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NEEDS ASSESSMENT REPORT

Toronto Region

Date: October 18, 2017

Prepared by: Toronto Region Study Team

Disclaimer

This Needs Assessment Report was prepared for the purpose of identifying potential needs in the Toronto Region and to recommend which needs may require further assessment and/or regional coordination to develop wires options. 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	Toronto (formerly Metro Toronto)		
LEAD	Hydro One Networks Inc. ("HONI")		
START DATE	June 26, 2017	**END DATE**	October 18, 2017

1. INTRODUCTION

The first cycle of the Regional Planning process for the Toronto Region was initiated in Q2 2014 and completed with the publication of the Regional Infrastructure Plan ("RIP") on January 12, 2016. The RIP provided a description of needs and recommendations of preferred wires plans to address near-term and mid-term needs that may emerge over the next ten years. The RIP also identified some long-term needs that will be reviewed during this planning cycle.

The purpose of this Needs Assessment is to identify any new needs and reaffirm needs identified in the previous Toronto Region RIP.

2. REGIONAL ISSUE/TRIGGER

In accordance with the Regional Planning process, the regional planning cycle should be triggered at least every five years. The trigger for this NA was several new needs emerging in the Toronto Region as discussed in this report.

3. SCOPE OF NEEDS ASSESSMENT

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

- New needs identified by Study Team members; and,
- Review and reaffirm needs/plans identified in the previous RIP

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

An updated load forecast for the region was provided by Toronto Hydro-Electric System Limited ("THESL") for the purposes of this NA. In addition, THESL is currently undertaking a study to develop a new load forecast, expected to be completed by Q4 2017. The updated load forecast will be taken into account during the next phases of regional planning, i.e. IRRP and/or RIP. Hydro One Distribution, Alectra Utilities, and Veridian reaffirmed their load forecast developed during the RIP phase and the Study Team deemed this to be adequate for this NA.

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 Toronto Region regarding capacity needs, system reliability, operational issues, and major assets/facilities approaching end-of-life ("EOL").

5. ASSESSMENT METHODOLOGY

The assessment's primary objective is to identify the electrical infrastructure needs in the Region over the study period. The assessment reviewed available information including load forecasts, system reliability and operation issues, and major high voltage equipment identified to be at the end of their useful life and requiring replacement/refurbishment.

A technical assessment of needs was undertaken based on:

- Station capacity and transmission adequacy;
- System reliability and operation; and,
- Major high voltage equipment reaching the end of its useful life with respect to replacing it with similar type equipment versus other options to determine the most optimal, resilient, and economic outcome.

6. RESULTS

I. Aging Infrastructure

In the Toronto Region, high voltage equipment at 13 stations and 3 transmission line sections have been identified to be at the end of their useful life and require replacement/refurbishment in the near and medium term. Refer to section 7.1.1 for more details.

II. 115kV Connection Capacity

A transformation capacity need to serve the potential load growth in the East Harbor / Port Lands area has been identified in the medium term. A transformation capacity need for Basin TS was also identified in the medium term. It is forecasted to slightly exceed its LTR in 2027. Refer to section 7.1.2 for more details.

III. System Reliability & Operation

Load restoration needs for the loss of circuits, C14L+C17L, C5E+C7E, and K3W+K1W have been identified. Refer to section 7.1.3 for more details.

IV. Needs Identified in Previous Toronto Region RIP

The study team reaffirms that the needs and their respective plans identified in the previous Toronto Region RIP (which are not yet underway) are still valid. Updates to the plans have been provided where relevant. Refer to sections 7.2.1 to 7.2.9 for more details.

7. RECOMMENDATIONS

The Study Team's recommendations are as follows:

a) Hydro One and THESL will coordinate a plan to address the following needs (further regional coordination is not required):

- EOL assets discussed in section 7.1.1.1 and 7.1.1.2

b) Further regional coordination is required for the following needs:

- EOL assets discussed in section 7.1.1.3 (EOL equipment replacement at Bermondsey TS, John TS, Main TS, and Manby TS) and 7.1.1.4 (EOL equipment replacement for C5E/C7E, H1L/H3L/H6LC/H8LC, and L9C/L12C)

- Additional transformation capacity need in the East Harbor / Port Lands area and Basin TS transformation capacity need discussed in section 7.1.2

- Load restoration need for the loss of circuits C14L+C17L, C5E+C7E, and K3W+K1W, discussed in section 7.1.3.

- Needs identified in previous Toronto RIP/IRRP (mostly the long term needs), discussed in sections 7.2.5 to 7.2.9 (transformation capacity need for 230/115kV Leaside autotransformers and voltage collapse of 115kV Leaside subsystem; line capacity need for 115kV Leaside TS x Wiltshire TS corridor; transformation capacity need for 230/115kV Manby TS autotransformers; line capacity need for 115kV Manby West x Riverside Junction; and, line capacity need for 115kV Don Fleet JCT x Esplanade TS)

c) The Study Team reaffirms the remaining needs that were identified in the previous RIP, discussed in sections 7.2.1 to 7.2.4. Their associated plans are valid and are in progress.

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1 INTRODUCTION

The first cycle of the Regional Planning process for the Toronto Region (formerly Metro Toronto) was completed in January 2016 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. The long term needs were recommended for further review during the next regional planning cycle.

The purpose of this Needs Assessment ("NA") is to identify new needs and reconfirm the needs identified in the previous Toronto Region regional planning cycle. Since the first regional planning cycle, several new needs in the region have been identified. The majority of these needs are a result of aging infrastructure which need to be replaced within the near to medium term.

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

Table 1: Toronto Region Technical Study Team Participants

Company
Alectra Utilities Corporation (formerly Enersource Hydro Mississauga, PowerStream Inc.)
Hydro One Networks Inc. (Distribution)
Hydro One Networks Inc. (Lead Transmitter)
Independent Electricity System Operator ("IESO")
Toronto Hydro-Electric System Limited ("THESL")
Veridian Connections Inc. ("Veridian")

2 REGIONAL ISSUE/TRIGGER

In accordance with the Regional Planning process, the Regional Planning cycle should be triggered at least every five years. The NA was triggered due to several new needs in the Toronto Region as discussed in this report.

3 SCOPE OF NEEDS ASSESSMENT

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

- New needs identified by the Study Team; and
- Needs already identified in the RIP report or IRRP report

The Study Team may identify additional needs during the next phases of the planning process, namely Scoping Assessment ("SA"), Local Planning ("LP"), Integrated Regional Resource Plan ("IRRP"), and/or RIP.

An updated load forecast for the region was provided by Toronto Hydro-Electric System Limited ("THESL") for the purposes of this NA. In addition, THESL is currently undertaking a study to develop a new load forecast, expected to be completed by Q4 2017. The updated load forecast will be taken into account during the next phases of regional planning, i.e. IRRP and/or RIP. Hydro One Distribution, Alectra Utilities, and Veridian reaffirmed their load forecast developed during the RIP phase and the Study Team deemed this to be adequate for this NA.

4 REGIONAL DESCRIPTION AND CONNECTION CONFIGURATION

The Toronto Region includes the area roughly bordered geographically by Lake Ontario on the south, Steeles Avenue on the north, Highway 427 on the west and Regional Road 30 on the east. It consists of the City of Toronto, which is the largest City in Canada and the fourth largest in North America. Please see Figure 1 for the map.

The Toronto Region is comprised of the City of Toronto. Electrical supply to the Region is provided by thirty-five 230kV and 115kV transmission and step-down stations as shown in Figure 2. The eastern, northern and western parts of the Region are supplied by eighteen 230/27.6kV step-down transformer stations. The central area is supplied by two 230/115kV autotransformer stations (Leaside TS and Manby TS) and fifteen 115/13.8kV and two 115/27.6kV step-down transformer stations.

