NAVIGANT CONSULTING

TORONTO HYDRO

Business Case Analysis

Downtown Toronto-Electric Supply Evaluation

Prepared for:

Toronto Hydro Electric System, Limited

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Overview

Background and Scope

New station capacity is needed to provide greater operating flexibility, improve reliability, and meet growing electric demand in downtown Toronto. Reliability of supply in downtown is critical, as this area includes major office complexes and the Toronto Stock Exchange. The existing Windsor station that serves downtown Toronto was originally constructed in 1950, and cannot be expanded to accommodate new transformation capacity. Further, the Windsor station requires refurbishment, and new station capacity or back-up ties are needed to enable Toronto Hydro-Electric System Limited (THESL) to install these upgrades without compromising station reliability.

Navigant Consulting Inc. (NCI) was engaged by THESL to investigate solutions to meeting the long-term electrical demand for downtown Toronto. It includes an independent assessment of station supply options to reliably serve downtown electrical demand. Among the options considered, NCI investigated the benefits of expanding existing stations in downtown Toronto. It also includes an evaluation of a new station located on a site adjacent to the Roundhouse Railway yard, otherwise known as the Bremner Transformer Station (TS). Our assessment addresses risk and need, including the potential for conservation and demand management (CDM) to defer the need for new station capacity.

Methodology

The approach NCI employed to evaluate supply options includes a technical and economic evaluation of alternatives. It includes a projection of need dates for station capacity, a risk assessment of existing facilities, and reliability analysis. Both demand and supply-side options are examined, and alternatives are compared using present value economic analysis.

Most of the technical data, cost and economic assumptions in our study are based on prior studies conducted by THESL. NCI independently reviewed these assumptions for reasonableness, and introduced new data and analyses where none existed or was insufficient to develop findings and recommendations. The analysis includes an independent risk assessment based on current industry practices and reliability criteria.

From our evaluation, we recommend a course of action to ensure reliability of electricity supply is maintained to critical downtown Toronto businesses and other retail customers. Our analysis examines need from a station supply perspective, but does not offer recommendations with regard to the Hydro One Network Incorporated transmission system, or regional power supply.

System Adequacy and Risk Assessment

The following describes NCI's assessment of need for expansion and reinforcement of electric supply stations serving downtown Toronto. The analysis examines demand and supply options for meeting long-term station capacity and reliability requirements, and includes a risk assessment of applicable alternatives.

Statement of Need

The City of Toronto is the fifth largest metropolitan area in terms of population in North America. The load density and type of load served suggest continuity of service to downtown electric load cannot be compromised: it includes Toronto's financial district, large office complexes, numerous high rises, and major tourist destinations. The economic impact of a major disruption of electric service is underscored by recent outages in New York City, Western United States and central U.S. and southern Canada in 2003. The economic impact of the 2003 Midwest event alone is estimated at $50 billion (U.S. dollars). Accordingly, reliability of electric supply to the City of Toronto and downtown is essential to the economic health of the region.

Total electric demand in downtown Toronto is approximately 2000 MW. Approximately 350 MW of this load is served by highly reliable, complex electrical distribution supply systems configured in a network or grid arrangement. Currently, five stations serve approximately 1000 MW of the downtown Toronto load, including those that serve secondary network grids. One of the oldest stations, Windsor TS, was constructed in 1950 and serves critical high density loads including the financial district, 9 of the 10 tallest buildings in Toronto, medical centers, and several government buildings.

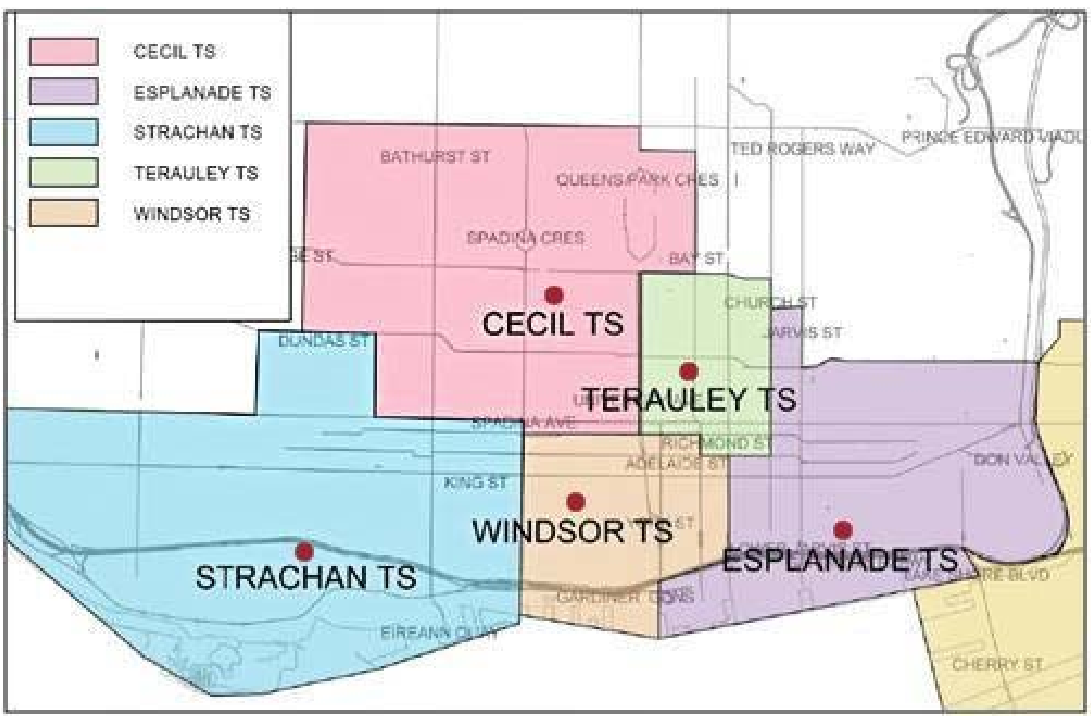
Because of age, condition, and limited functionality, some equipment at Windsor has become obsolete and should be replaced. Further, although station equipment is well-maintained, replacement parts are difficult to obtain. The switchgear should be replaced regardless of which option is selected to meet future demand. Significantly, there are no feeder ties to adjacent stations and virtually no back-up feeder positions to serve Windsor loads while switchgear sections are out of service and sequentially replaced.

