NEEDS WITHIN THE NIAGARA REGION.

The participants of the Niagara Region Regional Infrastructure Plan ("RIP") Technical Working Group ("TWG") included members from the following organizations:

- Alectra Utilities Corporation ("Alectra")
- Canadian Niagara Power Inc. ("CNP")
- Grimsby Power Inc. ("Grimsby Power")
- Hydro One Networks Inc. (Distribution)
- Hydro One Networks Inc. (Transmission)
- Independent Electricity System Operator ("IESO")
- Niagara-on-the-Lake Hydro Inc. ("NOTL")
- Niagara Peninsula Energy Inc. ("NPEI")
- Welland Hydro Electric System Corp. ("Welland Hydro")

This RIP is the final phase of the second cycle of the Niagara Region regional planning (RP) process and it follows the completion of the Niagara Region Integrated Regional Resource Plan ("IRRP") [1] in December 2022; and the Niagara Region Needs Assessment ("NA") [2] and Scoping Assessment ("SA") in May 2021 and August 2021, respectively. This RIP provides a consolidated summary of needs and recommended plans for the Niagara Region over a 10-year planning horizon (2023-2032) based on available information. The load forecast for the 2033-2042 period is provided to show the longer-term needs and trend. All needs for this long-term horizon will be covered and confirmed in future regional planning cycles.

The first cycle of Regional Planning process was completed in March 2017 with the publication of the Niagara Region RIP [3], which provided a description of needs and recommendations of preferred wires plans to address near-term needs. Since the previous planning cycle, the following projects have been completed:

- Decew Falls SS (2017) – Five (5) 115kV breakers were replaced with sulfur hexafluoride (SF_6) equivalent breakers to improve supply reliability.

- Q4N Line Section Upgrade (2019) – Line section of 115kV Q4N circuit between Beck SS #1 x Portal Junction section (egress out from the generation station) was upgraded to meet load supply needs.

- A6C Line Section Refurbishment (2020) –115kV A6C circuit line conductor between Crowland TS and Port Colborne TS was replaced. The conductor needed replacement due to its asset condition.

- Stanley TS (2022) – The existing 40/53/67 MVA, 115/13.8 kV transformer T2 was replaced with a 45/60/75 MVA unit. This transformer needed replacement due to asset condition. Some 13.8kV switchyard components and protection and control equipment were also replaced due to asset condition.

- Port Colborne TS (2022) – The 28/37/47 MVA, 115/27.6 kV transformers T61 and T62 were replaced with 50/66.7/83.3 MVA units. These transformers needed replacement due to asset condition. The 27.6kV switchyard components and protection and control equipment were also replaced due to asset condition to improve the reliability of supply.

The recommended major infrastructure investments including assets replacements in the Niagara Region over the near and medium-term (2023-2032) period are given in Table 1 on the next page, along with their planned in-service date and budgetary estimate for planning purposes.

The Niagara Region TWG recommends that:

- Hydro One and LDCs continue with the implementation of infrastructure investments listed in Table 1 while keeping the TWG apprised of project status;
- All the other identified needs/options are to be further reviewed by the TWG in the next regional planning cycle.

The next regional planning cycle for the Niagara Region must be triggered within five years, beginning with the Needs Assessment (“NA”) phase. It is expected that the next NA will be initiated in 2026. However, the next regional planning cycle can be started earlier if required to address any new emerging needs.

Table 0-1 Niagara Region - Recommended Plans over the 2023-2032 Study Period

No.	Investments	I/S Date	Cost[1]
A	**Increase Capacity**		
1	230 kV circuit Q28A – Uprate circuit between Beck 2 SS and Abitibi Jct.	TBD	$3M
2	Lincoln Area: Build new 230/27.6 kV, 50/83 MVA transformer station	2026	$45M
4	Crowland TS: Convert station to 230 kV with new 230/27.6 kV, 75/125 MVA transformer station and build a new 18 km of double circuit line from Abitibi Jct to Crowland TS	2027	$128M
5	Murray TS: Uprate T11/T12 75 MVA transformers with new 100MVA units	2027	$41M
6	Carlton TS: Transfer excess load to Bunting TS	2029	$5M
B	**Asset Replacement**		
1	Thorold TS: Replace Transformer T1	2024	$43M
2	Glendale TS: Replace Transformers T1 and T2	2027	$55M
3	Carlton TS: Replace LV Switchgear	2027	$55M
4	Bunting TS: Replace existing Transformers T1 and T2	2029	$45M
5	Murray TS: Replace Transformers T13 and T14	2031	$27M
6	Vansickle TS: Replace LV Switchgear	2032	$14M
7	Allanburg TS: Replace Transformer T3	2032	$20M
8	115kV Line D1A/D3A: Refurbish line section between Gibson Jct and Thorold TS	2024	$4M
9	115kV Line Q2AH: Refurbish line section between Rosedene Jct. and St. Anns Jct.	2025	$10M

[1] These costs are budgetary estimates for planning purposes only.

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1 INTRODUCTION

THIS REPORT PRESENTS THE REGIONAL INFRASTRUCTURE PLAN ("RIP") TO ADDRESS THE ELECTRICITY NEEDS OF THE NIAGARA REGION.

The report was prepared by Hydro One Networks Inc. (Transmission) ("Hydro One") on behalf of the Niagara Region Technical Working Group ("TWG") in accordance with the regional planning process established by the Ontario Energy Board ("OEB") in 2013. The TWG included members from the following organizations:

- Alectra Utilities Corporation ("Alectra")
- Canadian Niagara Power Inc. ("CNP")
- Grimsby Power Inc. ("Grimsby Power")
- Hydro One Networks Inc. (Distribution)
- Hydro One Networks Inc. (Transmission)
- Independent Electricity System Operator ("IESO")
- Niagara-on-the-Lake Hydro Inc. ("NOTL")
- Niagara Peninsula Energy Inc. ("NPEI")
- Welland Hydro Electric System Corp. ("Welland Hydro")

The Niagara Region includes the Regional Municipality of Niagara as shown in Figure 1-1. It includes the Cities of Niagara Falls, Port Colborne, St. Catharines, Thorold and Welland, the Towns of Fort Erie, Grimsby, Lincoln, Niagara-on-the-Lake and Pelham and the Townships of Wainfleet and West Lincoln.

Electrical supply to the Niagara region is provided through a network of 230kV and 115kV transmission circuits supplied mainly by the local generation from Sir Adam Beck Generating Station (GS) #1, Sir Adam Beck GS #2, Decew Falls GS, Thorold GS and the 230kV/115kV autotransformers at Allanburg TS. Bulk supply is provided through the 230kV circuits (Q23BM, Q24HM, Q25BM, Q26M, Q28A, Q29HM, Q30M, and Q35M) connecting the Sir Adam Beck #2 Switching Station (SS) to stations in the Hamilton/Burlington area. The summer 2022 non-coincident peak load of the Region was about 977 MW.

Figure 1-1: Niagara Region Map

1.1 Scope and Objectives

This RIP report examines the needs in the Niagara Region. Its objectives are to:

- Identify new supply needs that may have emerged since previous planning phases (e.g., Needs Assessment, Scoping Assessment, Local Plan, and/or Integrated Regional Resource Plan);
- Assess and develop wires plans to address these needs;
- Provide the status of wires planning currently underway or completed for specific needs;
- Identify investments in transmission and distribution facilities or both that should be developed and implemented on a coordinated basis to meet the electricity infrastructure needs within the region.

The RIP reviews factors such as the load forecast, transmission and distribution system capability along with any updates with respect to local plans, conservation and demand management ("CDM"), renewable and non-renewable generation development, and other electricity system and local drivers that may impact the need and alternatives under consideration.

The scope of this RIP is as follows:

- A consolidated report of the needs and relevant wires plans to address near- and medium-term needs (2023-2032) identified in previous planning phases (Needs Assessment, Scoping Assessment, Local Plan, or Integrated Regional Resource Plan);
- Identification of any new needs over the 2023-2032 period and wires plans to address these needs based on new and/or updated information;
- Consideration of long-term needs identified by the TWG.

1.2 Structure

The rest of the report is organized as follows:

- Section 2 provides an overview of the regional planning process;
- Section 3 describes the region;
- Section 4 describes the transmission work completed over the last ten years;
- Section 5 describes the load forecast and study assumptions used in this assessment;
- Section 6 describes the results of the adequacy assessment of the transmission facilities and identifies the needs;
- Section 7 discusses the needs and provides the alternatives and preferred solutions; and,
- Section 8 provides the conclusion and next steps.

2 REGIONAL PLANNING PROCESS

2.1 Overview

Planning for the electricity system in Ontario is done at essentially three levels: bulk system planning, regional system planning, and distribution system planning. These levels differ in the facilities that are considered and the scope of impact on the electricity system. Planning at the bulk system level typically looks at issues that impact the system on a provincial level, while planning at the regional and distribution levels looks at issues on a more regional or localized level.

Regional planning looks at supply and reliability issues at a regional or local area level. Therefore, it largely considers the 115 kV and 230 kV portions of the power system that supply various parts of the province.

2.2 Regional Planning Process

A structured regional planning process was established by the Ontario Energy Board in 2013 through amendments to the Transmission System Code ("TSC") and Distribution System Code ("DSC"). The process consists of four phases: the Needs Assessment [1] ("NA"), the Scoping Assessment ("SA"), the Integrated Regional Resource Plan ("IRRP"), and the Regional Infrastructure Plan ("RIP").

The regional planning process begins with the NA phase which is led by the transmitter to determine if there are regional needs. The NA phase identifies the needs, and the Technical Working Group (TWG) determines whether further regional coordination is necessary to address them. If no further regional coordination is required, further planning is undertaken by the transmitter and the impacted local distribution company ("LDC") or customer and a Local Plan ("LP") is developed to address them. These needs are local in nature and can be best addressed by a straightforward wires solution.

In situations where identified needs require further coordination at the regional or sub-regional levels, the IESO initiates the SA phase. During this phase, the IESO, in collaboration with the TWG, reviews the information collected as part of the NA phase, along with additional information on potential non-wires alternatives, and decides on the most appropriate regional planning approach. The approach is either a RIP, which is led by the transmitter, or an IRRP, which is led by the IESO. If more than one sub-region was identified in the NA phase, it is possible that a different approach could be taken for different sub-regions.

[1] also referred to as Needs Screening

The IRRP phase will generally assess infrastructure (wires) versus resource (CDM and Distributed Generation) options at a higher or more macro level, but sufficient to permit a comparison of options. If the IRRP phase identifies that infrastructure options may be most appropriate to meet a need, the RIP phase will conduct detailed planning to identify and assess the specific wires alternatives and recommend a preferred wires solution. Similarly, resource options which the IRRP identifies as best suited to meet a need are then further planned in greater detail by the IESO. The IRRP phase also includes IESO led stakeholder engagement with municipalities in the region or sub-region.