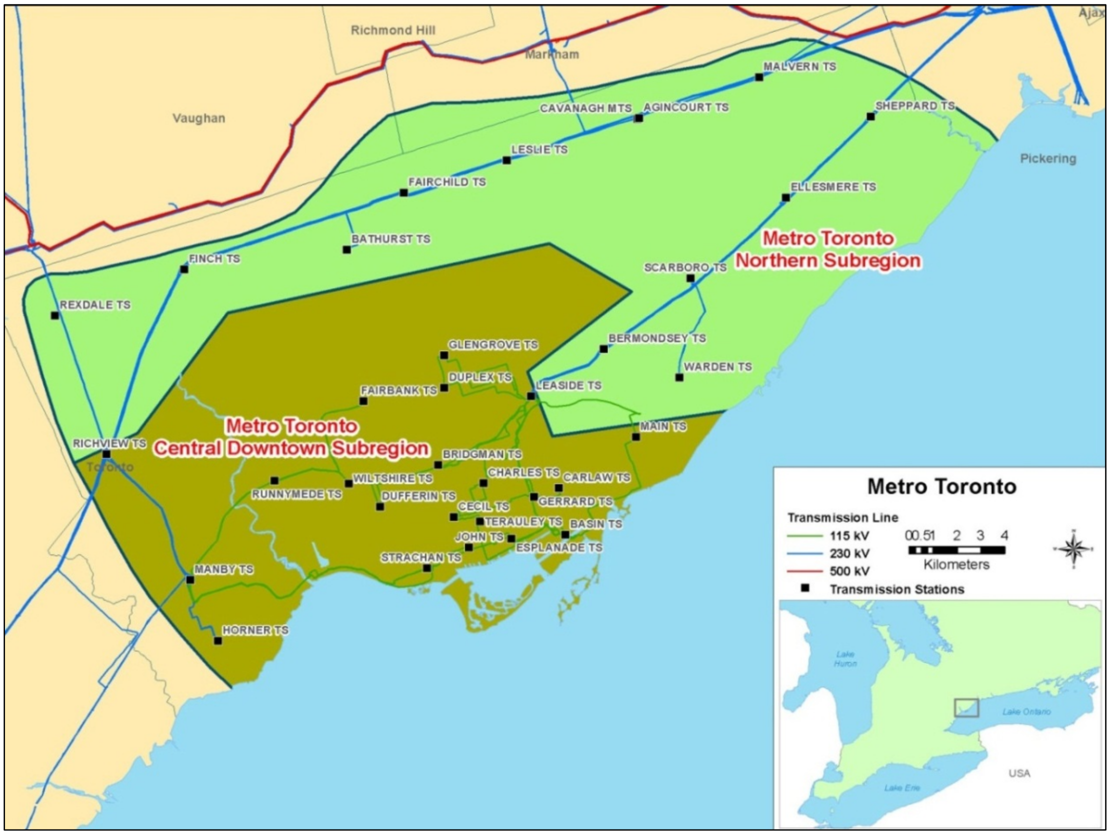

Figure 1: Toronto Regional and Sub-Regional Boundaries

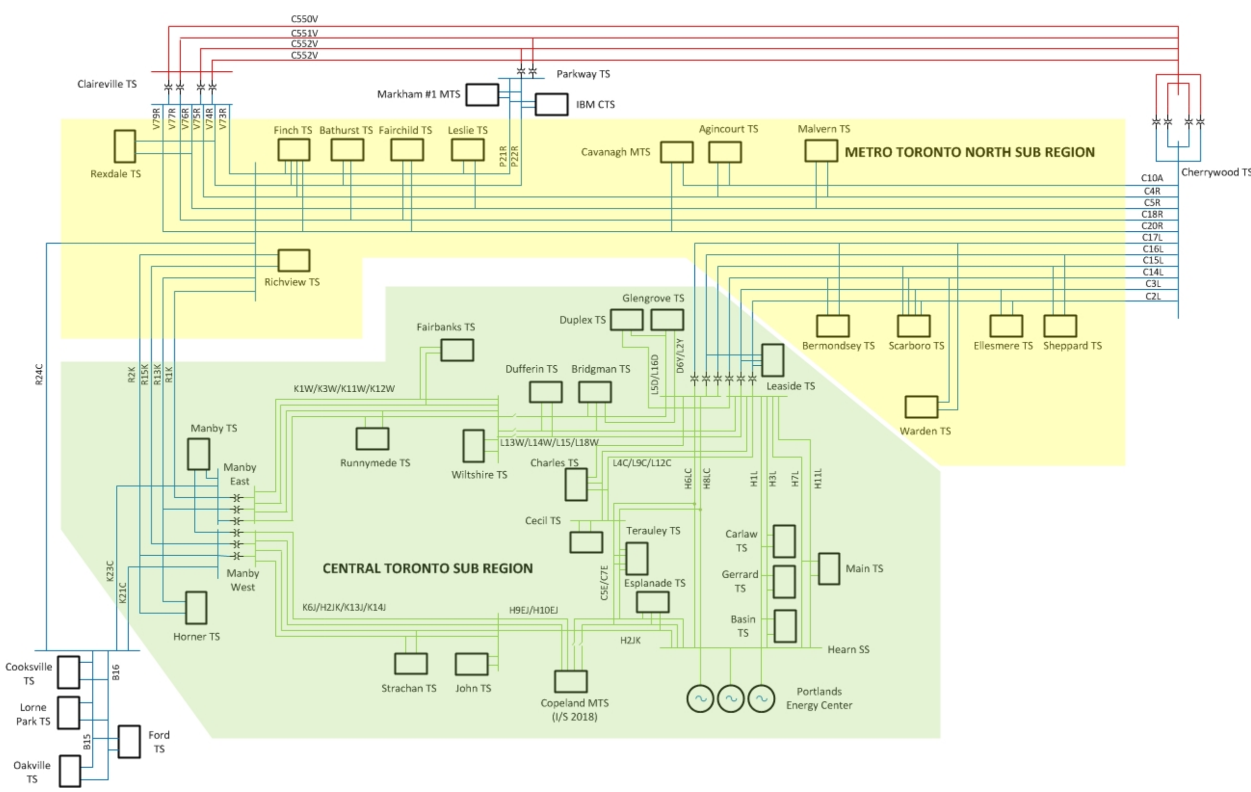

Figure 2: Toronto Region – Single Line Diagram

5 INPUTS AND DATA

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

- Load Forecast updates and/or reaffirmed from previous Toronto RIP;
- Any 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 Toronto Region

6 ASSESSMENT METHODOLOGY

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

Information gathering included:

i. Load forecast: THESL provided an updated load forecast. Hydro One Distribution, Alectra Utilities, and Veridian reaffirmed their load forecast developed during the RIP phase and the Study Team deemed this to be adequate for this NA (for more details on the RIP load forecast, please refer to Section 5 of the RIP report). The LDC's load forecast is translated into load growth rates and is applied onto the 2016 actual summer station peak load, adjusted for extreme weather conditions (according to Hydro One's methodology). It should be noted that the actual versus forecasted year to year demand can vary due to factors such as weather, economic development, etc.

   In addition, THESL is currently undertaking a study to develop a new load forecast, expected to be completed by Q4 2017. This updated load forecast will be taken into account during the next phases of regional planning, i.e. IRRP and/or RIP.

ii. Relevant information regarding system reliability and operational issues in the region;

iii. List of major HV transmission equipment a) recently replaced b) planned and/or identified to be refurbished 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.

Technical assessment of needs was based on:

i. Station capacity and Transmission Adequacy assessment

ii. System reliability and operation assessment

iii. End-of-life equipment: Major high voltage equipment reaching the end of its useful life with respect to replacing it with similar type equipment versus other options to determine the most optimal, resilient, and economic outcome.

Note that the Region is summer peaking so the assessment is based on summer peak loads.

7 NEEDS

This section describes emerging needs that have been identified in the Toronto Region since the previous regional planning cycle and reaffirms the near, medium, and long-term needs already identified in the previous RIP. The needs are summarized in Tables 2 and 3 below:

Table 2: New Needs

New Needs	Discussed in Section
End-of-Life Assets	7.1.1
East Harbor / Port Lands Area and Basin TS – Transformation Capacity	7.1.2
Load Restoration – C14L+C17L, C5E+C7E, K3W+K1W	7.1.3

Table 3: Needs Identified in Previous RIP and IRRP (1)

Needs Identified in Previous RIP	Discussed in Section	RIP Report Section
Southwest Toronto – Station Capacity	7.2.1	7.2
Downtown District – Station Capacity	7.2.2	7.3
230 kV Richview x Manby Corridor – Line Capacity	7.2.3	7.4
Supply Security – Breaker Failure at Manby West & East TS	7.2.4	7.6
230/115kV Leaside Autotransformers – Transformation Capacity	7.2.5	7.10
Voltage Instability of 115kV Leaside Subsystem	7.2.5	Identified in Central Toronto Area IRRP report – Appendix E
115 kV Leaside x Wiltshire Corridor – Line Capacity	7.2.6	7.10
230/115kV Manby Autotransformers – Transformation Capacity	7.2.7	7.10
115kV Manby West x Riverside Junction – Line Capacity	7.2.8	7.10
115kV Don Fleet JCT x Esplanade TS – Line Capacity	7.2.9	Identified in Central Toronto Area IRRP report – Appendix E

(1) Includes needs identified in the previous RIP and IRRP that do not have plans underway yet

7.1 New Needs

7.1.1 End-Of-Life (EOL) Asset Needs

Hydro One has identified the following major high voltage equipment and transmission lines to be reaching the end of their useful life over the next 10 years. Based on the equipment condition assessment including relevant tests, these EOL assets have been identified to be in poor condition. Replacement plans for EOL assets are summarized below in Table 4 with exceptions where implementation plans were developed and projects are already underway.