Surplus firm capacity of the five stations that serve downtown Toronto also is diminishing and new station capacity will be needed over the next seven years. Notably, the composite peak demand is expected to exceed the combined capability of these five stations by 2019. The original design criterion for these stations also do not address low probability, high impact events involving the loss of the entire station; extended outages likely would result if a major breakdown were to occur. These factors, when combined with the magnitude and criticality of load served, increased outage exposure, and the unavailability of back-up supply to accommodate required equipment replacement, underscore the need for new station capacity in downtown Toronto.

Electric Supply to Downtown Toronto

The total peak demand of the THESL system is about 5,000 MW. The total downtown Toronto load served (i.e., the former Toronto Hydro service area) is approximately 2,000 MW; about one-half or 1,000 MW is supplied by five stations in the core of downtown Toronto. Figure 1 highlights the location of these five stations and areas served. All stations are fed by 115kV transmission lines - most of these are underground.[1]

Figure 1: Downtown Toronto Stations & Electric Supply



[1] Transmission supply lines serving THESL load are owned and operated by Hydro One Networks, Inc (HONI).

Design Standards and Planning Criteria

The following describes planning criteria THESL employs in the planning and design of its electric power delivery system. Planning criteria are listed separately for transmission lines, stations and distribution feeders, with emphasis placed on facilities serving downtown Toronto.

Transmission

Generally, THESL does not own or operate network transmission lines and stations and therefore is not responsible for the establishment of planning, loading and reliability criteria for the high voltage system. Network transmission assets serving THESL stations are owned and operated by Hydro One Networks, Inc (HONI). Most stations located outside downtown Toronto are served by overhead 230kV lines, whereas most downtown stations, including the five cited in this study, are served by a combination of overhead and underground 115kV lines. In 2007, HONI constructed an underground tunnel in downtown Toronto to accommodate new transmission cables that will tie John (Windsor) and Esplanade TS. The tunnel runs on the south side of the Windsor station and is designed to readily interconnect to a new station in downtown Toronto – the tunnel includes duct banks with a tap designed to accommodate new transmission cable.

Although THESL is not responsible for the transmission planning and design criteria, it works closely with HONI, the Ontario Power Authority (OPA), the Independent Electricity System Operator (IESO), and participates in joint planning sessions to jointly coordinate and plan for the continuity of supply to THESL stations. THESL also has opined on transmission reliability in prior investigations conducted by the IESO.[2] Most important, THESL must design its station and distribution system with consideration given to the design and contingency criterion applied to the transmission system. For example, if a loss of key transmission lines or transformers were to cause the entire or partial loss of station capacity, then THESL would need to design its system in a manner to ensure back-up feeders and station capacity were available.

Currently, the 115kV and 230kV transmission system that serves downtown and outlying THESL stations is designed based on a single contingency (n-1) criteria; that is, the loss of any single line element, at peak, will not result in a loss of supply, create insufficient capacity or cause unacceptably low voltages to stations served by the 115kV and 230kV system.[3] The

[2] For example, THESL offered its comments to the IESO *Stakeholders Engagement Plan SE-50 for Supply to Large Urban Centres* in a letter dated February 28, 2008.

[3] Reliability standards are set forth in Section 7 of the Ontario Resource and Transmission Assessment Criteria (ORTAC).

network configuration of the 115kV and 230kV system enables HONI to achieve this objective.[4] However, transmission lines that serve Toronto have become increasingly loaded, which has decreased the margin under which the system is able to meet first contingency criterion.

Stations

THESL planning criteria specify that all downtown stations must be able to serve projected load for a single contingency; that is, a loss of a single station transformer, incoming supply line or switchgear bus section will not cause loss of load (also referred to as n-1 criteria). THESL employs a Dual Element Spot Network Design (DESN) standard for downtown stations, with each bus supplied by two transformers. Stations typically include four 100 MVA 115/13.8kV transformers (owned by HONI). A maximum of 10 to 16 feeders are allowed per switchgear bus. Under this design, the 13.8kV station bus rating typically is the limiting element from a capacity standpoint. Net firm station capacity is derated to 95 percent of the projected future peak to account for unanticipated loads or weather anomalies. For the loss of a single transformer, the utilization of the remaining transformers in service is increased above nameplate ratings to a level where transformer loss-of-life is at an acceptable level. These practices and criteria are consistent with industry practices.[5]

THESL's planning criteria allow for the loss of any single major station element, at peak, without full or partial loss of load. An Emergency Preparedness exercise conducted in May 2006 suggested that THESL's planning criteria should include a requirement that outages caused by a partial or full loss of a station should be restored within 24 hours. However, without adjacent TS switchgear ties in downtown Toronto, this objective cannot be met for a major outage at several stations. This finding prompted THESL to conduct studies that examined remediation options.[6] A determination was made that about 60MVa of surplus or additional capacity would be needed to provide sufficient capacity for the loss of any single switchgear line-up in a station serving downtown load, with the construction of dedicated TS switchgear tie capacity to enable inter-station switchgear load transfers, capacity that is currently not available. The issue is addressed later under demand and supply alternatives.