The RIP phase is the final stage of the regional planning process and involves confirmation of previously identified needs; identification of any new needs that may have emerged since the start of the planning cycle; and development of a wires plan to address these needs. This phase is led and coordinated by the transmitter and the deliverable of this stage is a comprehensive and consolidated report of a wires plan for the region. Once completed, this report can be referenced in rate filing submissions and as part of LDC rate applications with a planning status letter provided by the transmitter to the LDC(s). Respecting the OEB timeline provision of the RIP, plan level stakeholder engagement is not undertaken during this phase. However, stakeholder engagement at a project specific level will be conducted as part of the project approval requirement.

To efficiently manage the regional planning process, Hydro One has been undertaking wires planning activities in collaboration with the IESO and LDCs for the region as part of and/or in parallel with:

- Planning activities that were already underway in the region prior to the regional planning process taking effect;
- The NA, SA, IRRP and LP phases of regional planning;
- Conducting wires planning as part of the RIP for the region or sub-region;
- Planning for connection capacity requirements with the LDCs and transmission connected customers.

Figure 2-1 illustrates the various phases of the regional planning process (NA, SA, IRRP, and RIP) and their respective phase trigger, lead, and outcome.

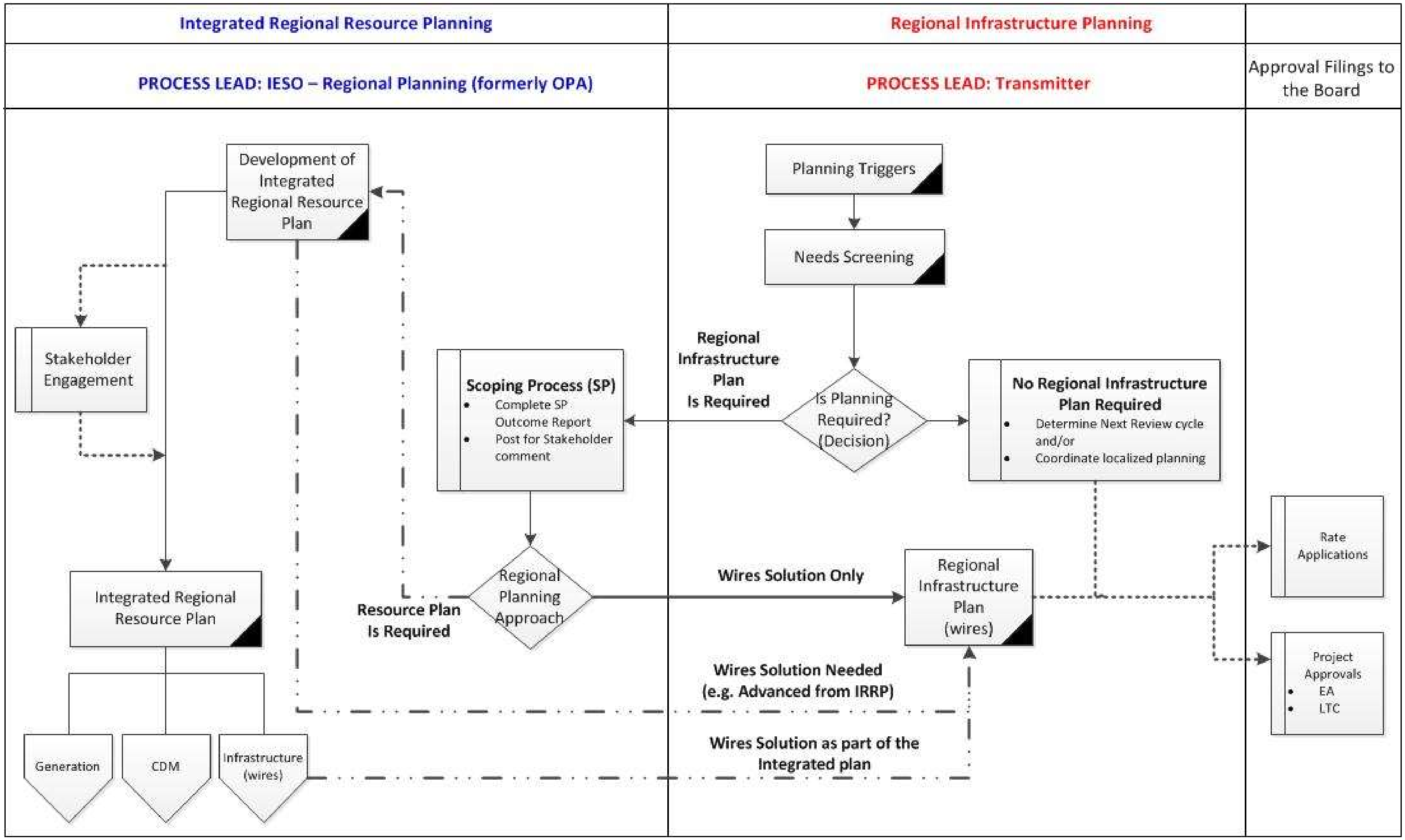

Figure 2-1: Regional Planning Process Flowchart

2.3 RIP Methodology

The RIP phase consists of four steps (see

Figure 2-2) as follows:

1. Data Gathering: The first step of the RIP process is the review of planning assessment data collected in the previous stages of the regional planning process. Hydro One collects this information and reviews it with the Working Group to reconfirm or update the information as required. The data collected includes:
   - Net peak demand forecast at the transformer station level. This includes the effect of any distributed generation or conservation and demand management programs.
   - Existing area network and capabilities including any bulk system power flow assumptions.
   - Other data and assumptions as applicable such as asset conditions, load transfer capabilities, and previously committed transmission and distribution system plans.
2. Technical Assessment: The second step is a technical assessment to review the adequacy of the regional system including any previously identified needs. Additional near and medium-term needs may be identified at this stage.
3. Alternative Development: The third step is the development of wires options to address the needs and to come up with a preferred alternative based on an assessment of technical considerations, feasibility, environmental impact, and costs.
4. Implementation Plan: The fourth and last step is the development of the implementation plan for the preferred alternative.

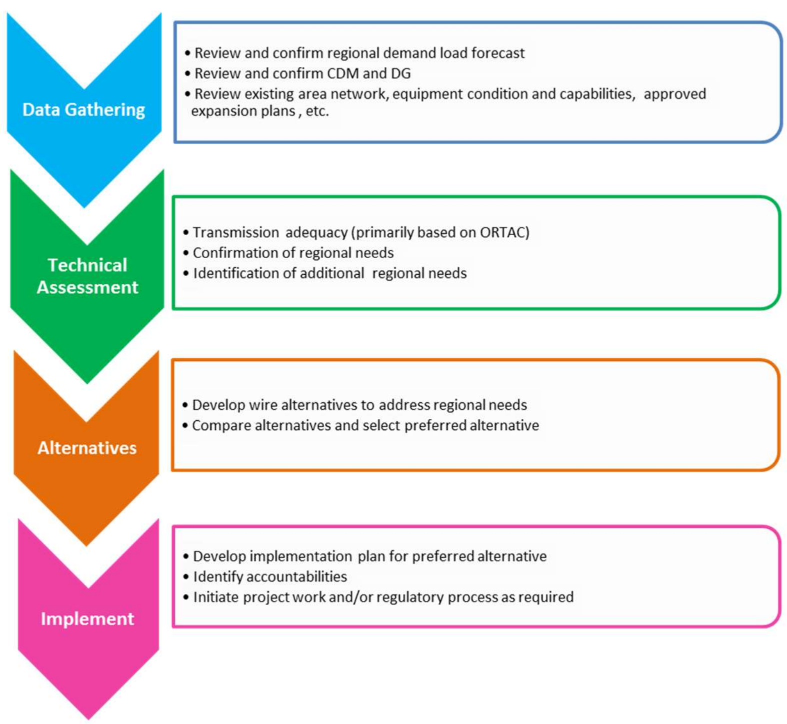

Figure 2-2: RIP Methodology

3 REGIONAL CHARACTERISTICS

THE NIAGARA REGION COVERS THE REGIONAL MUNICIPALITY OF NIAGARA AND INCLUDES THE CITIES OF NIAGARA FALLS, PORT COLBORNE, ST. CATHARINES, THOROLD AND WELLAND, THE TOWNS OF FORT ERIE, GRIMSBY, LINCOLN, NIAGARA-ON-THE-LAKE AND PELHAM AND THE TOWNSHIPS OF WAINFLEET AND WEST LINCOLN.

The Local Distribution Companies in the Niagara Region are Alectra Utilities Corporation, Canadian Niagara Power Inc., Grimsby Power Inc., Hydro One Networks Inc. (Distribution), Niagara-on-the-Lake (NOTL) Hydro Inc., Niagara Peninsula Energy Inc., and Welland Hydro Electric System Corp. A listing of the LDCs along with the associated supply stations is given in Appendix C. The high-voltage system in this Region also provides supply to number of direct transmission-connected customers transformer stations.

Electrical supply to the Niagara region is provided through a network of 230kV and 115kV transmission circuits supplied mainly by the local generation from Sir Adam Beck GS #1, Sir Adam Beck GS #2, Decew Falls GS, Thorold GS and the 230kV/115kV autotransformers at Allanburg TS. The 230kV circuits (Q23BM, Q24HM, Q25BM, Q26M, Q28A, Q29HM, Q30M, and Q35M) from Sir Adam Beck #2 SS connect this region to Hamilton/Burlington. The power is distributed through thirteen (13) HONI and six (6) LDC owned step-down transformer stations (please see Appendix B for a complete list. The distribution system in this Region is at two voltage levels, 27.6 kV and 13.8 kV. An electrical single line diagram for the Niagara Region transmission facilities is shown in Figure 3-1. The circuits and stations are provided in Table 3-1.