Table 4: End-of-Life Assets – Toronto Region

EOL Asset(1)	Replacement/ Refurbishment Timing(2)	Details
Fairbank TS: T1/T3, T2/T4 Transformers	2022-2023	EOL Transformers and other HV equipment are identified at these stations for replacement with similar type equipment with same ratings, and are discussed further in Section 7.1.1.1.
Fairchild TS: T1/T2 Transformers	2023-2024	
Leslie TS: T1 Transformer	2023-2024	
Runnymede TS: T3/T4 Transformers	2021-2022	
Sheppard TS: T3/T4 Transformers	2019-2020	
Bridgman TS: T11/T12/T13 Transformers	2022-2023	EOL Transformers and other HV equipment are identified at these stations for replacement with higher rated equipment, and are discussed further in Section 7.1.1.2
Charles TS T3/T4 Transformers	2024-2025	
Duplex TS: T1/T2	2023-2024	
Strachan TS: T12 Transformer	2020-2021	
Bermondsey TS: T3/T4 Transformers	2023-2024	EOL Transformers and other HV equipment are identified at these stations where scope for replacement is to be further assessed, and are discussed further in Section 7.1.1.3
John TS: T1, T2, T3, T4, T6 Transformers and 115 kV Breakers	2025-2026	
Main TS: T3/T4 Transformers and 115 kV line disconnect switches	2021-2022	
Manby TS: T7, T9, T12 Autotransformers, T13 Step-Down Transformer and rebuild 230kV yard	2024-2025	
115kV C5E/C7E Underground Cable: Esplanade TS to Terauley TS	TBD	EOL Line sections are identified for replacement where scope for replacement is to be further assessed, and are discussed further in Section 7.1.1.4
115kV H1L/H3L/H6LC/H8LC: Bloor Street JCT to Leaside JCT	TBD	
115kV L9C/L12C: Leaside TS to Balfour JCT	TBD	

(1) No other lines or stations in the Toronto region have been identified for major replacement/refurbishment at this time
(2) The replacement/refurbishment scope, timing, and prioritization are under review/development and are subject to change

The end-of-life equipment assessment for the above assets considered the following options:

1. Maintaining the status quo
2. Downsizing equipment with lower ratings and built to current standards by transferring load to underutilized facilities within a station or between stations
3. Eliminating equipment by transferring load to underutilized facilities within a station or between stations
4. Replacing equipment with similar equipment with same ratings and built to current standards
5. Replacing equipment with similar equipment with higher ratings and built to current standards

The study team agreed that non-wire options were not a viable option in cases where it has been recommended to replace EOL transformers with a similar transformer with the same or higher ratings (refer to section 7.1.1.1 and 7.1.1.2). With respect to (1), the EOL assets listed in Table 4 are in poor condition so maintaining the status quo for these assets is not an option due to the risk of equipment failure, customer outages and increased maintenance cost.

With respect to (2) and (3), it should be noted that the City of Toronto (within Toronto Region) is one of the most populous and congested cities in Canada where there is continued development, population and economic growth resulting in greater electricity demand. Efficient and effective/maximum use of land and station facilities includes planning ahead for long-term electricity needs, reliability and system resiliency. The majority of stations in the Toronto Region are above and forecasted to be over 75% of their Limited Time Rating ("LTR"). Accordingly, eliminating transformation capacity is not an option because total loads cannot be permanently transferred to neighboring stations. In addition, it is worth noting that:

- Upgrading equipment with higher capacity has very little incremental cost compared to replacing the equipment with similar equipment of the same or lower ratings. For example, it may cost \$200-\$300 thousand extra for the larger transformers rather than replacing them with similar transformers of the same or lower ratings now and then having to upgrade it later (due to eventual load growth) within the lifetime of the transformer for an additional cost of \$5-\$10M.
- Maintaining or upgrading capacity to the maximum at the station is the most effective and efficient use of maximizing land and infrastructure for little incremental cost, if any. The higher capacity at very low cost also provides operational flexibility, high resiliency during emergency and extreme weather conditions.
- There is no expectation and/or plan to downsize upstream facilities and therefore downsizing existing station capacity is not prudent.

Therefore, in many cases options (4) and (5) are considered better options. Further rationale for these options is provided in sections 7.1.1.1 to 7.1.1.4.

7.1.1.1 EOL Transformers: Replace with Similar Equipment with Same Ratings

This section describes EOL transformers which are recommended to be replaced with similar type of equipment with same ratings and built to current standards. This was determined to be the preferred option for the reasons listed below:

- Based on historical loading, future electricity needs, and the need for greater resiliency, it is not prudent to reduce the capacity of or eliminate the station, while still maintaining the capacity to reliably supply the demand.
- Hydro One has standardized transformer sizes in order to save costs on procurement, engineering, spares management, maintenance etc. For sustainment purposes the appropriate sized standard transformer is installed, which in some cases may be larger than what the load would currently require, but it is financially prudent.
- The cost savings of replacing EOL transformers with similar units of lower ratings (as opposed to similar units with the same ratings) is not significant compared to the cost of upgrading the

transformers in the future when needed. For example, it may cost $200-$300 thousand extra for the same size transformers as opposed to the smaller ones with lower ratings whereas upgrading them later (due to eventual load growth) within the lifetime of the transformer may cost an additional $5-$10 million. Such changes may also require reconfiguration of LV facilities resulting in additional cost.

- Customer determined that they do not require upgraded transformer(s) because:
  - current load forecast for electricity needs and existing configuration at station does not warrant an upgrade in capacity; or,
  - other measures, where feasible, are being taken to accommodate load growth (e.g. load transfers, new station being built, conservation and demand management programs)
- There is a need for the existing feeders to maintain distribution connections/reliability
- Non-wires options are not a viable option to address the need for these specific EOL transformers

Additional comments and further rationale for the Study Team's recommendations are provided below.

Fairbank TS

Fairbank TS comprises two DESN units, T1/T3 (50/83 MVA) and T2/T4 (50/83 MVA), having a summer 10-Day LTR of 182 MW. The station's 2016 actual non-coincident summer peak load (adjusted for extreme weather) was about 169 MW and is forecasted to be approximately 173 MW and 188 MW in 2017 and 2027 respectively. Transformers T1/T3 and T2/T4 are currently about 46 years old and have been identified to be at their EOL.

The load at Fairbank TS is forecasted to exceed its LTR in the medium term. As per the IRRP and RIP recommendations, a new Runnymede TS T1/T2 DESN will be built and is expected to be in-service in 2018. Currently, two feeders from Fairbank TS are planned to be moved to the new Runnymede TS T1/T2 DESN to keep Fairbank TS load under its LTR. The other two closest stations, Duplex TS and Glengrove TS, are 13.8kV stations so permanent load transfer from Fairbank TS, which is a 27.6kV station, is not a viable option. Further, the load at Duplex TS is forecasted to be over 90% of its LTR in the medium term. For these reasons, downsizing T1/T3 and T2/T4 to 42MVA transformers (the lower rated standard transformer size for 115/27.6kV) is not prudent. Moreover, downsizing capacity today and then later upgrading within the lifetime of the transformer due to eventual load growth will be significantly more costly. For example it may cost an additional $5-$10 million for the replacement of the transformers plus the incremental cost for the LDC to reconfigure feeders. It should also be noted that maintaining capacity, as opposed to downsizing, is a more resilient option as it provides additional flexibility during emergency conditions through load transfers.

Based on the above, the study team recommends that this need be addressed by Hydro One and THESL to coordinate the replacement plan. The timing of replacement for the EOL equipment is 2022-2023.