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[4] In addition to HONI transmission lines, the Portland Energy Center provides contingency support to downtown transmission lines, and is a critical resource needed to ensure continuity of supply.

[5] Some North American urban utilities serving critical, high density loads have adopted second contingency (n-2) station planning criterion.

[6] In June 2006, THESL prepared a response that included a plan to create back-up capability via two new feeders and a new "Satellite" station and new feeder ties. A follow-up study, Toronto Hydro Internal Report, Interties to Provide Backup Capacity to Downtown Stations, issued in November 2006, outlined options for enhancing feeder tie capability.

Distribution Feeders

Outside of the former downtown Toronto system, most THESL's feeders are rated 27kV and designed in a radial "open loop" configuration. The open loops include several transfer switches and normally open feeder ties that are suitable for inter-station load transfers. In the event of a contingency loss of station transformation capacity, these ties can be utilized to transfer load to other nearby stations where sufficient transformation capacity exists to carry the load. Many of the 27kV feeders and transfer switches are located overhead.

The mostly underground 13.8kV system in downtown Toronto predates the overhead 27kV open loop design located in the amalgamated distribution systems. Unlike the 27kV system, downtown stations and radial 13.8 kV distribution feeders rely on the 115kV voltage transmission system to maintain reliability to downtown customers. The current downtown 13.8kV design criterion excludes reservation of feeder capacity to back-up load from other stations. This design configuration has no inter-station feeder ties, which limits load transfer among downtown stations.[7] Thus, the loss of a downtown station would result in significant and extended loss of load until repairs are completed and the station returned to service.[8] Notably, lack of space in the downtown area for underground feeder-tie switch installations and the absence of spare conduit or underground duct bank systems is a major deterrent to creating feeder ties where none currently exist.

About 350 MW of high density load in downtown Toronto is served by low voltage secondary grid networks. These networks operate in a looped arrangement such that a loss of any single element will not cause overloads or loss of load. A substantial portion of secondary network load in downtown Toronto is served from the Windsor station.

Conformance with Industry Planning Criteria

As noted, planning guidelines for stations in Ontario (and adopted by THESL) are based on a single contingency (n-1) planning criterion. Station bus design includes transfer busses with full feeder back-up capability reserved for maintenance or when outages occur. As noted, many

[7] The absence of feeder ties and reliance on incoming supply to maintain reliability does not address the complete loss of a station, which usually is deemed a very low probability, but high impact event. However, the near full utilization of station bus capacity and deterioration of equipment has increased outage exposure and the probability of station outages.

[8] Three recent events highlight the exposure caused by the loss of downtown stations. In January 2009, one of the coldest days of the year, the Dufferin station was shut down due to flooding caused by the operation of HONI's transformer fire protection system. Over 34,000 customers were interrupted, some up to 24 hours. A similar flooding event occurred at the Terauley station in January 2005, causing an interruption of service to over 3,500 downtown customers for ten hours. Lastly, a TS transformer failure at Windsor on October 14, 2010 caused an interruption of service to several downtown high rise buildings and retail centers during daytime business hours.

downtown loads are served by secondary grid (lower load density) or spot (highest load density such as high rise buildings) networks. Each of these design practices is consistent with common utility practices for urban areas.

The single contingency criterion that THESL applies to station transformers is less conservative than other large utilities serving critical, high density loads. For example, the City of Manhattan (Consolidated Edison Company of New York) applies a second contingency (n-2) criterion for lines and stations serving the Island of Manhattan. Similar criterion has been adopted for critical government and commercial load centers in Washington, D.C. by the Potomac Electric Power Company, Houston, and other large cities worldwide, such as downtown Tokyo.

Demand Forecast

The 2011 non-coincident peak demand of the five stations serving downtown Toronto was approximately 980 MW. Table 1 presents the 2011 actual peak and 10-year forecast for the downtown core (5 stations) and the remainder of Toronto, which indicates downtown load will increase by over 200 MW by 2021. The majority of downtown load is commercial, mostly large office complexes and load associated with the financial and business districts.

Table 1: Downtown Toronto Peak Demand Forecast (MVA)

	Year										
Area Served	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
Downtown Core	982	1,000	1,029	1,051	1,071	1,099	1,122	1,145	1,168	1,190	1,217
Remaining Toronto	4319	4352	4431	4488	4541	4591	4647	4693	4741	4795	5084
Total System	5301	5352	5460	5539	5612	5690	5769	5838	5909	5985	6066

Source: Total system and downtown core station load forecasts supplied by THESL

Remaining Toronto load is estimated by assuming the composite peak of the 5 core stations is coincident with the total system peak. Notably, the five stations that serve the heart of downtown Toronto supply 20 percent of the total area load – the remaining 80 percent is served by 30 other stations. The high ratio of load served per station for the five downtown stations underscores the need to maintain reliability at levels equal to or higher than other sections of Toronto. Also, most downtown load is served by underground cable, including all secondary networks.