Table 3-1: Station and Circuits in the Niagara Region

115kV circuits	230kV circuits	Hydro One Transformer Stations	Generation Stations
Q3N, Q4N, Q11S, Q12S, A36N, A37N, A6C, A7C, D9HS, D10S, D1A, D3A, Q2AH	Q23BM, Q24HM, Q25BM, Q26M, Q28A, Q29HM, Q30M, Q35M, Q10P	Allanburg TS*, Beamsville TS, Bunting TS, Carlton TS, Crowland TS, Dunnville TS, Glendale TS, Kalar MTS, Niagara Murray TS, Niagara West MTS, NOTL York MTS, NOTL #2 MTS, Port Colborne TS, Stanley TS, Thorold TS, Vansickle TS, Vineland DS, CNPI Station #17 MTS, CNPI Station #18 MTS	Sir Adam Beck GS #1, Sir Adam Beck GS #2, Sir Adam Beck PGS, Thorold CGS, Decew Falls GS

*Station with Autotransformers installed

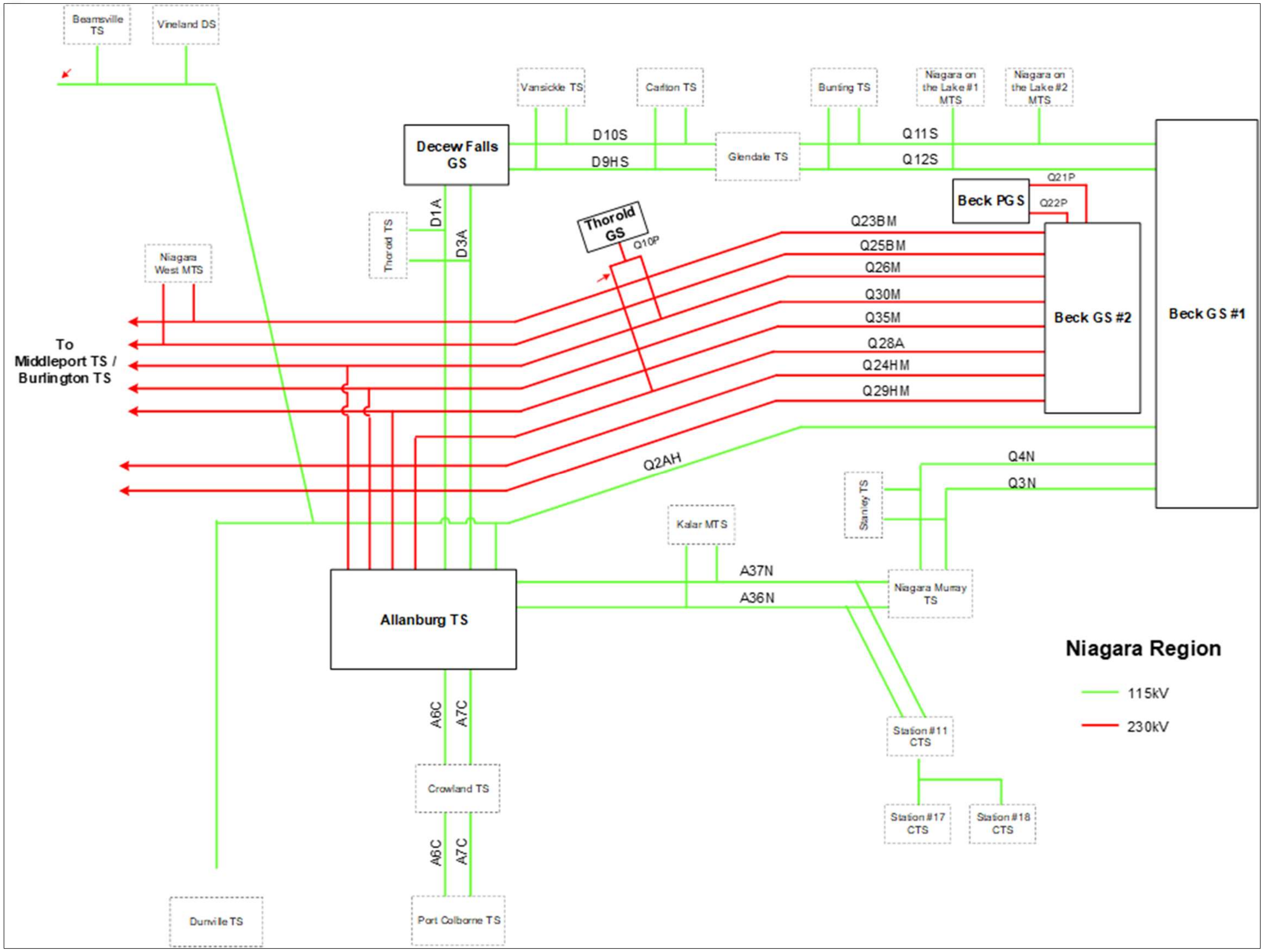

Figure 3-1: Niagara Region Single Line Diagram

4 TRANSMISSION FACILITIES COMPLETED AND/OR UNDERWAY IN THE LAST TEN YEARS

IN THE LAST TEN YEARS A NUMBER OF TRANSMISSION PROJECTS HAVE BEEN PLANNED AND UNDERTAKEN BY HYDRO ONE, OR ARE UNDERWAY, AIMED AT IMPROVING THE SUPPLY CAPABILITY AND RELIABILITY IN THE NIAGARA REGION.

A summary and brief description of the major projects completed and/or currently underway over the last ten years is provided below:

Projects Completed

- Decew Falls SS (2017) – Existing five (5) 115kV breakers were replaced with sulfur hexafluoride (SF6) equivalent breakers to improve supply reliability.

- Q4N Line Section Upgrade (2019) – Line section of 115kV Q4N circuit between Beck SS #1 x Portal Junction section (egress out from the generation station) was upgraded to meet load supply needs.

- A6C Line Section Refurbishment (2020) –115kV A6C circuit line conductor between Crowland TS and Port Colborne TS was replaced. The conductor needed replacement due to its asset condition.

- Stanley TS (2022) – Existing 40/53/67 MVA T2 transformer was replaced with a 45/60/75 MVA unit. This transformer needed replacement due to asset condition. Work at 13.8kV switchyard components and protection and control equipment were also replaced due to asset condition.

- Port Colborne TS (2022) – Existing T61 and T62 28/37/47 MVA transformers was replaced with 50/66.7/83.3 MVA units. These transformers needed replacement due to asset condition. The 27.6kV switchyard components and protection and control equipment were also replaced due to asset condition to improve the reliability of supply.

5 LOAD FORECAST AND STUDY ASSUMPTIONS

5.1 Load Forecast

A detailed load forecast for the Niagara region was developed as part of the area IRRP study. The TWG participants, including representatives from LDC's, IESO and Hydro One provided information and input for the IRRP Load forecast.

The IRRP forecast used in this RIP study includes minor increases at a few stations as per the LDCs[2]. Also included is a LDC connected industrial customer with curtailable load under specific outage conditions.

The load in the Niagara Region is expected to grow at an average rate of approximately 2.3% annually from 2023 to 2032. However, a major portion of this load increase is due to industrial customers. The growth rate for the LDCs, not accounting for the industrial customers, is about 1.3%. Longer term growth rate between 2033 to 2042 for all customers is forecast to be about 0.9%.

Figure 5-1 shows the Niagara region extreme summer weather net forecast from 2023-2042. The forecast shown is the regional non-coincident forecast and shows the load for all Niagara customers as well as the load for all the LDCs. The regional non-coincident peak load is forecast to increase from approximately 1092MW in 2023 to about 1505MW in 2042.

[2] Loading at Crowland TS adjusted as per new forecast from Welland Hydro. Loading at NOTL #2 MTS and NOTL York MTS adjusted as per new forecast from NOTL Hydro.

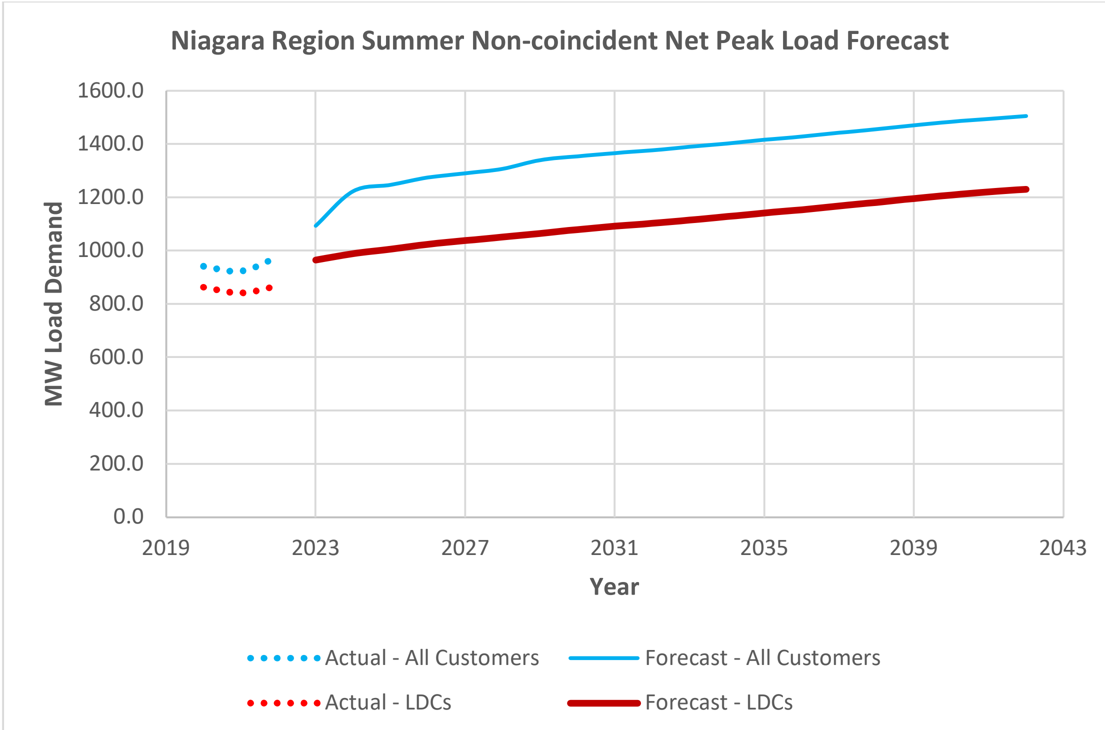

Figure 5-1: Niagara Region Summer Non-Coincident Weather Corrected Forecast

5.2 Other Study Assumptions

The following other assumptions are made in this report.

- The study period for the RIP assessments is 2023-2032. However, a longer term forecast up to 2042 is provided to identify long-term needs and align with the Niagara region IRRP.
- LDCs reconfirmed load forecasts up to 2041. The additional year of forecast to 2042 was extrapolated to complete the 20 year period.
- All planned facilities for which work has been initiated and are listed in Section 4 are assumed to be in-service.
- Summer is the critical period with respect to line and transformer loadings for this region. The assessment is therefore based on summer peak loads.
- Station capacity adequacy is assessed by comparing the non-coincident peak load with the station's normal planning supply capacity, where the power factor used for the load stations are from the IRRP Appendix G.
- Normal planning supply capacity for transformer stations in the region is determined by the summer 10-day Limited Time Rating (LTR).
- Bulk transmission line capacity adequacy is assessed by using coincident peak loads in the area. Radial line adequacy is assessed using non-coincident peak loads.
- Adequacy assessment is conducted as per ORTAC.