Fairchild TS

Fairchild TS comprises two DESN units, T1/T2 (75/125 MVA) and T3/T4 (75/125 MVA), having a summer 10-Day LTR of 346 MW. The station's 2016 actual non-coincident summer peak load (adjusted for extreme weather) was about 272 MW and is forecasted to be approximately 275 MW and 296 MW in 2017 and 2027 respectively. Transformers T1 is 43 years old and has been identified to be at its EOL. The companion DESN transformer T2 failed and was replaced under emergency this year with a similar 75/125 MVA unit.

The load at Fairchild TS is forecasted to be over 85% of its LTR in the medium term. The load at the two closest stations, Bathurst TS and Leslie TS, is also forecasted to be over 85% and 90% of their respective LTR's in the medium term. Therefore, downsizing T1 and consolidating load within the station and/or with area stations is not a prudent or viable option given medium term load growth at these stations. It is also important to note that the station is configured as a dual secondary yard (230/27.6-27.6kV) and the standard lower rated unit has only one secondary and would have different impedance than the companion T2 transformer. Consequently, replacing T1 with a lower rated unit could cause significant operational and configuration issues. Moreover, downsizing capacity today and then later upgrading within the lifetime of the transformer due to eventual load growth will be significantly more costly. For example it may cost an additional $5-$10 million for the replacement of the transformers plus the incremental cost for the LDC to reconfigure feeders. It should also be noted that maintaining capacity, as opposed to downsizing, is a more resilient option as it provides additional flexibility during emergency conditions through load transfers. Upgrading T1 is also not an option since it's already at the maximum standard size.

Based on the above, the study team recommends that this need be addressed by Hydro One and THESL to coordinate the replacement plan. The timing of replacement for the EOL equipment is 2023-2024.

Leslie TS

Leslie TS comprises two DESN units, T1/T2 (75/125 MVA) and T3/T4 (75/125 MVA), having a summer 10-Day LTR of 325 MW. The station's 2016 actual non-coincident summer peak load (adjusted for extreme weather) was about 237 MW and is forecasted to be approximately 249 MW and 294 MW in 2017 and 2027 respectively. Transformer T1 is currently about 54 years old and has been identified to be at its EOL. The companion DESN transformer T2 is currently 19 years old and is not close to its EOL.

The load at Leslie TS is forecasted to be 90% of its LTR in the medium term. The load at the three closest stations, Fairchild TS, Cavanagh MTS, and Agincourt TS, is also forecasted to be over 85%, 65%, and 65% respectively of their LTR's in the medium term. Although Agincourt TS and Cavanagh MTS have available station capacity, they do not have spare feeder positions to potentially accommodate a permanent load transfer from Leslie TS as more than one feeder would have to be transferred to make downsizing T1 to 83MVA feasible. Adding new feeder positions would be much more costly as opposed to replacing the transformer with a similar unit. Therefore, downsizing T1 and consolidating load within the station and/or with Fairchild TS is not prudent given medium term load growth at these stations and because permanent load transfer to Agincourt TS and Cavanagh MTS is not a viable or economical option. Moreover, downsizing capacity today and then later upgrading within the lifetime of the transformer due to eventual load growth will be significantly more costly. For example it may cost an additional $5-$10 million for the replacement of the transformers plus the incremental cost for the LDC to reconfigure feeders. It should also be noted that maintaining capacity, as opposed to downsizing, is a more resilient option as it provides additional flexibility during emergency conditions through load transfers. Upgrading T1 is also not an option since it's already at the maximum standard size.

Based on the above, the study team recommends that this need be addressed by Hydro One and THESL to coordinate the replacement plan. The timing of replacement for the EOL equipment is 2023-2024.

Runnymede TS

Runnymede TS comprises one DESN unit, T3/T4 (58/93 MVA), having a summer 10-Day LTR of 111 MW. The station's 2016 actual non-coincident summer peak load (adjusted for extreme weather) was about 119 MW and is forecasted to be approximately 121 MW and 185 MW in 2017 and 2027 respectively. Transformers T3/T4 are currently about 45 years old and have been identified to be at their EOL.

As per the previous IRRP and RIP report, building a new Runnymede TS T1/T2 DESN (50/83 MVA) was recommended and is expected to be in service in 2018-2019 to supply the load growth in this area and will keep the Runnymede TS T3/T4 DESN under its LTR. The neighbouring station, Fairbank TS, is also forecasted to exceed its capacity in the near term and currently two of its feeders are planned to be moved to the new Runnymede TS T1/T2 DESN to keep its load under its LTR. Further, the other closest station, Wiltshire TS, is a 13.8kV station so permanent load transfer from Runnymede T3/T4, which is a 27.6kV DESN, is not a viable or economical option. For these reasons, downsizing T3/T4 to 42MVA transformers (the lower rated standard transformer size for 115/27.6kV) is not prudent. Moreover, downsizing capacity today and then later upgrading within the lifetime of the transformer due to eventual load growth will be significantly more costly. For example it may cost an additional $5-$10 million for the replacement of the transformers plus the incremental cost for the LDC to reconfigure feeders. It should also be noted that maintaining capacity, as opposed to downsizing, is a more resilient option as it provides additional flexibility during emergency conditions through load transfers.

Based on the above, the study team recommends that this need be addressed by Hydro One and THESL to coordinate the replacement plan. The timing of replacement for the EOL equipment is 2021-2022

Sheppard TS

Sheppard TS comprises two DESN units, T1/T2 (75/125 MVA) and T3/T4 (50/83 MVA), having a summer 10-Day LTR of 204 MW. The station's 2016 actual non-coincident summer peak load (adjusted for extreme weather) was about 170 MW and is forecasted to be approximately 171 MW and 192 MW in 2017 and 2027 respectively. Transformers T3/T4 are currently 55 years old and have been identified to be at their EOL.

The load at Sheppard TS is forecasted to be over 90% of its LTR in the medium term. However, the Sheppard TS T1/T2 DESN is more lightly loaded than the T3/T4 DESN (T3/T4 is approximately 60% of total station loading in the past three years). Given the potential for load transfers from the T3/T4 DESN to the T1/T2 DESN, upgrading T3/T4 is not prudent. Downsizing T3/T4 is also not an option since the transformers are already at the smallest standard size for a 230/27.6kV DESN.

Based on the above, the study team recommends that this need be addressed by Hydro One and THESL to coordinate the replacement plan. The timing of replacement for the EOL equipment is 2019-2020.

7.1.1.2 EOL Transformers: Replace with Similar Equipment with Higher Ratings

This section describes EOL transformers which are recommended to be replaced with similar type units with higher ratings (60/100 MVA units) and built to current standards. As stated earlier, maintaining or upgrading capacity to the maximum at the station is the most effective and efficient use of maximizing land and infrastructure. Upgrading equipment with higher capacity has little incremental cost compared to replacing the equipment with similar equipment of the same or lower ratings. For example, it may cost $200-$300 thousand extra for the larger transformers rather than replacing them with similar transformers of the same or lower ratings now and having to upgrade it later (due to eventual load growth) within the lifetime of the transformer for an additional $5-$10M. Upgrading equipment also provides additional flexibility and reliable supply in emergency situations. This was also determined to be the preferred option for the reasons listed below:

- Load transfer is not viable because:
    - Capability to transfer load does not currently exist or is not cost effective at the distribution level
    - Insufficient proximity of neighbouring stations that have capacity to accommodate load transfer
- Hydro One has standardized transformer sizes in order to save costs on procurement, engineering, spares management, maintenance etc. For sustainment purposes the appropriate sized standard transformer is installed, which in some cases may be larger than what the load would currently require, but it is financially prudent.
- Customer does not require an upgrade of transformer(s) to accommodate load growth in area;
- Non-wire options are not a viable option to address the need for these specific EOL transformers

Bridgman TS

Bridgman TS comprises of five transformers, T11, T12, T13, T14, and T15, having a summer 10-Day LTR of 183 MW. The station's 2016 actual non-coincident summer peak load (adjusted for extreme weather) was about 159 MW and is forecasted to be approximately 162 MW and 175 MW in 2017 and 2027 respectively. Transformers T11, T12 and T13 (46/67 MVA) are currently about 50 years old and have been identified to be at their EOL.