Conservation and Demand Management (CDM)

In response to a Provincial mandate to reduce the composite Ontario peak by 1330 MW by 2014 via CDM[9], THESL proposes to implement a wide range of CDM programs for 2012 and beyond, culminating in 286 MW of peak load reduction between 2011 and 2014. Program results and forecasted savings for THESL and downtown Toronto are presented in Table 2.[10] By 2014, new CDM in an amount equal to approximately 6 percent of the annual peak load will be installed. As an alternative to new station capacity, options for increasing firm CDM penetration or the introduction of new programs are considered later in this report.

Table 2: Downtown Toronto CDM Firm Demand (MW)

CDM Program	Year			
	2011	2012	2013	2014
Downtown Core	9	12	16	21
Remaining System	34	48	63	83
Total CDM	43	60	79	104
Cumulative CDM	**43**	**103**	**182**	**286**

Station Capacity

Table 3 lists station effective firm transformation capacity for the five stations that serve downtown Toronto. The net capability reflects THESL and HONI planning criteria, which specifies that all downtown stations must be able to serve entire station load for a single contingency outage; that is, a loss of a single station transformer or bus section. Net firm capacity is de-rated to 95 percent to account for unanticipated loads or weather anomalies.

Table 3: Downtown Toronto Station Capacity

Station	Original Construction	Number of XFMRs	Transformer Rating (MVA)[11]	Firm Station Capacity
Cecil	1969	4	236	224
Esplanade	1992	3	207	198
Strachan	1955	4	184	175
Terauley	1929	4	240	240
Windsor	1950	6	356	340

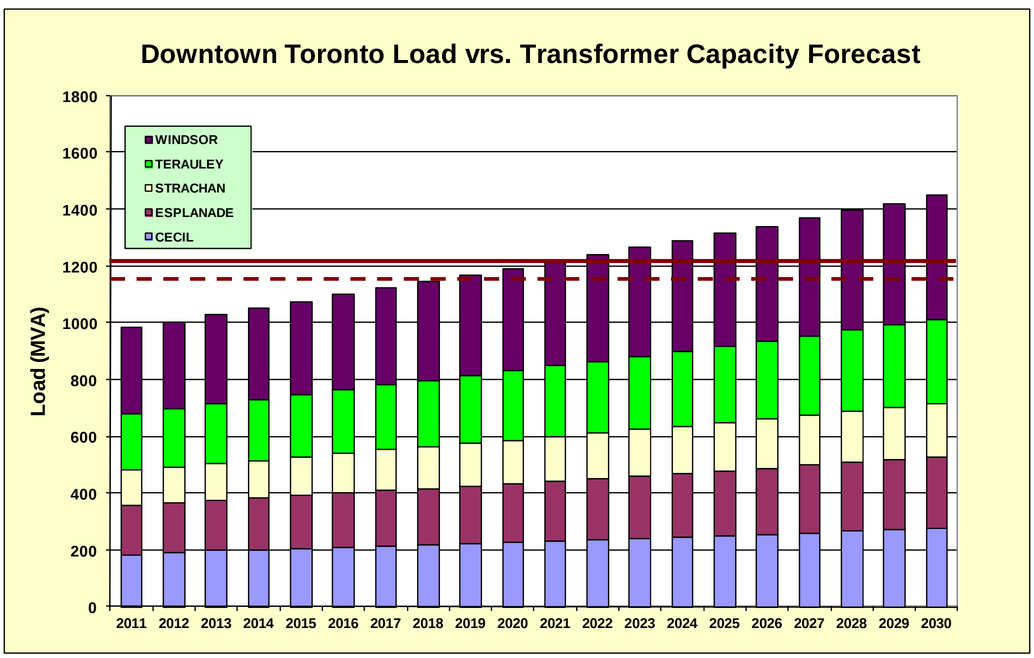
[9] http://www.powerauthority.on.ca/sites/default/files/page/17069_minister_directive_20100423.pdf
[10] The station forecast presented in Table 1 reflects the CDM peak load savings presented in Table 2. Values for downtown Toronto are derived by allocating total THESL CDM projections on a pro rata basis using area peak load.
[11] Transformer ratings based on nameplate ratings. Net effective transformer capacity is based on the loss of a single transformer (n-1). This upper rating is the Summer Limited Time Rating (LTR), which assumes 10 days would be needed to install a replacement transformer. Recent experience indicates actual time for replacement is up to 90 days.

For the loss of a single transformer, the utilization of the remaining transformers in service is increased above nameplate ratings to reflect higher short-term ratings, which is consistent with current industry practices.[12] Notably, net firm capacity for most downtown stations excludes mutual support for adjacent stations, as there no feeder tie transfer capability between these stations.