6 SYSTEM ADEQUACY AND REGIONAL NEEDS

THIS SECTION REVIEWS THE ADEQUACY OF THE EXISTING TRANSMISSION SYSTEM AND TRANSFORMER STATION FACILITIES SUPPLYING THE NIAGARA REGION AND LISTS FACILITIES REQUIRING REINFORCEMENT OVER THE 2023-2032 PERIOD.

In the current regional planning cycle, the three regional assessments were completed for the Niagara Region and their findings were used as inputs to this RIP report. These assessments are:

- Niagara Region Needs Assessment (NA) Report, May 2021.
- Niagara Region Scoping Assessment (SA) Report, August 2021
- Niagara Region Integrated Regional Resource Plan (IRRP), December 2022 and Appendices, February 2023

The NA and IRRP reports identified several needs because of the forecasted load demand and condition of major high voltage transmission assets. This section reviews the adequacy of the transmission lines and stations in the Niagara Region based on the updated regional load forecast provided in Appendix C. Sections 6.1 to 6.3 present the results of this review. Asset replacement needs identified in the previous NA report are discussed in Section 6.4 of this report. Load security and load restoration needs are discussed in Section 6.5.

6.1 230 kV and 115kV Transmission Circuits

All 230 kV transmission circuits in the Niagara Region are classified as part of the Bulk Electricity System (“BES”). They connect the Region to the Ontario’s transmission system, carry power from the Niagara River Generation to the rest of Ontario and are part of the interconnection path that connects Ontario to neighboring New York State at the Beck 2 SS. The 230 kV circuits Q26M, Q28A, Q30M and Q35M circuits also supply the 230/115 kV autotransformer station at Allanburg TS to serve local area stations within the region. The power flow on these circuits depend on the bulk system transfers as well as the local area loads.

Over the study period 2023-2032 the RIP reviewed the capacity of all the 230kV and 115kV Transmission lines within the Niagara Region. The NA and IRRP studies had previously indicated that the following Transmission lines require capacity relief within the study period. This RIP has further confirmed those needs and based on the load forecast and following contingencies, the Transmission lines which require capacity relief during the study period are shown in Table 6-1 below. The need date defines the time when the peak load forecast exceeds the most limiting summer Limited Time Ratings. Mitigation measures are discussed in Section 7.1.

Table 6-1: Niagara Region - Lines Sections Exceeding Ratings

No.	Voltage	Line	Section	Contingency	Line Rating MW	Need Date
1	230kV	Q28A	Beck 2 x Abitibi Jct.	N-2[1]	386	2024[2]
2	115kV	A6C/A7C	Allanburg TS x Crowland TS	N-1	214	2029

1. Loss of double circuit line Q26M/Q35M
2. Need date dependent on customer forecast load increase

6.2 230/115kV Transformation Facilities

Almost ninety percent of the Niagara Region load is supplied from the 115 kV transmission system. This power is supplied to the 115kV system through the four 230/115 kV autotransformers at Allanburg TS together with 115kV generation at Sir Adam Beck #1 GS and Decew Falls GS.

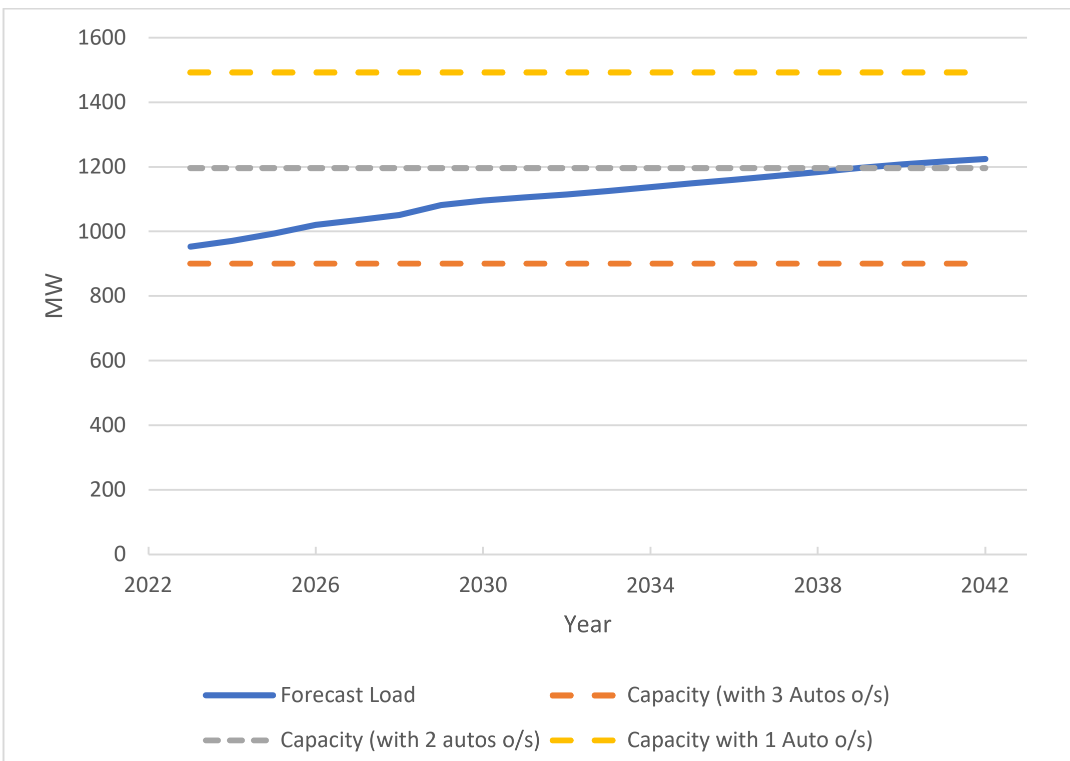

Figure 6-1: Niagara Region – 115kV Area Load and Supply Capacity

The forecast loading on the 115kV system is shown in Figure 6-1, together with the supply capacity with one, two and three autotransformers out of service at Allanburg TS and the local 115kV generation at 605MW[3]. There is adequate supply capacity in the region for the loss of up to 2 of the 4 autotransformers beyond the 2023-2032 RIP study period. However, since the autotransformers are connected to the 230kV circuits directly – loss of up to three autos can occur under an outage condition followed by a double circuit line outage – resulting in load exceeding supply capacity (N-1-2 contingency). Mitigation measures to address this issue are described in Section 7.2.

6.3 Step Down Transformation Facilities

There are a total of twenty-six (26) step-down transformer stations supplying power to customers in the Niagara Region as listed in Table 6-2. These include thirteen stations owned by Hydro One, six by area LDCs and seven (7) by direct industrial customers. The stations' summer peak load forecast is given in Appendix D Table D-1.

Table 6-2: Niagara Region - Step-Down Transformer Stations

Allanburg TS	CNPI Station #18 MTS	Murray TS	Stanley TS
Beamsville TS	Crowland TS	Niagara West MTS	Thorold TS
Bunting TS	Dunnville TS	NOTL #2 MTS	Vansickle TS
Carlton TS	Glendale TS	NOTL York MTS	Vineland DS
CNPI Station #17 MTS	Kalar MTS	Port Colborne TS	CTS #1
CTS #2	CTS #3	CTS #4	CTS #5
CTS #6	CTS #7		

Over the study period 2023-2032 the RIP reviewed the capacity of all the 230kV and 115kV transformer stations within the Niagara Region. The NA and IRRP studies had previously indicated that the following stations require capacity relief within the study period. This RIP has further confirmed those needs and based on the load forecast, the stations which require capacity relief during the study period are shown in Table 6-3.

[3] Beck GS #1 is assumed at 490MW and Decew Falls GS at 115 MW.

The need timeframe defines the time when the peak load forecast exceeds the most limiting seasonal (summer) Limited Time Ratings. Mitigation measures to address this issue are described in Section 7.3.

Table 6-3: Niagara Region Station Capacity Needs in the Study Period

No.	Station Name	Capacity (MVA)	2023 Loading (MW)	Station 10- day LTR (MW)	Need Date
1	Beamsville TS	25/42	64.2	59.0	2023
2	Murray TS T11/T12	45/75	77.7	73.2	2023
3	Niagara West MTS	40/67	54.6	66.0	2024
4	Crowland TS	50/83	100.9	101.7	2024
5	Carlton TS	45/75	89.2	95.4	2029

6.4 Asset Replacement Needs for Major High Voltage (HV) Transmission Equipment

Several Hydro One facilities in the Niagara Region will require asset renewal work over the 2023-2032 study period. These needs are determined by asset condition based on a range of considerations such as equipment deterioration, technical obsolescence due to outdated design, lack of spare parts availability or manufacturer support, and/or potential health and safety hazards.

Asset replacement work is planned over the study period at area transformer stations and lines listed in Table 6-4. The options and preferred solutions to address these needs are discussed further in Section 7.4 of the report.

Table 6-4: Niagara Region - Planned Replacement Work

No.	Station	Planned I/S Date
A - Station Work		
1	Thorold TS	2024
2	Glendale TS	2027
3	Murray TS T11/T12	2027
4	Carlton TS	2027
5	Crowland TS	2027
6	Bunting TS	2029
7	Murray TS T13/T14	2031
8	Vansickle TS	2032
9	Allanburg TS	2032
B – Lines Work		
1	115kV D1A/D3A	2024
2	115kV Q2AH	2025

6.5 Load Security and Load Restoration Needs

Load security and load restoration needs were reviewed as part of the current study and one load security need has been identified for the region. The ORTAC requires that not more than 150MW of load may be interrupted by planned load curtailment or load rejection and the Allanburg Load Rejection scheme does not meet the criteria.

6.5.1 A6C/A7C Load Security

The loss of the 230kV double circuit line Q26M/Q28A, will result in the coincidental loss of autotransformers T1 and T2 at Allanburg TS and the separation of the 115kV A6C/A7C and D1A and A36N circuits from the Allanburg TS 115kV bus. Under this scenario the Allanburg Load Rejection scheme trips the A6C and A7C circuits to prevent loads connected to the A6C/A7C circuits from excessive voltage declines. The load on the A6C/A7C is currently about 200MW and forecast to increase to 278MW by the end of the plan period. The amount of load rejected is thus more than the permitted amount of 150 MW allowed under ORTAC. Mitigation measures to address this need are discussed in Section 7.5.

7 REGIONAL PLANS

THIS SECTION DISCUSSES NEEDS, PRESENTS WIRES ALTERNATIVES AND THE PREFERRED WIRES SOLUTIONS FOR ADDRESSING THE ELECTRICAL SUPPLY NEEDS FOR THE NIAGARA REGION.