The load at Bridgman TS is forecasted to be over 95% of its LTR in the medium term. The load at four of the closest stations, Cecil TS, Charles TS, Duplex TS, and Dufferin TS, is also forecasted to be over 80% of their respective LTR's in the medium term. Therefore, downsizing T11, T12, and T13 and consolidating load within the station and/or with area stations is not a prudent or viable option given long term load growth at these stations. It should also be noted that by upgrading T11, T12, and T13 to 100MVA units (the higher rated standard transformer size for 115/13.8-13.8kV), similar to the T15 unit, T14 can ultimately be removed while still increasing capacity and at a lower cost compared to replacing all the transformers with similar units with the same ratings. Moreover, downsizing capacity today and then later upgrading within the lifetime of the transformer due to eventual load growth will be significantly more costly. For example it may cost an additional $5-$10 million for the replacement of the transformers plus the incremental cost for the LDC to reconfigure feeders. It should also be noted that maintaining capacity, as opposed to downsizing, is a more resilient option as it provides additional flexibility during emergency conditions through load transfers.

Based on the above, the study team recommends that this need be addressed by Hydro One and THESL to coordinate the replacement plan. The EOL transformers will be replaced with 60/100MVA units and the timing of replacement is 2022-2023.

Charles TS

Charles TS comprises two DESN units, T1/T2 (60/100 MVA) and T3/T4 (45/75 MVA), having a summer 10-Day LTR of 200 MW. The station's 2016 actual non-coincident summer peak load (adjusted for extreme weather) was about 139 MW and is forecasted to be approximately 146 MW and 174 MW in 2017 and 2027 respectively. Transformers T3/T4 are currently about 50 years old and have been identified to be at their EOL.

The load at Charles TS is forecasted to be over 85% of its LTR in the medium term. The load at three of the closest stations, Bridgman TS, Cecil TS and Terauley TS, is also forecasted to be approaching their respective LTR's in the medium term. Therefore, downsizing T3/T4 and consolidating load within the station and/or with area stations is not a prudent or viable option given medium term load growth at these stations. Moreover, downsizing capacity today and then later upgrading within the lifetime of the transformer due to eventual load growth will be significantly more costly. For example it may cost an additional $5-$10 million for the replacement of the transformers plus the incremental cost for the LDC to reconfigure feeders. It should also be noted that maintaining capacity, as opposed to downsizing, is a more resilient option as it provides additional flexibility during emergency conditions through load transfers.

Based on the above, the study team recommends that this need be addressed by Hydro One and THESL to coordinate the replacement plan. The EOL transformers will be replaced with 60/100MVA units and the timing of replacement is 2024-2025.

Duplex TS

Duplex TS comprises two DESN units, T1/T2 (45/75 MVA) and T3/T4 (45/75 MVA), having a summer 10-Day LTR of 121 MW. The station's 2016 actual non-coincident summer peak load (adjusted for extreme weather) was about 97 MW and is forecasted to be approximately 101 MW and 109 MW in 2017 and 2027 respectively. Transformers T1/T2 are currently about 49 years old and have been identified to be at their EOL.

The load at Duplex TS is forecasted to be 90% of its LTR in the medium term. The load at two of the closest stations, Bridgman TS and Glengrove TS, is also forecasted to be over 95% and 65% respectively of their LTR's in the medium term. Although Glengrove TS has capacity in the medium term, maximizing use of existing land and station facilities at Duplex TS (as opposed to downsizing or eliminating) allows for effective planning for long-term electricity needs, reliability and system resiliency. The third neighbouring station, Fairbank TS, is a 27.6kV station so permanent load transfer from Duplex TS, which is a 13.8kV station, is not a viable or economical option. Further, the load at Fairbank TS will be close to its LTR following the transfer of its two feeders to the new Runnymede T1/T2 DESN). For these reasons downsizing T1/ T2 is not prudent. Moreover, downsizing capacity today and then later upgrading within the lifetime of the transformer due to eventual load growth will be significantly more costly. For example it may cost an additional $5-$10 million for the replacement of the transformers plus the incremental cost for the LDC to reconfigure feeders. It should also be noted that maintaining capacity, as opposed to downsizing, is a more resilient option as it provides additional flexibility during emergency conditions through load transfers.

Based on the above, the study team recommends that this need be addressed by Hydro One and THESL to coordinate the replacement plan. The EOL transformers will be replaced with 60/100MVA units and the timing of replacement is 2023-2024.

Strachan TS

Strachan TS comprises two DESN units, T12/T14 (T12: 40/67 MVA; T14: 45/75 MVA) and T13/T15 (45/75 MVA), having a summer 10-Day LTR of 161 MW. The station’s 2016 actual non-coincident summer peak load (adjusted for extreme weather) was about 142 MW and is forecasted to be approximately 148 MW and 166 MW in 2017 and 2027 respectively. Transformer T12 is currently about 60 years old and has been identified to be at its EOL. The companion DESN transformer T14 is currently 42 years old and is not at its EOL.

The load at Strachan TS is forecasted to approach capacity in the medium term. The load at the closest station, John TS, is also forecasted to be 85% of its LTR’s in the medium term. Therefore, downsizing T12 and consolidating load within the station and/or with area stations is not a viable option given medium term load growth at these stations. Moreover, downsizing capacity today and then later upgrading within the lifetime of the transformer due to eventual load growth will be significantly more costly. For example it may cost an additional $5-$10 million for the replacement of the transformers plus the incremental cost for the LDC to reconfigure feeders. It should also be noted that maintaining capacity, as opposed to downsizing, is a more resilient option as it provides additional flexibility during emergency conditions through load transfers.

Apart from the above transformer replacement options, the Study Team suggested evaluating the option of replacing T12 with a 115/230kV dual winding transformer (versus 115kV) since the 115kV cables, K6J and H2JK, between Strachan TS and Riverside JCT were recently replaced with cables built to 230kV (but currently operating at 115kV). It was determined that this option is not viable as there is insufficient space at the Strachan TS site to accommodate this and the associated station reconfiguration that would be required. Moreover, these dual winding transformers are not standard and would have to be custom built (if possible) which would result in a significant incremental cost, including the additional operating and maintenance costs, compared to replacing the transformer with a similar standard unit.

Based on the above, the study team recommends that this need be addressed by Hydro One and THESL to coordinate the replacement plan. The EOL transformer will be replaced with a 60/100MVA unit and the timing of replacement is 2020-2021. The preliminary plan also includes the upgrade of 115kV strain bus and replacement of 115kVdisconnect switches.

7.1.1.3 EOL Station Equipment: Replacement Plan to be Further Assessed

This section describes EOL station equipment where the replacement plan requires further assessment and regional coordination.

Bermondsey TS

Bermondsey TS comprises two DESN units, T1/T2 (75/125MVA) and T3/T4 (75/125 MVA), having a summer 10-Day LTR of 348 MW. The station's 2016 actual non-coincident summer peak load (adjusted for extreme weather) was about 179 MW and is forecasted to be approximately 185 MW and 200 MW in 2017 and 2027 respectively. Transformers T3 and T4 are currently about 51 years old and have been identified to be at their EOL.

The load at Bermondsey TS is forecasted to be 57% of its LTR in the medium term. The Bermondsey T1/T2 DESN is more lightly loaded than the T3/T4 DESN (T3/T4 is approximately 70% of total station loading over the last 3 years).The load at the three closest stations, Scarboro TS, Warden TS, and Leaside TS is forecasted to be over 75%, 85%, and over 95% respectively of their LTR's in the medium term.

A review of options such as the feasibility of downsizing T3/T4 and partially consolidating with T1/T2 DESN and/or with area stations should be assessed. Hence, further regional coordination in the IRRP and/or RIP phase is required to identify a preferred replacement plan. The timing of replacement for EOL equipment is 2023-2024.

John TS

John TS is connected to the 115kV Manby West system and jointly supplies Toronto's downtown district. Station facilities include six 115/13.8kV step-down transformers (T1, T2, T3, T4, T5, T6) and a 115kV switchyard. The summer 10-Day LTR is 262 MW. The station's 2016 actual non-coincident summer peak load (adjusted for extreme weather) was about 282 MW and is forecasted to be approximately 285 MW in 2017 and 224 MW in 2027 due to load transfers to the new Copeland MTS scheduled to be in service in 2018 (Phase 1).

John TS was built in the 1950's and THESL's switchgear at the station has reached the end of its useful life. It is expected to be replaced with new metalclad line-ups in the near term around 2022-2023. In addition, five step-down transformers at John TS, T1, T2, T3, T4, and T6, as well as the 115 kV breakers have been identified to be at the end of their useful life and require replacement within the near to medium term. The new equipment is currently expected to be in service by 2025-2026.