Projected Capacity Need

A comparison of the firm transformer capacity of the existing five stations versus projected peak demand is presented in Figure 2. The forecast incorporates and reflects savings achieved by prior CDM programs. However, future CDM is not included due to the lack of assurance of *firm* peak demand reduction. On an aggregate basis, the collective capacity of these stations is well utilized, as the 2011 actual peak is about 80 percent of the total station capacity. This percentage increases to about 90 percent by 2015. By 2019, the composite area peak will exceed the total capacity of these five stations when the 95 percent loading criterion is applied. By 2030, this capacity deficit increases to almost 300 MW, indicating that additional capacity will be needed at more than one station in the downtown core.

Figure 2: Downtown Toronto Firm Capacity Surpluses/Deficits[13]



[12] Some North American urban utilities serving critical, high density loads have adopted second contingency (n-2) station planning criterion.

[13] The solid line represents maximum transformer rating. The dashed is the 95% future loading criteria that THESL uses to project the need date for additional capacity to account for extreme weather or unanticipated loads.

On an individual basis, upper loading limits on two of five stations (Windsor, Esplanade) will be exceeded by 2018 and four by 2021. Table 4 compares annual station projected peak load versus transformation and switchgear capacity to year 2026 (overloads are highlighted light yellow). The first year of capacity deficits occur in 2017, when the composite station rating at Windsor will be exceeded. Hence, reinforcement in the form of additional transformation capacity or transfer of load via 13.8kV feeders to another station will be needed to avoid overloads. Because Esplanade and Windsor require feeder expansion to permanently transfer load, a solution that addresses capacity limitations at one station, to a large extent, can be viewed as a solution to both. However, feeder loadings and increased growth likely will create a need for additional transformation capacity at Esplanade, Windsor or at a new station in downtown Toronto.

Table 4: Year of Capacity Deficit by Station (MVa)

Station	Station Rating	Year															
		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Cecil	224	182	189	196	199	203	207	212	216	220	224	229	233	239	242	248	252
Esplanade	198	175	173	177	182	187	192	196	199	204	208	212	216	221	225	230	234
Strachan	175	122	127	130	131	133	140	143	147	151	153	157	159	163	166	169	172
Terauley*	240	199	205	211	215	220	225	229	234	238	243	248	252	258	263	269	273
Windsor	340	304	306	315	324	328	335	342	349	355	362	371	377	383	391	399	405

*Terauley is restricted by transmission line capacity to 240 MVA
Source: Toronto Hydro 2012 Station Load Forecast

Notably, by 2017, the first year of a station overload, total downtown demand will be over 90 percent of the composite rating of the five stations that serve downtown load. This high level of utilization increases the potential risk that there will be insufficient capacity if a major outage involving multiple transformers or station busses, or combination thereof, were to occur; particularly if loads are higher than the current forecast. For example, if a major heat wave were to occur, loads would be higher as would the likelihood of incipient failure due to heating of station equipment. Good utility planning suggests that THESL should proactively address projected area transformer capacity deficits that are expected to occur over the next ten years and as early as 2017.[14] Service reliability and the impact of outages are discussed in the follow section.

Equally important is the compelling need to change out obsolete and heavily loaded switchgear busses at Windsor. One of the primary reasons new station capacity is needed downtown is to provide back-up support while switchgear is sequentially removed and upgraded at Windsor. Several of the busses at Windsor will soon be overloaded. Table 5 presents Windsor bus load

[14] Station bus capacity will be exceeded by 2017 at Windsor.

forecast, indicating overloads by 2014. Because of the grid network configuration and load location, further balancing of load among the busses is difficult.

Table 5: Windsor Substation Bus Loading Forecast

Bus Section	Firm Capacity Rating (MVA)		Year					
	100%	95%	2011 Act	2012	2013	2014	2015	2016
A11-12	69	66	55	56	58	59	60	61
A13-14	41	39	34	34	35	38	39	40
A15-16	69	66	67	66	68	69	70	72
A17-18	49	47	42	42	43	41	41	42
A3-4	64	61	49	50	52	56	57	58
A5-6	64	61	57	58	59	61	62	63

Risk Assessment

The potential for and impact of major events on reliability of supply to downtown Toronto is highlighted in the following risk assessment. It includes a condition assessment of critical equipment at Windsor.

Outage Scenarios and Area Reliability

The greatest outage risk to customers in downtown Toronto is a catastrophic outage, such as a loss of multiple transmission supply lines, station transformers or bus sections at one of the five critical downtown stations. The original design criteria for THESL stations also do not address low probability, high impact events involving the loss of the entire station. In particular, the exposure at Windsor is of particular concern as the equipment, although well-maintained, is older, the load density and load served is high, and because of the lack of back-up capability.

The simultaneous loss of multiple equipment, commonly referred to as common mode failures, is a low risk, high impact event. However, the risk and consequences of equipment failure and lengthy outages at Windsor and other downtown stations are increasing, both due to increased loading on already heavily loaded equipment, and the length of time that would be needed to restore service following an outage. As noted, there is no back-up capability from adjacent stations via feeder ties. Accordingly, a major failure at Windsor and other area stations would cause loss of supply and load unserved until repairs were completed. For a major common mode failure, repairs could require an extended period to complete. For example, a loss of multiple transformers at Windsor would require removal and installation of spare transformers within an enclosed structure in a busy section of downtown. The time for removal, transport, and reconnection of an extremely large and heavy 100 MVA transformer would be up to 90 days or longer. Similarly, a fire on a station bus in an enclosed structure could take equally long to repair.