The electrical infrastructure needs for the Niagara Region are summarized in Table 7-1. These needs include those previously identified in the Niagara Region NA and IRRP as well as those resulting from the adequacy assessment carried out as part of this RIP report. The details of the project/plan to address these needs are provided in Sections 7.1 through 7.5.

Table 7-1: Niagara Region – Identified Near and Medium-Term Needs

Section	Facilities	Need	Timing
Transmission Line Capacity Needs			
7.1.1	Q28A -Beck 2 TS to Abitibi Jct.	Line Capacity Exceeded	2024
7.1.2	115 kV Circuits A6C and A7C – Allanburg TS to Crowland TS	Line Capacity Exceeded	2029
230/115 kV Transformation Capacity/115kV Supply Area Capacity			
7.2	Allanburg TS	Loading exceeds Capacity at Allanburg TS	2023
Station Capacity			
7.3.1	Beamsville TS and Niagara West MTS	Forecast load exceeds normal supply capacity	2023
7.3.2	Crowland TS	Forecast load exceed normal supply capacity	2024
7.3.3	Murray TS and Kalar TS	Forecast load exceed normal supply capacity	2028
7.3.4	Carlton TS	Forecast load exceed normal supply capacity	2029
Asset Replacement			
7.4	Thorold TS	Transformer T1 replacement	2024
7.4	Carlton TS	LV Switchyard refurbishment	2027
7.4	Glendale TS	Transformers T1 and T2 replacement	2027
7.4	Crowland TS	Transformer T5 and T6 replacement	2027
7.4	Murray TS	Transformers T11 and T12 replacement	2027
7.4	Bunting TS	Transformers T1 and T2 replacement	2029
7.4	Murray TS	Transformers T13 and T14 replacement	2031
7.4	Vansickle TS	LV Switchyard refurbishment	2032
7.4	Allanburg TS	Transformer T3 replacement	2032
7.4	115kV Line D1A/D3A	Gibson Jct. x Thorold TS	2024
7.4	115kV Line Q2AH	Rosedene Jct. x St. Anns Jct.	2025
Load Security			
7.5	115kV A6C/A7C Load Security	Forecast exceeds ORTAC load rejection Criteria	2023

7.1 Transmission Line Capacity

This section describes work required to address the transmission line capacity needs associated with the 230kV circuit Q28A and 115kV circuits A6C and A7C as described in Section 6.1.

7.1.1 230kV circuit Q28A – Beck #2 TS x Abitibi Junction

7.1.1.1 Introduction

The 230kV circuit Q28A is part of the eight transmission circuits egressing from Beck #2 GS and connects to Allanburg TS. The planning forecast based on new customer load indicates that the loading will exceed the circuit 980A rating by summer 2024 for a loss of the double circuit line Q26M/Q35M.

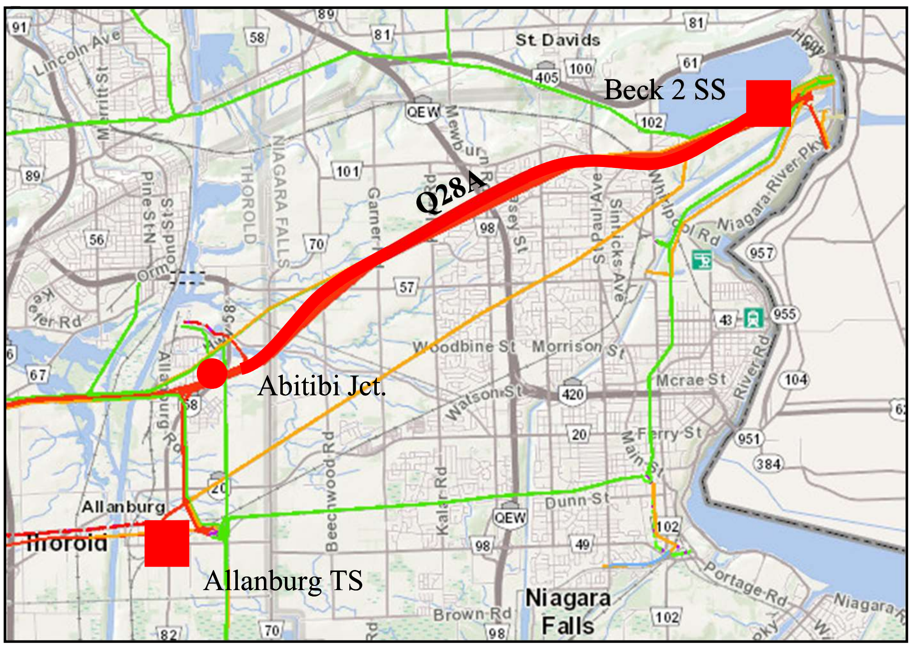

Figure 7-1: Uprate Q28A Circuit

7.1.1.2 Alternatives and Recommendation

The following alternatives were considered to address the 230kV circuit Q28A capacity need:

- **Alternative 1 – Maintain Status Quo:** This alternative is not viable as it does not address meeting the area customers' load requirements. It is therefore not considered further.
- **Alternative 2 – Uprate 230kV Q28A Circuit:** This alternative considers uprating the conductor by tensioning the conductors to reduce the line sag and allow the line conductor to operate at a higher temperature. This will increase the circuit rating from 980A to 1310A. The estimated cost of the work is about $3M.

The TWG recommends Alternative 2 as the preferred and cost-effective alternative for increasing the capacity of the line. Hydro One has advised the customer of the proposed work and will initiate the work once confirmed by the customer.

7.1.2 115 kV Circuits A6C and A7C – Allanburg TS to Crowland TS

7.1.2.1 Introduction

The 115 kV double circuit line A6C/A7C supplies Crowland TS and Port Colborne TS along with several directly connected transmission customers as shown in Figure 7-2. The load connected on this line is forecast to exceed the line capacity by summer 2029 as shown in Table 7-2.

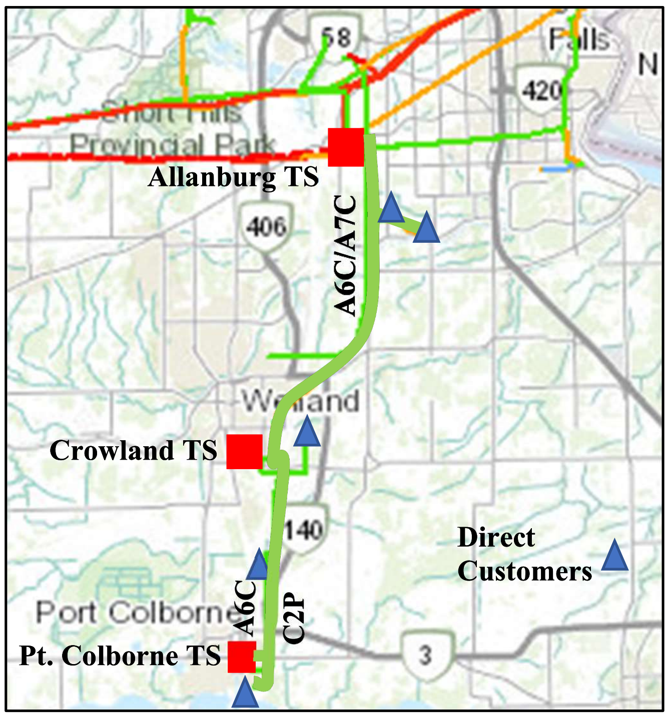

Figure 7-2: Map of 115kV A6C/A7C Circuits

Table 7-2: 115kV circuit A6C/A7C -Connected Loads

Load	Circuit Limit	Act.[1] 2022	Load Forecast 2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2042	Need Date
A6C/A7C[2]	213.9[3]	169.5	174.0	182.4	191.6	202.2	206.8	211.6	232.7	234.9	236.8	236.9	246.1	2029
Crowland TS		93.6	100.9	108.8	110.6	112.6	114.1	115.9	117.6	119.6	121.3	121.2	128.5	---
A6C/A7C post Crowland[4]			-	-	-	-	92.7	95.7	115.1	115.3	115.5	115.7	117.6	---

1. Actual summer load adjusted for extreme weather
2. Loading excludes Allanburg TS DESN
3. Rating of A6C/A7C circuit between Allanburg TS DESN and Crowland TS

4. After Crowland TS conversion to 230KV as per Section 7.3.2 in 2027

7.1.2.2 Alternatives and Recommendation

The following alternatives were considered to address the overloading issue on the 115kV line A6C/A7C line:

- **Alternative 1 – Maintain Status Quo:** This alternative is not viable as it does not address meeting the area customers' load requirements. It is therefore not considered further.
- **Alternative 2 – Uprate the A6C and A7C Circuits:** This alternative considers reconductoring the A6C/A7C line between Allanburg TS and Crowland TS (~ 14.5 km) using a higher rated conductor. This will increase the circuit rating from 214 MW to about 280 MW. The estimated cost of the work is $23M.
- **Alternative 3 – Reduce Loading on A6C/A7C:** This alternative reduces loading on circuits A6C and A7C by rebuilding Crowland TS[4] as a 230/27.6 kV station supplied from and supplying it from a new 230kV circuit line.

The TWG recommends Alternative 3 as the preferred and cost-effective alternative addressing the overloading issue on the A6C/A7C line. Transferring of Crowland TS to a 230 kV supply also addresses multiple other issues; reduces load on the Allanburg TS autotransformers (See Section 7.2.2), allows increase capacity at Crowland TS (see Section 7.3.2), and reduces the severity of the load security issue (Section 7.5).

7.2 115kV Supply Area Capacity

7.2.1 Introduction

As shown in Section 6.2, the loads on the Niagara Region 115kV system exceeds the 115 kV system supply capability under certain contingency conditions which result in three out of the four autotransformers being out of service at Allanburg TS. Specifically, this occurs under a 230kV outage condition followed by a double 230kV circuit line outage (N-1-2 contingency).

7.2.2 Alternatives and Recommendation

The following alternatives were considered to address the 115 kV supply capacity:

- **Alternative 1 – Maintain Status Quo:** This alternative is not viable as it does not address meeting the area customers' load requirements. It is therefore not considered further.

[4] Crowland TS needs to be refurbished and will be rebuilt. Please refer to Section 7.3.2 and 7.4 for more details.