Since John TS requires a significant rebuild including the replacement of all EOL assets, options and an implementation plan need to be further assessed as part of the IRRP and RIP phase to develop a comprehensive plan. In addition, coordination of this work with Copeland MTS will be important because Copeland MTS' added capacity will be needed in order to improve execution of the replacement plan at John TS to maintain reliable supply in Toronto's downtown district. Therefore, it is recommended that the replacement plan for EOL equipment at John TS be further assessed as part of the IRRP and RIP phase.

Main TS

Main TS comprises one DESN unit, T3/T4 (45/75 MVA), having a summer 10-Day LTR of 74 MW. The station's 2016 actual non-coincident summer peak load (adjusted for extreme weather) was about 64 MW and is forecasted to be approximately 65 MW and 70 MW in 2017 and 2027 respectively. Transformers T3/T4 are currently about 49 years old and have been identified to be at their EOL.

The load at Main TS is forecasted to be 95% of its LTR in the medium term. The load at two of the closest stations, Carlaw TS and Warden TS, is forecasted to be at capacity, and 85% of LTR respectively in the medium term. Main TS is a 115/13.8 kV station that is supplied by the Leaside 115 kV system. There is a need to relieve Leaside autotransformers (described in section 7.2.5) in the long term (beyond 2027[1]). Moving over 60 MW of load (2016 actual non-coincident summer peak load) from Main TS off of the Leaside 115kV supply and onto the upstream 230 kV supply (CxL circuits) could potentially defer the need for Leaside autotransformer upgrades (or a new transmission supply point) by 4-5 years. This deferral could represent a significant value to ratepayers.

Accordingly, the Study Team will further assess the option of adding a 230/13.8 kV DESN at Warden TS with express 13.8 kV feeders running to Main TS along with other potential options. Hence, further regional coordination in the IRRP and/or RIP phase is required to identify a preferred replacement plan. The timing of replacement for EOL equipment is 2021-2022.

Manby TS

Manby TS is a major switching and autotransformer station in the Toronto region. Station facilities include six 230/115kV autotransformers (T1, T2, T7, T8, T9, T12), a 230 kV switchyard, a 115kV switchyard, and six 230/27.6kV step-down transformers (T3, T4, T5, T6, T13, T14). The total summer 10-Day LTR of the six step-down transformers is 226 MW. The station's 2016 actual non-coincident summer peak load (adjusted for extreme weather) was about 206 MW and is forecasted to be approximately 208 MW and 252 MW in 2017 and 2027 respectively. Three of the autotransformers, T7, T9, and T12, and one of the step-down transformers, T13, are close to 50 years old and have been identified to be at the end of their useful life. The 230 kV oil breakers have also been identified to be at EOL and require replacement. The timing of replacement for EOL equipment is 2024-2025.

[1] The need date assumes that two of the three units at Portland Energy Centre are out and total plant generation is 160MW and a high demand growth scenario. Under a low demand growth scenario, the need was identified in the IRRP to occur in the post 2035 timeframe, which was outside of the IRRP study timeframe. The need for Leaside autotransformer relief will be re-assessed as part of the next IRRP.

In addition to the EOL asset needs at Manby TS, there are also needs for: additional step down transformation capacity to relieve Manby TS loading discussed in section 7.2.1; transmission line capacity on the 230kV Richview TS to Manby TS corridor discussed in section 7.2.3; addressing potential violation of ORTAC load rejection limit of 150 MW discussed in section 7.2.4; and, transformation capacity to relieve Manby TS 230/115kV autotransformers in the long term discussed in section 7.2.7. Since the EOL equipment need may impact these additional needs it is recommended that the replacement plan for EOL equipment at Manby TS be further assessed as part of the IRRP and RIP phase.

7.1.1.4 EOL Transmission Lines

The table below lists sections of HV overhead lines and underground cables in the Toronto Region that are at the end of their useful life and require replacement in the near term.

Table 5: End-of-Life Lines

EOL Lines	Voltage Level (kV)	Est. Conductor Replacement (route length, km)	Asset Age (years)	Description
C5E/C7E (UG Cable)	115	3.6	58	Replacement of deteriorated cable from Esplanade TS to Terauley TS
H1L/H3L/H6LC/H8LC	115	2.05	64	Replacement of deteriorated overhead line from Bloor St. JCT to Leaside JCT
L9C/L12C	115	3.55	88	Replacement of deteriorated overhead line from Leaside TS to Balfour JCT

C5E/C7E Cable

Circuits C5E and C7E provide critical 115kV supply to Toronto's downtown core. The underground cables from Esplanade TS to Terauley TS (about 3.6 route km) are paper-insulated low pressure oil filled and are 58 years old and partially routed along Lake Ontario. These cables are in poor condition and deemed to be at the end of their useful life, and hence require replacement in the near-term. Due to their deteriorated condition, the risk of cable failure and oil leaks resulting in loss of supply and adverse environmental impact will only increase with age.

The preliminary scope of work involves replacement of the 115kV low pressure oil filled underground transmission cable with XLPE cable between Esplanade TS to Terauley TS with a 1200A continuous summer rating and an option for insulation for 230kV, although the cable would be operated at 115kV. The need and cost for a higher rated cable will also be assessed. Various routes will be identified and evaluated such as the existing route, utilizing the John x Esplanade TS tunnel, etc. The route investigation will assess existing easements and right-of-ways, cost, and other technical and environmental considerations. OEB Leave to Construct approval may be required.

Further regional coordination in the IRRP and RIP phase is required to review options and identify a preferred replacement plan.

H1L/H3L/H6LC/H8LC

Circuits H1L, H3L, H6LC, and H8LC provide 115kV supply to the eastern part of central Toronto from Hearn TS to Leaside TS. The line section between Bloor St. JCT to Leaside JCT (about 2 route km), is 64 years old and its conductors have been identified as reaching the end of their useful life and require replacement for safety, reliability and maintainability purposes.

The preliminary scope of work involves refurbishing the circuits between Bloor St. JCT to Leaside JCT to like-new conditions and built to current standards. Options for upgrading the circuits to 230kV will also be assessed.

Further regional coordination in the IRRP and RIP phase is required to review options and identify a preferred replacement plan.

L9C/L12C

Circuits L9C and L12C provide 115kV supply to central Toronto from Leaside TS to Cecil TS. The line section between Leaside TS and Balfour JCT (about 3.6 route km), are over 80 years old and their conductors have been identified as reaching the end of their useful life and require replacement for safety, reliability and maintainability purposes.

The preliminary scope of work involves refurbishing the circuits between Leaside TS and Balfour JCT to like-new conditions and built to current standards.

Further regional coordination in the IRRP and RIP phase is required to review options and identify a preferred replacement plan.

7.1.2 East Harbor / Port Lands Area – Transformation Capacity

THESL has identified an emerging area of load growth in the East Harbor and Port Lands in Toronto. The current load in the area is supplied from Esplanade TS and Basin TS. The area currently consists of prime land for future development. Among recent proposals in the East Harbor includes re-development of a former 60-acre Unilever factory site as a new master-planned district consisting of commercial and residential towers. Nearby, the Port Lands have also been in the City of Toronto's plans for renewed development. In addition to these, the potential expansion of Ashbridges Bay Wastewater treatment plant and the future construction of the Toronto Transit Commission's (TTC) downtown relief subway line may also impact load growth in the area. Recently THESL has been in discussions with Toronto Water for the tentative connection of about 14MVA of new electrical load.

Transformation capacity in the area is sufficient with present day loading however, due to the area's load growth potential there may be a need for increased capacity around 2025+. The infrastructure planning for this expansion could be complex due to urban vicinity and municipal plans/needs and should be undertaken for broader coordination as soon as possible. The existing Basin TS and Esplanade TS load forecasts do not include the impact of this major undertaking. Furthermore, based on the existing Basin TS forecast, it may reach capacity by 2026 and slightly exceed its LTR by 2027.

Further regional coordination in the IRRP and RIP phase is required to review options and identify a preferred plan.

7.1.3 Load Restoration – C14L+C17L, C5E+C7E, and K3W+K1W

For the loss of 230kV circuits C14L and C17L (stations connected are Warden TS and Bermondsey TS), the load interrupted by configuration can exceed 150 MW and 250 MW and are required to be restored within the prescribed time periods as stated in the ORTAC.

For the loss of 115kV circuits C5E and C7E (station connected is Terauley TS), the load interrupted by configuration can exceed 150 MW over the study period and are required to be restored within the prescribed time periods as stated in the ORTAC.