Specific common mode failures relevant to facilities serving downtown include:

- Loss of two or more transformers due to catastrophic faults, overloads due to unanticipated heat waves, or fires causing collateral damage to adjacent devices,
- A fire caused by high fault currents and interrupter failure, spreading to adjacent bus sections,
- Equipment failure caused by sabotage or third-party impacts,
- Loss of several major incoming transmission supply lines, thereby interrupting service to one or more stations, and
- Loss of several primary feeder sections, located within a manhole or vault.

Such events, while infrequent, are not unprecedented. Examples of catastrophic events similar to those cited above include:

- Loss of major secondary networks in downtown Manhattan (Washington Heights)
- Loss of major station in Queens, New York due to multiple and cascading cable failures
- Loss of downtown Chicago load ("Chicago Loop") due to multiple transmission cable failures and subsequent station loss
- Loss of service to major sections of downtown Vancouver
- Loss of service to the City of Auckland, New Zealand due to cascading loss of cross-channel 69kV transmission cables

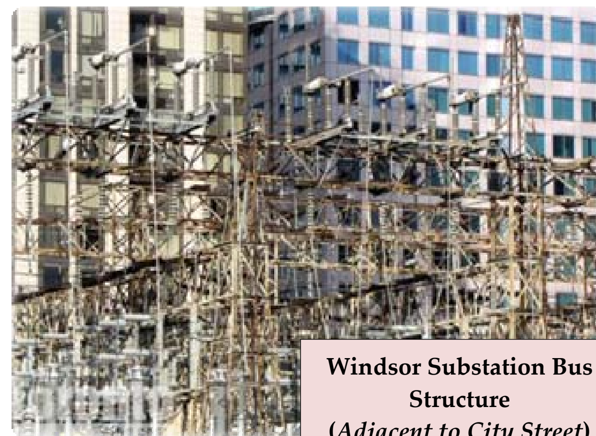
The economic, social and political consequences of these events were significant, and resulted in extensive financial loss and follow-up mitigation by the utility. We anticipate a major event causing lengthy load loss in downtown Toronto would result in similar economic and financial consequences, particularly if such an event were to impact the financial and business districts.

The impact of such an event likely would impair the image of Toronto as a leading urban center, causing unwanted attention and a tarnished reputation, both within and outside of Ontario. Notably, THESL previously experienced the loss of the Windsor station due to a transformer failure, and the Terauley and Dufferin stations due to flooding. Although the economic consequences were not as significant as the events listed above, these provide examples of how entire stations can be interrupted by contingencies.

Windsor Station Assessment

The Windsor Station, originally constructed in 1950, contains some of THESL's oldest equipment -- some obsolete -- yet serves what arguably might be deemed the most critical and sensitive load in the GTA (Greater Toronto Area). There are six 13.8kV switchgear busses, each of which has few or no spare feeder positions to unload other feeders or pick up load from other switchgear line-up, either for feeder outages or maintenance. Compounding this problem is the absence of interior and floor space to add new or expand existing switchgear busses.

Expanding the building is not an option, as it borders adjacent streets on two sides, the incoming HONI high voltage switchyard and transformer station on another, and private property under development and not for sale on the other (it also is not in a desirable location for new switchgear). Expanding the building upward also is not an option, as the installation of switchgear on the upper floors would pose major cable routing and logistical problems during construction. It also is not consistent with common utility station design practices.



Windsor Substation Bus Structure (*Adjacent to City Street*)

Further complicating expansion is the highly occupied basement, which contains medium and low voltage cable throughout the floor and attached to concrete walls. Adding additional cables presents significant routing and placement issues. The following photos readily illustrate the building confinement and crowded space that obviates the potential for any meaningful expansion at Windsor.

Figure 3: Windsor Station Cable Congestion

The above factors collectively present major obstacles to expanding the station to accommodate new transformation or switchgear and feeder capacity. High station loads and the inability to install new switchgear busses also restrict THESL's ability to replace obsolete switchgear, as there are no spare switchgear feeder positions or feeder ties to carry the load while switchgear busses are sequentially replaced, a lengthy construction process during which outage exposure would increase significantly, as the loss of a single source (transformer or switchgear bus) could lead to extensive load loss until repairs were completed.

In addition, several of the switchgear busses have feeders dedicated to serving secondary networks. Secondary networks are designed using single contingency (n-1) criteria, such that a loss of one primary 13.8kV feeders will not cause overloads on the grid connected low voltage secondary grid, or spot networks connected to these primary feeders. Extreme care must be exercised when transferring primary feeders serving network load to avoid primary or secondary main cable overloads. The limited spare feeder capacity and absence of spare feeder positions create considerable operational challenges to operating personnel responsible for maintaining service continuity during and after load transfers, including assurance that network secondary mains do not become overloaded during switching operations.

The continued use of existing switchgear busses that use air blast or magnetic interrupters is not an option, as these are not arc resistant and spare parts are increasingly difficult to obtain. THESL previously extended the life of the air-blast breakers by replacing the air supply system in the early 1990's. Despite these efforts and ongoing proactive maintenance, these station switchgear busses have become heavily loaded and outage exposure will increase over time. The potential for major outages and collateral damage is greater with switchgear utilizing air blast and magnetic breakers, as they are not constructed using arc resistant interrupting medium found on currently available equipment.

Supply Alternatives

Possible demand and supply alternatives are presented below. Each option is analyzed from a technical and economic perspective. A recommended course of action is provided based on the results described herein.