- **Alternative 2 – Modify Existing Load Rejection Scheme for 115kV Subsystem:** This alternative modifies the Allanburg load rejection scheme to include rejection of up to 150MW of load whenever three autotransformers are out. The estimated cost of this alternative is about $8M.
- **Alternative 3 – New 230kV Switchyard at Allanburg TS:** The work required in this alternative is to build a new 230kV switchyard to eliminate the N-1-2 contingency at Allanburg TS (loss of three autotransformers contingency) to supply more power to the 115kV network. The work required would consist of four new 230kV bus diameters, each accommodate an autotransformer to eliminate any coincidental loss of the autotransformers. This work has an estimated cost of $253M.
- **Alternative 4 – Reduce load on 115kV system by introducing 230kV Supply to the Welland Area -** This alternative would transfer Crowland TS to 230kV supply by building a 18km double circuit 230kV transmission line from Q24HM/Q29HM to connect to a new 230/27.6kV transformer station at the Crowland TS site. The new TS will replace the existing station that requires replacement. This work has an estimated cost of $128M.

The TWG recommends Alternative 4 as the most cost effective and preferred alternative. Besides addressing the 115kV supply capacity needs, this alternative also addresses; the A6C/A7C overloading issue (Section 7.1.2); the Crowland TS capacity needs (Section 7.3.2); the Crowland TS asset renewal needs (Section 7.4); and reduces the severity of the A6C/A7C load security issue (Section 7.5). The work is planned to be in service by summer 2027.

7.3 Station Capacity Needs

This section describes the work required to address the station capacity needs identified in Section 6.3.

7.3.1 Beamsville TS, Vineland DS, Niagara West MTS – 115kV Lincoln Area

7.3.1.1 Introduction

Beamsville TS and Vineland DS are 115/27.6kV stations and Niagara West MTS is a 230/27.6kV station which supplies the towns of Grimsby, West Lincoln, and Lincoln. The area is experiencing load growth where the summer weather extreme demand forecast will exceed the area normal supply capacity.

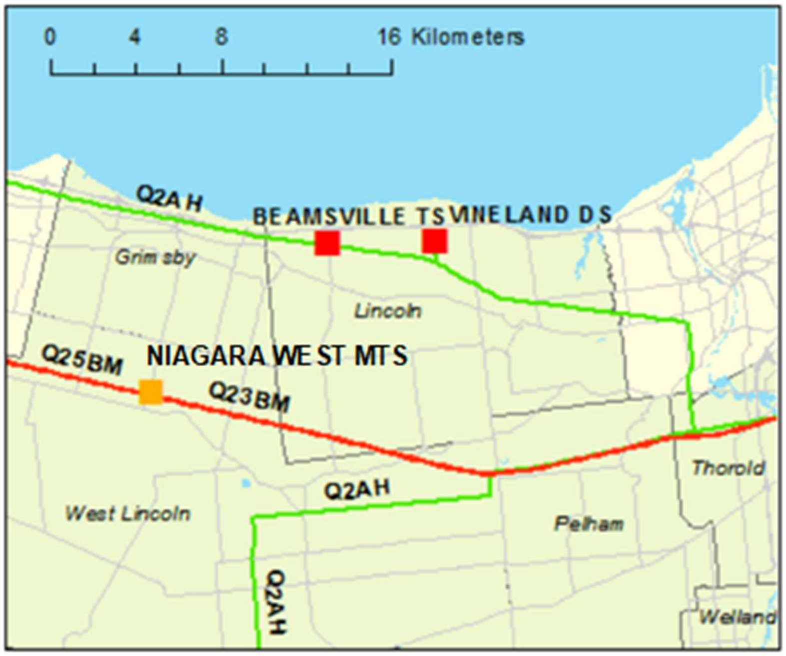

Figure 7-3: Map of 115kV Lincoln Area

Beamsville TS presently has 115kV/27.6kV 42MVA transformers (T3/T4) with a summer LTR of 59.0MW. This station has operated at or slightly over the LTR over the past few years.

Table 7-3 shows the forecast for the three area stations. The forecast shows that the combined capacity of the three stations would be exceeded by summer 2024. The TWG agrees that a solution is required to address the upcoming supply capacity needs.

Table 7-3: 115kV Lincoln Area Stations Load Forecast

Station	LTR MW	Act. [1]	Load Forecast										Need Date
		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2042	
Beamsville	59.0	63.1	77.2	79.2	80.5	81.4	82.1	82.9	83.7	84.6	85.6	86.5	101.9	---
Niagara West MTS[2]	63.4	41.6	49.0	56.8	57.6	58.2	58.9	60.3	61.7	63.2	64.7	66.2	84.3	---
Vineland DS	26.4	20.5	20.7	20.9	21.1	21.3	21.6	22.5	23.5	24.5	24.7	25.0	27.6	---
Total	148.8	125.3	147.0	156.9	159.2	161.0	162.5	165.7	168.9	172.3	175.0	177.7	213.8	2024

1. Actual summer load adjusted for extreme weather

7.3.1.2 Alternatives and Recommendation

The following alternatives were considered to address the area capacity need:

- **Alternative 1 – Maintain Status Quo:** This solution is not recommended as it does not address the supply capacity needed in the area. This solution will also prevent load growth in this area.

- **Alternative 2 – Load Transfer to Neighbouring Stations:** This solution is not viable as there is no nearby station where the load can be transferred.
- **Alternative 3 – Replace Beamsville and Niagara West transformers:** Replace existing Beamsville TS T3/T4 transformers and Niagara West MTS T1/T2 with larger 50/83MVA units, providing total additional capacity of 100 MW at both stations to address the existing and future load demand. Additional feeder positions will be required at both stations to utilize the additional capacity. The cost of this work is estimated to be about $48M.
- **Alternative 4 – Build new 230/27.6kV DESN station in Local Area:** This alternative would build a new 230/27.6kV DESN station to supply the increased load demand forecast required in the local area. The new station would be supplied by the double circuit 230kV transmission line Q23BM/Q25BM with new 50/83MVA transformers. The new station will provide about 102 MW of new capacity. The estimated cost of this alternative is about $45M.

The TWG recommends proceeding with Alternative 4. This alternative provides a robust transmission solution to meeting the area LDCs demand forecast and will also allow for future load growth beyond the study period on the 230kV system. This solution will also provide better reliability for future loads as the new station will have dual incoming transmission supplies into station instead of being on a single supply like Beamsville TS. Loads will be managed by the respective LDCs between 2024 and 2027 when the new facility is expected to go into service.

Hydro One will work with all the respective parties to find a suitable location to meet the load. Possible locations could be an expansion at Niagara West MTS or a location central to Vineland DS and Beamsville TS to supply local growth (e.g., the southwest corner in the Town of Lincoln).

7.3.2 Crowland TS

7.3.2.1 Introduction

Crowland TS is a 115/27.6kV 50/83MVA transformer station located in Welland. The station load is at or near its 10-day LTR of 101.7 MW and load is forecasted[5] to increase up to 121MW by the end of 2032 as shown in Table 7-4 below. A permanent supply solution is required for the increased load growth as the current loading will surpass the station capacity in 2024.

The transformers, T5 and T6, at Crowland TS are about 55 years old and based on asset condition assessment Crowland TS has been identified for asset renewal by summer 2027.

[5] Forecast updated from IRRP as per Welland Hydro

Figure 7-4: Map of Crowland TS

Table 7-4: Crowland TS Load Forecast

Station	LTR MW	Act.[1]	Load Forecast										Need Date
		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2042	
Crowland TS	101.7	93.6	100.9	108.8	110.6	112.6	114.1	115.9	117.6	119.6	121.3	121.2	128.5	2024

1. Actual summer load adjusted for extreme weather

7.3.2.2 Alternatives and Recommendation

The following alternatives were considered to address Crowland TS capacity need:

- **Alternative 1 – Maintain Status Quo:** This alternative was considered and rejected as it does not provide supply capacity to area customers during the study period. Under this scenario load cannot be increased at this station.
- **Alternative 2 – Rebuild existing DESN at Crowland TS and add a second DESN at Crowland TS:** Under this alternative the existing Crowland TS transformers will be replaced, and the station refurbished. A new second DESN would be built to handle the increased load. This alternative would maintain the existing 115kV loading on the Allanburg autotransformers and work will be required to address the issue. Work also would be required to address the capacity need on the A6C/A7C circuits and address the load security concern at Allanburg TS. This alternative is estimated to cost $78M for the refurbishment work and new DESN at Crowland TS. An additional $253M will be required to provide additional switching at Allanburg TS to reinforce the 115kV supply.

- **Alternative 3 – Provide a new 230kV Supply to Welland Area and convert Crowland TS to 230kV:** Under this alternative the existing Crowland TS would be replaced with a new 230/27.6 kV DESN station with 75/125 MVA transformers to supply the increased load demand. A new 18km double circuit 230kV transmission line will be constructed to supply this new transformer station from the double circuit 230 kV line Q24HM/Q29HM. This new station would allow the station LTR to increase to approximately 170 MW (summer) with 75/125MVA transformers. The estimated cost of this alternative is about $128M.

The TWG recommends Alternative 3 as it is the lowest cost alternative. It provides new area transmission and load growth opportunities. The conversion of Crowland TS to 230kV will reduce the loading on the 115kV autotransformer at Allanburg TS, alleviating the constrained supply to the 115 kV sub-system described previously. It will also remove the existing Crowland TS loads from the 115kV A6C/A7C circuits, alleviating the severity of the load security constraint at Allanburg TS. This alternative will also provide a parallel opportunity for load growth on the 115kV A6C/A7C circuits as the Crowland TS load is removed from the 115kV system.

7.3.3 Murray TS and Kalar MTS – Niagara Falls

7.3.3.1 Introduction

Murray TS and Kalar TS are two transformer stations located in Niagara Falls. Murray TS has two 115/13.8 DESNs, T11/T12 and T13/T14, with a summer LTR of 73.2MW and 79.8MW respectively. Kalar MTS has one 115/13.8 kV DESN with a summer LTR of 72.0 MW. The stations forecast loads are given in Table 7-5. Considerable new loads are expected to connect in the area. Loading on the Murray TS T11/T12 DESN is forecast to exceed its LTR by summer 2023. Loading on Kalar MTS is forecast to exceed LTR by summer 2028.

The Murray TS transformers, T11, T12, T13 and T14 are between 46 and 52 years old and have been identified for replacement due to asset condition. It is planned to replace T11 and T12 by summer 2027. This will be followed by the replacement of the T13 and T14 transformers by summer 2031.