For the loss of 115kV circuits K3W and K1W (stations connected are Fairbank TS and Wilshire TS), the load interrupted by configuration can exceed 150 MW and 250 MW and are required to be restored within the prescribed time periods as stated in the ORTAC.

Further regional coordination in the IRRP and RIP phase is required to review options and identify a preferred restoration plan.

7.2 Needs Identified in Previous RIP

The following section summarizes the needs and their respective plans identified in the previous RIP report which are not yet underway. The Study Team reaffirms these needs and an update with respect to their plans is provided below.

7.2.1 Southwest Toronto – Station Capacity

To address the station capacity need at Manby TS and Horner TS, the RIP recommended adding two 230/27.6 kV, 75/125MVA transformers and a new 27.6kV switchyard at the existing Horner TS site. New distribution feeder ties are required to be built between Manby TS and Horner TS by THESL to accommodate load transfer out of Manby TS to Horner TS as the loading at Manby TS exceeds its capacity. The need date is 2021. For more details, refer to section 7.2 of the RIP report.

The Study Team reaffirms this need. Hydro One is continuing the development and estimate work for this project. The planned in service date is 2020.

7.2.2 Downtown District – Station Capacity

The Toronto Downtown District is mainly supplied by the three existing 115/13.8 kV stations: John TS, Esplanade TS, and Terauley TS. THESL is building a new 115/13.8kV owned transformer station, Copeland MTS, in the Downtown District near John TS with normal supply from the 115 kV Manby West system. Copeland MTS Phase 1 is currently under construction with a planned in service date of 2018. It will provide a new source of supply to the area customers.

As identified in the RIP report (refer to section 7.3 of the RIP report), a number of factors including additional transformation capacity, but also feeder positions would drive the need for Copeland MTS Phase 2 – a second 115/13.8kV DESN[2] at the Copeland MTS site. THESL anticipates that the need for a new transformation facility is more advanced due to: significant load transfers required to facilitate the refurbishment work at John TS (as discussed in section 7.1.1.3); and, limited spare feeder positions at existing stations for new customer connections and to maintain n-1 contingencies for dual radial feeders. THESL foresees substantial load additions due to new developments to the east of the station, which are not included in the existing Copeland MTS forecast.

Based on the station capacity consideration alone for the Downtown District stations, the need date for Copeland MTS Phase 2 is 2027+. However, based on the other considerations identified by THESL such as their requirements for spare feeder positions, the need date may be earlier around 2023-2024.

The Study Team reaffirms this need and recommends that the need and timing for Phase 2 be further refined by THESL through their distribution planning process and included in updates to the next IRRP and/or RIP.

7.2.3 230kV Richview TS x Manby TS Corridor – Line Capacity

Various alternatives were assessed to address the line capacity need for the two double circuit 230kV lines, R1K/R2K and R13K/R15K, along the Richview TS to Manby TS corridor. The RIP recommended that Hydro One proceed with the development and estimate work on the alternatives. With the effect of the proposed Metrolinx Mimico Traction Power Station ("TPS") load, the need date for relief may be 2020 at the earliest. For more details, refer to section 7.4 of the RIP report.

The Study Team reaffirms this need and has determined a recommended plan. This plan is staged as follows:

- Stage 1: Rebuild existing 115kV idle line to 230kV and reconfigure two existing circuits R2K and R15K into "Super-circuits"
- Stage 2: Terminate the new conductors on V73R and V79R circuits and Manby TS (3 new breakers) and complete station work coincident with Manby TS EOL replacement work planned in 2023-2024 (discussed in section 7.1.1.3)

Hydro One is continuing the development and estimate work on this plan with an in service date of 2021. Updates will be included in the next IRRP and RIP.

[2] A third 60/100 MVA transformer will also be installed, which under normal operation will remain on potential, but off-load. This transformer will only be loaded in the event of a contingency at Copeland MTS or at Windsor TS/John TS (following the replacement of the THESL switchgear after which inter-station support capability will have been installed). The site and the HV switching facilities required to accommodate Phase 2 are already included as part of the Copeland MTS Phase 1 project.

7.2.4 Breaker Failure at Manby TS

To address the risk of breaker failure at Manby TS causing the outage of any two of the three 230/115kV autotransformers at either the west or east yard of Manby TS and resulting in the remaining transformer exceeding its Short Term Emergency (STE) rating, the RIP recommended the installation of a Special Protection Scheme (SPS). The need date is summer 2018 and summer 2021 for Manby West and Manby East respectively. For more details refer to section 7.6 of the RIP report.

The Study Team reaffirms this need. Hydro One is continuing the development and estimate work for this project. The planned in service date is Q2 2018.

Since the RIP, IESO completed a System Impact Assessment (SIA) for the Manby SPS and it found that based on the coincident load forecast in order to respect post contingency thermal ratings of Manby T12 and T7 for the loss of two companion autotransformers, the ORTAC load rejection limit of 150 MW may be exceeded in the long term (around 2028+). This need and associated plan should be coordinated with the 230/115kV Manby TS transformer capacity need discussed in section 7.2.7 and the Manby TS EOL equipment need discussed in section 7.1.1.3. Hence further regional coordination in the IRRP and RIP is required.

7.2.5 230/115 kV Leaside Autotransformers Transformation Capacity and Voltage Collapse

Based on the load forecast, the Leaside TS autotransformers will require relief in the long term, beyond 2027. The need date assumes that two of the three units at Portland Energy Centre (PEC) are out and total plant generation is 160MW.

Following the loss of 230 kV circuits, C16L and C17L, while all three units at PEC are out of service pre-contingency, voltage collapse in the Leaside TS 115kV subsystem may be caused. This becomes a credible contingency once the current PEC contract expires. This need was identified in the Central Toronto Area IRRP report.

The Study Team reaffirms these needs and recommends that they be further assessed in the IRRP and/or RIP phase. For more details, refer to section 6.2.1 of RIP report and Appendix E of the IRRP report.

7.2.6 115 kV Leaside TS x Wiltshire TS Corridor – Line Capacity

Based on the RIP coincident load forecast, the Leaside TS x Wiltshire TS circuits will require relief in the long term (2034). For more details, refer to section 7.10 of the RIP report.

The Study Team reaffirms this need and recommends that it be further assessed in the next phases of the regional planning process, i.e. IRRP and/or RIP.

7.2.7 230/115 kV Manby Autotransformers – Transformation Capacity

Based on the RIP coincident load forecast, the Manby TS autotransformers will exceed their LTE and require relief in the long term (2035+).

As noted in section 7.1.1.3, three of the autotransformers at Manby TS, T7, T9, and T12, are at EOL and require replacement in 2023-2024. Currently, T7 and T9 in the Manby East switchyard are rated about 65 MVA and 40 MVA less than their third companion autotransformer, while T12 in the Manby West switchyard is rated about 52 MVA and 92 MVA less than its two companion autotransformers.

The Study Team reaffirms this need. Since the 230/115kV Manby transformer capacity need impacts the Manby TS EOL plans and the need to address the potential violation of the ORTAC 150 MW load rejection limit (discussed in section 7.2.4), there are benefits to coordinating the plans to address all these needs. Therefore, further regional planning in the IRRP and RIP is required. For more details, refer to section 7.10 of the RIP report.

7.2.8 115 kV Manby West x Riverside Junction – Line Capacity

Based on the RIP coincident load forecast, the Manby West x Riverside Junction circuits will require relief in the long term (2035+). For more details, refer to section 7.10 of the RIP report.

The Study Team reaffirms this need and recommends that it be further assessed in the next phases of the regional planning process, i.e. IRRP and/or RIP.

7.2.9 115 kV Don Fleet Junction x Esplanade TS – Line Capacity

The 115kV circuit H2JK between Don Fleet Junction and Esplanade TS is forecast to exceed its Long Term Emergency (LTE) rating in 2026 following the loss of 115 kV circuit H9EJ. This need was identified in the Central Toronto Area IRRP report.

The Study Team reaffirms this need and recommends that it be further assessed in the next phases of the regional planning process, i.e. IRRP and/or RIP. For more details, refer to Appendix E of the IRRP report.

It should also be noted that Metrolinx is planning to expand their Don Yard in downtown Toronto. The expansion will require the relocation of 115 kV overhead line section, H9EJ and H10EJ between Cherry St. and Don Fleet Junction (approximately 0.6 km) and 115 kV underground cable section, H2JK between Don Fleet Junction and Esplanade TS (approximately 1.8 km).

Further regional coordination in the IRRP and/or RIP phase is required to review options (including upgrading H2JK and converting it to an overhead line) and identify the preferred relocation plan.