Alternatives considered for meeting long-term electrical demand for downtown Toronto include both demand and supply-side options. Supply-side options include expanding or adding new station capacity, whereas demand-side options include conservation and demand management (CDM). We also investigate the implications and viability of a status quo option, which assumes no additional station or feeder capacity, and current levels of CDM.

Status Quo Option

The Status Quo option assumes that existing station and feeder capacity would be used to the extent possible to serve future load. It includes rebalancing of feeder and transformer load via use of spare switchgear and transformer capacity. We do not view this option as viable, as transformer and feeder loading are reaching upper limits, and therefore, cannot accommodate additional load. The absence of firm feeder ties between and among substations is a primary deterrent to serious consideration of a status quo option. Also, it does not address the compelling need to replace obsolete switchgear at Windsor, a task that would cause THESL to violate its single contingency criteria for up to a year without back-up ties to transfer load from 13.8kV feeders normally supplied by Windsor. Importantly, there is no back-up source -- if one of the switchgear busses at Windsor were to fail catastrophically while another was out of service for replacement, a lengthy outage likely would ensue. Given the two to five year lead time needed to plan, design, procure equipment and construct major new facilities, THESL should proceed expeditiously to minimize risk exposure.

A variation of the Status Quo option is to transfer load among existing busses at Windsor. However, there is minimal spare bus capacity, and any shifting of load will do little to address long-term capacity needs at Windsor and other area stations. Further, it does not provide a remedy to the absence of sufficient back-up capacity to enable replacement of obsolete switchgear. This option also violates THESL's single contingency design criterion.

Targeted CDM

A significant portion of downtown Toronto load is commercial, and includes the financial district, many high rises and several tourist destinations. THESL has actively promoted CDM in downtown Toronto, including commercial lighting and heating, ventilation and air conditioning (HVAC) programs. These savings are reflected in the current load forecast. However, additional savings via these programs are limited, as THESL has identified and implemented cost-effective CDM opportunities in downtown Toronto. For example, aggressive change-out of commercial lighting and replacement of low-efficiency air conditioning now limits the opportunities for additional CDM.

The analysis presented in Table 6 assesses the extent to which targeted CDM – beyond existing levels - would potentially defer need dates for additional station capacity. The analysis assumes the maximum amount of additional CDM that THESL could reasonably add by 2014 is fifty percent above levels proposed or already achieved in downtown Toronto

Table 6: Targeted CDM – Impact on Station Need Dates

Station	Year												
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
(1) Windsor													
Net Firm Surplus Capacity	36	34	25	16	12	5	-2	-9	-15	-22	-31	-37	-43
Base CDM	3	4	5	7	7	8	9	10	11	13	15	16	18
Targeted CDM	1	2	2	3	4	4	5	5	6	6	7	8	9
Firm Cap & Targeted CDM	**37**	**36**	**27**	**19**	**16**	**9**	**3**	**-4**	**-9**	**-16**	**-24**	**-29**	**-34**
(2) Esplanade													
Net Firm Surplus Capacity	23	25	21	16	11	6	2	-1	-6	-10	-14	-18	-23
Base CDM	3	4	5	7	7	8	9	10	11	13	15	16	18
Targeted CDM	1	2	2	3	4	4	5	5	6	6	7	8	9
Firm Cap. & Targeted CDM	**24**	**27**	**23**	**19**	**15**	**10**	**7**	**4**	**0**	**-4**	**-7**	**-10**	**-14**
(3) Windsor & Esplanade													
Net Firm Surplus Capacity	59	59	46	32	23	11	0	-10	-21	-32	-45	-55	-66
Base CDM	5	7	10	13	15	16	18	21	23	26	29	33	37
Targeted CDM	3	4	5	7	7	8	9	10	11	13	15	16	18
Firm Cap. & Targeted CDM	**62**	**63**	**51**	**39**	**30**	**19**	**9**	**0**	**-10**	**-19**	**-30**	**-39**	**-48**

While this amount of CDM may be cost-effective and provide benefits independent of area capacity needs, even a fifty percent increase is insufficient to materially defer the date for additional station capacity. Because the additional amount of CDM that could be achieved is uncertain, it is not advisable to defer new capacity for the few years the need date might be extended. Further, additional CDM does not address the need to replace obsolete switchgear at Windsor, where substantial back-up capacity is needed to accommodate load transfers while the switchgear is replaced.

Distributed Generation

Distributed generation (DG) generally is included as one of the resource options under CDM, and the 6,300 MW demand reduction targeted for the province by 2025 includes substantial amounts of DG. A recent study completed for THESL and the OPA evaluated the potential for

DG to provide support to the transmission system and high voltage substation, and to provide back-up to near-term station upgrades.[15]

The results of the study indicated significant technical potential for DG in Toronto, but amounts likely to be installed as uncertain. Estimates of the potential market penetration for customer-connected distributed generation in Central and Downtown Toronto ranged from 140 MW in the medium term to more than 550 MW in the long-term. Attachment I presents ranges of market potential and penetration by technology type.