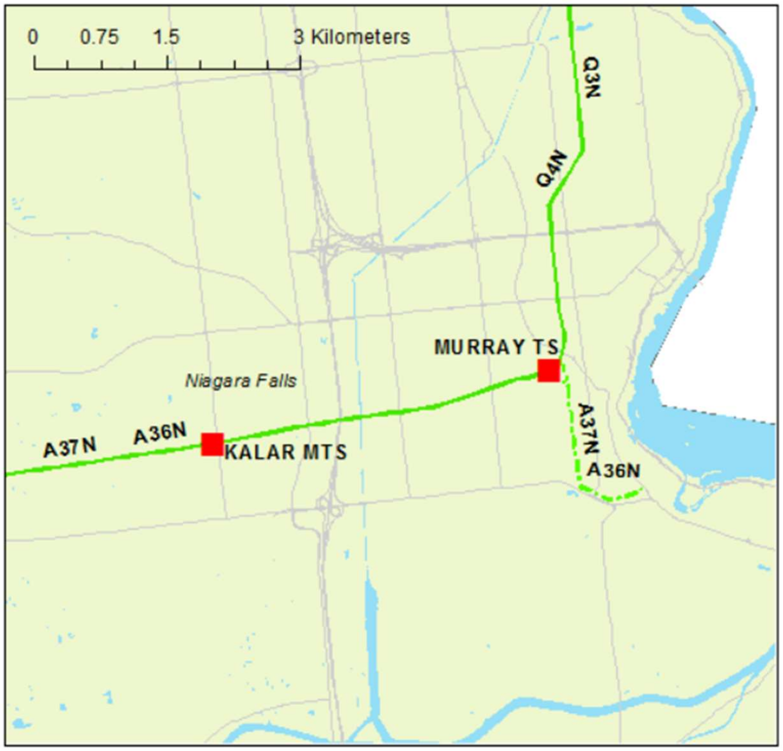

Figure 7-5: Map of Murray TS and Kalar MTS

Table 7-5: Murray TS, and Kalar MTS Load Forecast

Station	LTR MW	Act[1]	Load Forecast											Need Date
		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2042	
Murray TS T11/T12	73.2	66.3	77.7	77.7	77.8	78.0	77.9	78.1	78.3	78.7	78.9	79.1	86.2	2023[2]
Murray TS T13/T14	79.8	41.7	42.0	42.2	42.4	42.6	42.9	43.1	43.3	43.5	43.8	44.0	46.6	Note[3]
Kalar MTS	72.0	46.5	46.9	47.4	54.2	60.7	64.4	65.8	67.1	68.6	68.8	69.0	75.1	2039
Total	225.0	166.3	166.6	167.3	174.4	181.3	185.2	187.0	188.7	190.8	191.5	192.1	207.9	

1. Actual summer load adjusted for extreme weather
2. Earliest replacement to happen by 2027
3. The transformers T13 and T14 will be replaced in 2031as per asset condition.

7.3.3.2 Alternatives and Recommendation

The following alternatives were considered to address the current and future capacity need:

- **Alternative 1 – Maintain Status Quo:** This alternative was considered and rejected as it does not address the need as the near and mid-term load forecast exceeds the LTR at Murray TS T11/T12. Asset renewal needs are also not addressed.
- **Alternative 2 – Replace T11/T12 at Murray TS with 60/100MVA transformers:** This alternative would replace the T11/T12 transformers with larger 60/100MVA transformers, with an approximate

LTR of 130MW instead of the 45/60/75MVA units specified for the asset renewal project at Murray TS. This will increase supply capacity of approximately 43MW at Murray TS at an estimated incremental cost of $2M to the asset renewal upgrade cost of $39M. The earliest this work can be done is summer 2027.

- **Alternative 3 – Transfer T11/T12 load to T13/T14 at Murray TS:** This alternative would transfer load from T11/T12 to T13/T14 at a cost of $5M. The T13/T14 bus supplies a large industrial load customer with fluctuating load and customers connected to the bus would experience power quality issues.
- **Alternative 4 – Build new 115kV/13.8kV Station near Kalar MTS:** This alternative would build a new 115/13.8kV DESN station with 25/41.7MVA transformers to supply the increased load demand forecast required at Kalar MTS and Murray TS T11/T12. This new station would provide the station an LTR of 51MW (summer). The estimated cost for this alternative is expected to be $40M.

The TWG recommends Alternative 2 as the preferred alternative for addressing the capacity need as it is the most economical alternative with the ability to increase supply capacity. Alternative 3 is not recommended since is more expensive, will introduce power quality issues to the transferred load and is not acceptable to the LDC. Loading will be monitored and managed at Murray TS by the LDC and Hydro One in the interim before the additional capacity is provided in 2027. The Kalar MTS load growth will be monitored to verify if the actual summer peak loads are close to the mid-term forecast. When the actual load is approaching the forecast, the respective LDC will re-evaluate and can transfer the extra load from Kalar MTS to Murray TS.

7.3.4 Carlton TS and Bunting TS – St. Catharines

Carlton TS and Bunting TS are two transformer stations located in St. Catharines. Carlton TS has one 115/13.8 kV T1/T2 DESN with a summer LTR of 95.4 MW. Bunting TS has one 115/13.6 kV T1/T2 DESN with a summer LTR of 78.2 MW. The stations forecast loads are given in Table 7-6. Loading on Carlton TS is forecast to exceed its LTR by summer 2029. Bunting TS is adequate over the study period.

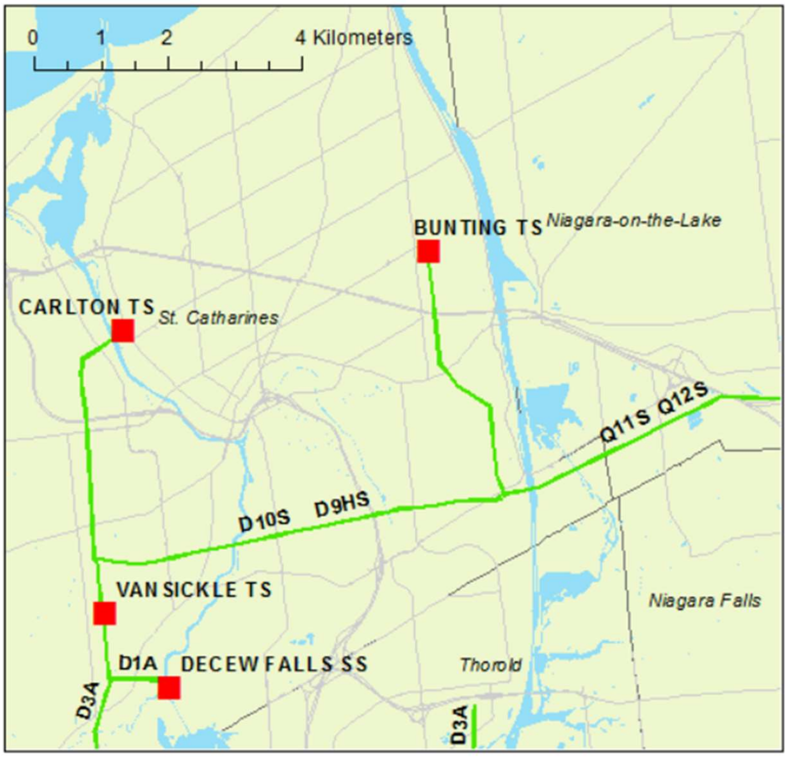

Figure 7-6: Map of Carlton TS and Bunting TS

Table 7-6: Carlton TS and Bunting TS Load Forecast

Station	LTR MW	Act. [1]	Load Forecast											Need Date
		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2042	
Carlton TS	95.4	82.6	89.2	90.1	91.1	92.2	93.3	94.6	95.9	97.3	98.9	100.3	105.7	2029
Bunting TS	78.2	54.4	57.8	58.3	58.8	59.6	60.4	61.4	62.4	63.6	64.7	65.9	77.1	---
Total	173.6	137.0	147.1	148.4	149.9	151.8	153.7	156.0	158.3	160.9	163.6	166.2	182.8	----

1. Actual summer load adjusted for extreme weather

Both Carlton TS and Bunting TS also have renewal work planned. The LV switchyard at Carlton TS is over 50 years old and refurbishment is required. The Transformer T3 at Bunting TS is also over 50 years and identified for replacement.

7.3.4.1 Alternatives and Recommendation

The following alternatives were considered to address the current and future capacity need:

- **Alternative 1 – Maintain Status Quo:** This alternative was considered and rejected as it does not address the stations sustainment need. Carlton TS load also exceeds its LTR and action is required to address the issue.

- **Alternative 2 –Carry out Asset Renewal at Carlton TS and Bunting TS**: Monitor Carlton TS loading and transfer excess load to Bunting TS: The station refurbishment work will be carried out at both stations. Carlton TS load growth will be monitored to see if the actual summer peak loads are close to the mid-term forecast. When the actual load is approaching the forecast, the respective LDC will re-evaluate and transfer the excess load over the LTR from Carlton TS to Bunting TS. The cost to transfer the load between stations is estimated to be $5M.

The TWG recommendation is that it is prudent to monitor the area load and complete load transfer at nearby stations with available station capacity when required. The TWG recommends Alternative 2 as the preferred and cost-effective alternative for addressing the need.

7.4 Asset Replacement for Major HV Transmission Equipment

As discussed in Section 6.3, Hydro One has identified the need for replacement of major HV transmission assets over the next ten years at several Niagara Region Hydro One stations as well as two small line sections. Details of the work along with its planned in-service year is given in Table 7-7.

Table 7-7: Niagara Region – Asset Replacement Plans

No.	Station /Line	Planned Work	Planned I/S Date[1]
1	Thorold TS	Replace the existing 45/60/75 MVA T1 transformer with a new 45/60/75 MVA unit.	2024
2	Glendale TS	Replace the existing T1/T2 45/60/75 MVA transformers, with new 45/60/75 MVA units.	2027
3	Crowland TS	The existing 115/27.6 kV T5/T6 DESN will be replaced by a new 230/27.6 kV DESN rated for 170 MW.	2027
4	Murray TS	Replace the existing 45/60/75 MVA transformers T11 and T12 with new 60/80/100 MVA units. Replace the existing 45/60/75 MVA transformers T13 and T14 with new 60/80/100MVA units.	2027 2031
5	Bunting TS	Replace the existing 40/53/67 MVA transformers, with new 45/60/75 MVA units	2029
6	Vansickle TS	Replace LV Switchgear	2032
7	Allanburg TS	Replace Autotransformer T3	2032
8	115kV Line D1A/D3A	115kV kV line refurbishment of a 5 km line section between Gibson Jct and Thorold TS with conductor to be replaced due to asset condition	2024
9	115kV Line Q2AH	115kV line refurbishment of 11.2km between Rosedene Jct. and St. Anns Jct. with conductor to be replaced due to asset condition	2025

1. The planned in-service date is tentative and is subject to change

The TWG recommends that Hydro One proceed with the above work to ensure that the system meets reliability criteria and supply to customers is not affected.