8 RECOMMENDATIONS

The Study Team's recommendations to address the needs identified are as follows:

a) The equipment discussed in sections 7.1.1.1 and 7.1.1.2 is 40-60 years old. It has been determined that these assets are at the end of their useful life. From a cost, loading, timing, and customer connection needs perspective, none of these assets should be eliminated or have their capacity reduced. The study team recommends that these EOL needs be addressed by Hydro One and THESL to coordinate the replacement plan.

b) The Study Team will further assess the following needs discussed in sections: 7.1.1.3 (EOL station equipment needs); 7.1.1.4 (EOL line equipment needs); 7.1.2 (transformation capacity needs); 7.1.3. (load restoration need); 7.2.5 to 7.2.9 (needs identified in previous RIP/IRRP, mostly long-term); as part of the next phases of regional planning, i.e. IRRP and RIP, to develop a preferred plan.

c) The Study Team reaffirms the remaining needs that were identified in the previous RIP, discussed in sections 7.2.1 to 7.2.4 of this report. Updates (where relevant) to the associated plans are provided and implementation of these plans should be continued.

The table below summarizes the above recommendations.

Table 6: Summary of Recommendations

Further Regional Coordination Not Required	Further Regional Coordination Required
EOL Station Equipment: • Bridgman TS: T11/T12/T13 • Charles TS: T3/T4 • Duplex TS: T1/T2 • Fairbank TS: T1/T3, T2/T4 • Fairchild TS: T1/T2 • Leslie TS: T1 • Runnymede TS: T3/T4, 115 kV line grounding switches • Sheppard TS: T3/T4 • Strachan TS: T12	**EOL Station Equipment:** • Bermondsey TS: T3/T4 • John TS: T1, T2, T3, T4, T6, 115 kV breakers • Main TS: T3/T4, 115 kV line disconnect switches, installation of 115 kV CVTs • Manby TS: T7, T9, T12 autotransformers, T13 step-down transformer, rebuild 230kV yard **EOL Lines:** • 115kV C5E/C7E Underground Cable: Esplanade TS to Terauley TS • 115 kV H1L/H3L/H6LC/H8LC Overhead Line: Bloor St. JCT to Leaside JCT • 115kV L9C/L12C Overhead Line: Leaside TS to Balfour JCT **Transformation Capacity Need:** • East Harbor / Port Lands Area and Basin TS **Load Restoration Need:** • C14L+C17L (Warden TS and Bermondsey TS)

Further Regional Coordination Not Required	Further Regional Coordination Required
	• C5E+C7E (Terauley TS) • K3W+K1W (Fairbank TS and Wiltshire TS) **Needs identified in Previous RIP/IRRP:** Medium Term • 115kV Don Fleet JCT x Esplanade TS – Line Capacity Long-Term • 230/115kV Leaside TS autotransformers – Transformation Capacity and Voltage Collapse of 115kV Leaside Subsystem • 115kV Leaside TS to Wiltshire TS Corridor – Line Capacity • 230/115kV Manby autotransformers – Transformation Capacity • 115kV Manby West x Riverside Junction – Line Capacity

9 REFERENCES

[1]. Hydro One, "Metro Toronto Regional Infrastructure Plan", January 12, 2016.
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Appendix A: Non-Coincident Summer Peak Load Forecast (2016 to 2027)

			LTR (MW)	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Central 115kV	Lea115kV	BASIN TS	85	52	61	69	76	81	82	83	83	83	84	85	86
		BRIDGMAN TS	183	159	162	164	164	165	166	169	170	171	172	173	175
		CARLAW TS	70	56	56	65	66	68	68	68	69	69	70	70	70
		CECIL TS	204	173	177	182	190	194	197	198	200	200	202	203	204
		CHARLES TS	200	139	146	155	161	164	166	166	167	169	170	172	174
		DUFFERIN TS	161	132	132	138	124	126	127	127	128	129	131	132	132
		DUPLEX TS	121	97	101	109	113	112	110	108	105	106	107	108	109
		ESPLANADE TS	177	167	169	179	157	160	162	163	163	166	166	168	170
		GERRARD TS	94	38	40	36	46	48	50	50	51	51	51	52	53
		GLENGROVE TS	84	54	54	51	52	54	54	54	56	56	56	56	56
		MAIN TS	74	64	65	66	66	66	67	68	68	68	70	70	70
		TERAULEY TS	205	174	181	188	200	206	199	203	204	204	205	205	205
	ManbyE-115-27.6	FAIRBANK TS	182	169	173	180	162	169	174	178	183	183	185	186	188
		RUNNYMEDE TS	111	119	121	123	169	176	178	178	181	182	183	184	185
	ManbyE-115-13.8	WILTSHIRE TS	126	61	65	63	79	79	80	81	81	83	83	83	83
	ManbyW-115	COPELAND MTS	111	0	0	0	0	54	101	102	103	103	107	107	107
		STRACHAN TS	161	137	143	147	150	154	154	156	156	158	160	160	160
		WINDSOR TS (John TS)	262	282	285	283	286	235	214	217	218	219	222	223	224
Central 115kV Total			2611	2073	2130	2198	2259	2309	2351	2371	2387	2400	2424	2436	2450
Eastern 230kV	CxL230	BERMONDSEY TS	348	179	184	179	184	187	188	192	193	194	196	198	200
		ELLESMERE TS	189	139	141	143	145	147	148	149	150	151	152	153	154
		LEASIDE TS	210	157	164	180	185	190	192	193	194	196	197	199	201
		SCARBORO TS	341	230	235	239	243	245	246	248	249	251	253	254	255
		Metrolinx - Scarboro	0	0	0	0	0	0	0	78	78	78	78	78	78
		SHEPPARD TS	204	170	171	175	178	181	183	185	185	187	188	190	192
		WARDEN TS	183	138	139	144	147	148	149	150	151	152	153	155	156
Eastern 230kV Total			1474	1013	1034	1061	1082	1098	1105	1194	1200	1209	1218	1227	1236
Northern 230kV	CxR	AGINCOURT TS	174	101	101	102	105	108	111	112	113	114	114	114	114
		BATHURST TS	334	232	237	253	264	271	275	276	278	280	282	284	286
		CAVANAGH MTS	157	93	95	95	96	97	97	98	99	100	100	101	102
		FAIRCHILD TS	346	272	275	278	282	284	286	288	290	292	294	295	296
		FINCH TS	363	278	285	293	298	302	304	306	308	310	312	314	316
		LESLIE TS	325	237	249	262	273	277	280	283	286	287	290	292	293
		MALVERN TS	176	95	100	102	105	106	106	107	108	108	109	110	111
Northern 230kV Total			1701	1308	1342	1385	1421	1444	1458	1469	1481	1491	1502	1511	1519
Western 230kV	Manby230	HORNER TS	183	146	155	160	163	165	167	168	169	171	172	173	174
		MANBY TS	226	206	208	218	229	232	241	242	243	245	246	249	252
	Metrolinx	Metrolinx - Cityview	0	0	0	0	0	59	59	59	59	59	59	59	59
		Metrolinx - Mimico	0	0	0	0	0	28	28	28	28	28	28	28	28
	Rich230	REXDALE TS	187	140	142	145	147	148	150	150	152	152	154	154	154
		RICHVIEW TS	454	248	250	256	243	246	248	250	250	252	255	256	257
Western 230kV Total			1049	740	755	779	782	877	892	896	901	908	914	919	924
Grand Total			**6834**	**5134**	**5262**	**5422**	**5545**	**5729**	**5806**	**5930**	**5970**	**6008**	**6057**	**6093**	**6129**

Appendix B: 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
DCF	Discounted Cash Flow
DESN	Dual Element Spot Network
DG	Distributed Generation
DSC	Distribution System Code
GATR	Guelph Area Transmission Reinforcement
GS	Generating Station
GTA	Greater Toronto Area
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
PEC	Portland Energy Centre
PF	Power Factor
PPWG	Planning Process Working Group
RIP	Regional Infrastructure Plan
ROW	Right-of-Way
SA	Scoping Assessment
SIA	System Impact Assessment
SPS	Special Protection Scheme
SS	Switching Station
STG	Steam Turbine Generator
TPS	Traction Power Station
TS	Transformer Station
TSC	Transmission System Code
UFLS	Under Frequency Load Shedding
ULTC	Under Load Tap Changer
UVLS	Under Voltage Load Rejection Scheme