7.5 Load Security – 115kV circuits A6C/A7C

As discussed in Section 6.4.1 the *Allanburg Load Rejection scheme* trips 115kV circuits A6C/A7C under certain contingencies to prevent stations supplied from these circuits being subjected to excessive voltage declines.

The *Allanburg Load Rejection Scheme* is designed to address post contingency voltage decline issues following the coincident loss of Allanburg 230/115 kV Autotransformers T1 and T2. The coincidental loss of Allanburg T1 and T2 transformers will result in circuits A6C and A7C being disconnected from the Allanburg TS 115kV and buses radially connected to circuits D1A and A36N, respectively. As such, this causes excessive voltage to decline at stations supplied from circuits 115kV A6C and A7C. The scheme rejects the load connected to circuits A6C and A7C and will prevent the radial feeds (from Decew Fall GS on D1A and the Niagara Corridor on A36N) from trying to support the load of A6C and A7C.

The load security need arises from Section 7.1 of the ORTAC. As defined under this section, Not more than 150MW of load may be interrupted by configuration and by planned load curtailment or load rejection, excluding voluntary demand management. The A6C/A7C load forecast is provided in Table 7-8.

Table 7-8: 115kV Circuit A6C/A7C -Connected loads

Load	ORTAC L/R Limit	Act.[1]	Load Forecast									
		2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2042
A6C/A7C	150	209.6	219.3	227.8	237.1	247.9	252.6	257.5	278.7	281.1	283.1	283.4	297.0
Crowland TS		93.6	100.9	108.8	110.6	112.6	114.1	115.9	117.6	119.6	121.3	121.2	128.5
A6C/A7C post Crowland[2]		-	-	-	-	-	138.5	141.7	161.2	161.5	161.9	162.2	168.5

1. Actual summer load adjusted for extreme weather
2. After Crowland TS conversion to 230KV as per Section 7.3.2

This forecast exceeds the permissible limit set by ORTAC. It also exceeds the A6C/A7C line limit for loss of one of the two circuits.

7.5.1.1 Alternatives and Recommendation

The following alternatives were considered to address the current and future capacity need:

- **Alternative 1 – Maintain Status Quo:** This alternative was considered and rejected as it does not address the ORTAC load security need.
- **Alternative 2 – Reduce Loading on A6C/A7C:** This alternative reduce loading on 115kV circuits A6C and A7C by removing Crowland TS from the A6C/A7C supply. Crowland TS is rebuilt as a 230/27.6 kV station supplied from a new 230kV double circuit line.

The TWG recommends Alternative 2 as the preferred alternative to addressing the load security issue in the ORTAC. This alternative will be partially addressed by converting Crowland TS to a 230kV supply as described in Section 7.3.2. Since the Crowland TS work will not be completed till 2027, the issue will be managed by operational measures. Load can be restored within 15 minutes by opening both T1 and T2 disconnect switches and supplying all the Allanburg 115kV load from the remaining T3 and T4 autotransformers during a coincident T1 and T2 outage. This work reduces the severity of the load security issue. The loading on the A6C/A7C will continue to be monitored and reviewed in the next planning cycle with the option to transfer Allanburg TS DESN to 230kV.

8 CONCLUSION AND RECOMMENDATION

This Regional Infrastructure Plan report concludes the Regional Planning process for the Niagara Region.

The major Infrastructure investments recommended by the TWG in the near and mid-term planning horizon 2023-2032 are provided in Table 8-1 below, along with their planned in-service dates (ISD) and budgetary estimates for planning purposes.

Table 8-1: Recommended Plans over the next 10 Years

No.	Need	Recommended Action Plan	Lead	Timing[1]	Budgetary Estimates[2]
1	230 kV circuit Q28A – Additional capacity required	Uprate circuits between Beck 2 SS and Abitibi Jct. to meet expected load demand	Hydro One	TBD[3]	$3M
2	Loading in the Lincoln area exceeding supply capability	Build new 2 x 50/83MVA, 230kV/27.6 station	Hydro One	2028	$45M
3	Crowland TS: Station loading exceeds LTR	Build new 2 x 75/125MVA, 230kV/27.6 station and a new 18 km line from Abitibi Jct to Crowland TS	Hydro One	2027	$128M
4	Murray TS T11/T12 DESN: DESN loading exceeds LTR. Transformers T11/T12 need to be replaced	Replace existing 45/75MVA transformers with larger 60/100MVA units	Hydro One	2027	$41M
5	Carlton TS: T1/T2 DESN loading exceeds LTR	Transfer excess load to Bunting TS	Alectra	2029	$5M
6	**Asset Replacement:** Thorold TS Glendale TS Carlton TS Bunting TS Murray TS T13/T14 Vansickle TS Allanburg TS 115kV Line D1A/D3A 115kV Line Q2AH	Refurbish/replace major high voltage transmission equipment	Hydro One	 2024 2027 2027 2029 2031 2032 2032 2024 2025	 $43M $55M $55M $45M $27M $14M $20M $4M $10M

1. The planned in-service dates are tentative and subject to change
2. Costs are based on budgetary planning estimates and excludes the cost for distribution infrastructure (if required)
3. Contingent on customer

9 REFERENCES

[1] Niagara Region Integrated Resource Plan - Dec 2022

[2] Niagara Region NA report - May 2021

[3] Niagara Region Regional Infrastructure Plan Report - March 2017

APPENDIX A: NIAGARA REGION - STEP-DOWN TRANSFORMER STATIONS AND SUPPLY CIRCUITS

No.	Transformer Station	Voltage (kV)	Supply Circuits
1	Allanburg TS	115	A6C/A7C
2	Beamsville TS	115	Q2AH
3	Bunting TS	115	Q11S/Q12S
4	Carlton TS	115	D9HS/D10S
5	CNPI Station #17 MTS	115	A37N
6	CNPI Station #18 MTS	115	A37N
7	Crowland TS	115	A6C/A7C
8	Dunnville TS	115	Q2AH
9	Glendale TS	115	Q11S/Q12S, D9HS/D10S
10	Kalar MTS	115	A36N/A37N
11	Murray TS	115	A36N/A37N
12	Niagara West MTS	230	Q23BM/Q25BM
13	NOTL #2 MTS	115	Q11S
14	NOTL York MTS	115	Q12S
15	Port Colborne TS	115	A6C/A7C
16	Stanley TS	115	Q3N/Q4N
17	Thorold TS	115	D1A/D3A
18	Vansickle TS	115	D9HS/D10S
19	Vineland DS	115	Q2AH

APPENDIX B: NIAGARA REGION - DISTRIBUTORS

No.	Name of LDC
1	Alectra Utilities
2	Canadian Niagara Power Inc.
3	Grimsby Power Inc.
4	Hydro One Networks Inc. (Distribution)
6	Niagara-on-the-Lake Hydro Inc.
7	Niagara Peninsula Energy Inc.
8	Welland Hydro Electric System Corp.

APPENDIX C: NIAGARA REGION – STATIONS LOAD FORECAST (MW)

Station	LTR MW	2022 Actual[1]	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042
Allanburg TS	58.7	40	45	45	45	46	46	46	46	46	46	47	47	47	48	48	49	49	50	50	51	51
Beamsville TS	59.0	63	77	79	81	81	82	83	84	85	86	86	88	89	90	92	93	95	97	98	100	102
Bunting TS	78.2	54	58	58	59	60	60	61	62	64	65	66	67	68	70	71	73	74	76	77	77	77
Carlton TS	95.4	83	89	90	91	92	93	95	96	97	99	100	102	104	106	105	105	105	105	106	106	106
CNPI Station #17 MTS	59.4	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	27	27
CNPI Station #18 MTS	59.4	37	36	36	36	36	36	35	35	35	35	35	35	35	35	35	35	36	36	36	36	36
Crowland TS	101.7	94	101	109	111	113	114	116	118	120	121	121	121	122	122	123	124	125	126	126	128	129
Dunnville TS	53.3	30	36	36	37	37	37	38	38	38	39	39	39	40	40	40	41	41	41	42	42	42
Glendale TS (T1/T2)	96.3	41	31	32	32	32	33	33	34	35	35	36	37	37	38	39	40	40	41	42	42	42
Glendale TS (T3/T4)	20.1	14	6	6	6	7	7	7	7	7	8	8	8	9	9	9	10	10	10	11	11	11
Kalar MTS	72.0	44	47	47	54	61	64	66	67	69	69	69	69	70	70	71	72	72	73	74	75	75
Murray TS (T11/T12)	73.2	66	78	78	78	78	78	78	78	79	79	79	79	80	80	81	82	83	83	84	85	86
Murray TS (T13/T14)	79.8	44	42	42	42	43	43	43	43	44	44	44	44	45	45	45	45	45	46	46	46	47
Niagara West MTS	63.4	41	49	57	58	58	59	60	62	63	65	66	68	69	71	73	75	77	78	80	82	84
NOTL #2 MTS	63.5	48	33	34	36	38	39	40	40	41	42	43	44	45	45	46	47	48	49	50	51	52
NOTL York MTS	75.5	17	18	18	19	20	21	22	22	23	23	24	24	25	25	26	26	27	27	28	28	29
Port Colborne TS	50.8	37	35	36	36	36	36	36	36	37	37	37	37	37	38	38	38	38	38	39	39	39
Stanley TS	103.6	57	60	61	62	62	63	64	64	65	65	66	67	67	68	69	69	70	71	72	72	73
Thorold TS	91.3	23	24	25	25	25	25	25	26	26	26	26	26	26	27	27	27	27	27	28	28	28
Vansickle TS	99.5	47	52	52	53	53	54	55	56	57	58	59	60	62	63	64	66	67	68	68	68	68
Vineland DS	26.4	20	21	21	21	21	22	23	23	24	25	25	25	25	26	26	26	27	27	27	27	28
Industrial Customer 1	-	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Industrial Customer 2	-	7	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Industrial Customer 3	-	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Industrial Customer 4	-	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Industrial Customer 5	-	20	17	17	24	32	35	38	57	57	57	57	57	57	57	57	57	57	57	57	57	57
Industrial Customer 6	-	4	3	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Industrial Customer 7	-	24	80	146	146	146	146	146	146	146	146	146	146	146	146	146	146	146	146	146	146	146
Industrial Customer 8[2]	-	-	10	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50

1. Actual summer load adjusted for extreme weather.
2. Curtailable load under specific outage conditions.

APPENDIX D: LIST OF ACRONYMS

Acronym	Description
A	Ampere
BES	Bulk Electric System
BPS	Bulk Power System
CDM	Conservation and Demand Management
CEP	Community Energy Plan
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
MEP	Municipal Energy Plan
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
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