Several studies recently were completed to determine whether DG would be able to support the downtown area. These included identifying methods to reduce barriers to DG penetration. One of the key findings of these studies is the difficulty in siting DG in dense downtown load areas, particularly on secondary grid networks. (A substantial amount of Windsor load is on secondary networks.) The ability to install rotating devices (e.g., synchronous generators) is limited by fault current limits, and by the likely de-sensitization of network protectors, which are not designed to accommodate generators. (Network protectors will quickly open and isolate circuits under reverse power flow conditions, whether due to steady-state power flows from the generator or transient fault currents caused by generator fault contribution for primary or secondary cable faults.) Further, programs introduced in the U.S. have seen limited success due to a physical assurance requirement adopted by utilities.[16]

The results of the DG study indicate there is considerable uncertainty that customers will install DG in an amount sufficient to back up Windsor or to defer station capacity needed to serve downtown Toronto. Further, the use of intermittent sources such as wind and PV may not provide firm reliability capacity in amounts sufficient to meet Ontario and THESL capacity planning criterion. Accordingly, DG as an option is speculative and not determined to be a viable near-term option at this time. However, if the follow-up activities described above result in a finding that DG will likely be added in amounts sufficient to defer energy delivery facilities, the DG option should be reconsidered.

Expand Existing Stations and Inter-Station Transfer Capability

Of the five stations serving downtown Toronto, only Strachan and Esplanade are suitable for expansion. The primary factor limiting expansion at Cecil, Terauley and Windsor is space: each of these stations is enclosed with no space available to install new transformers and switchgear.

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[15] The study responded to a request by the Ontario Energy Board in its EB-2007-0680 decision that Toronto Hydro investigate distributed generation in its service territory as a supply alternative.

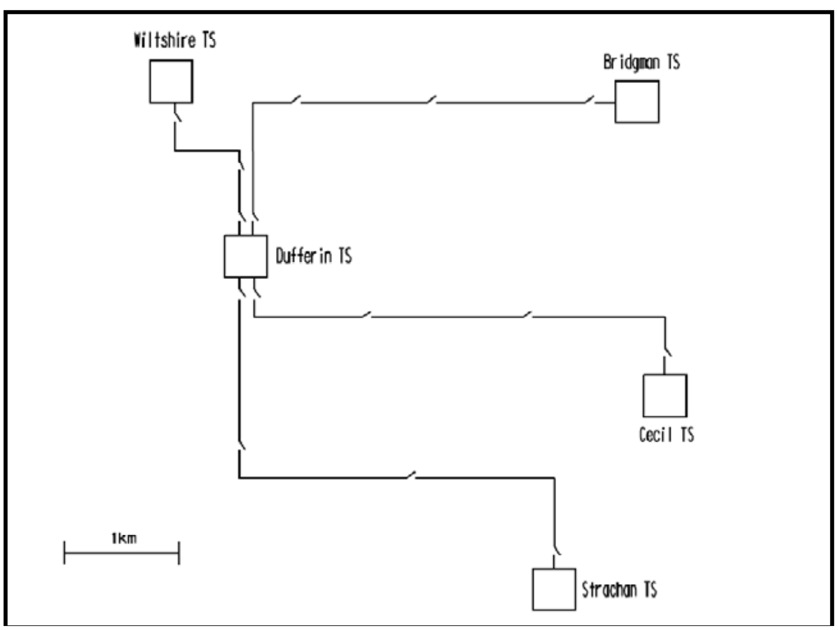
[16] Physical assurance is a requirement that customers that own generation guarantee the generators will operate when needed, and agree to allow the utility to interrupt an equal amount of customer load in the event the generator is not started or unable to operate.

In particular, the absence of spare switchgear positions to accommodate new 13.8kV distribution feeders and limited ability to transfer load between switchgear busses are major limitations at Windsor. Terauley is another nearby station with surplus firm capacity. However, the Terauley station also has transmission loading limits, and would not be able to pick-up the additional 60 MW of load from Windsor while station switchgear is replaced.

The Strachan and Esplanade sites each have sufficient space to accommodate new transformers and feeder positions. These stations are located in areas targeted for development and are electrically close to downtown load and the Windsor station. However, a considerable amount of new underground 13.8kV feeder capacity would be needed to transfer load from Windsor to these two stations. Nonetheless, the expansion of Esplanade and Strachan should be considered as a potentially viable option for meeting capacity deficiencies in downtown Toronto. Of these stations, Esplanade is a superior near-term choice as it can accommodate more new feeders than Strachan, as Strachan only has space to add one new switchgear line-up (16 feeders) compared to three (48 feeders) for Esplanade.

Over time, THESL proposes to reconfigure downtown distribution system to improve operating flexibility and reliability. These changes include installation of feeder ties where practicable and cost-effective. One example where feeder ties are proposed is the Dufferin TS. It would include the installation of remotely-operated load break switches at Dufferin and on several feeders to enable transfers between Dufferin and the Bridgeman, Cecil, Strachan and Wiltshire stations. A simplified diagram of proposed feeder ties at Dufferin is illustrated in Figure 4.

Figure 4: Proposed Dufferin Feeder Ties in Downtown Toronto



Expand Esplanade

The cost to expand the number of feeders and ties to Windsor from the Esplanade station (2km) to pick up Windsor loads is about $1.4 million per feeder. Up to 48 new feeders (about 250 MW total) would be needed at a cost of approximately $67.3 million. In addition, Esplanade contains some equipment that may need to be upgraded to bring it to current HONI standards. These upgrades would include new transformers, switchgear, bus structure, protection and controls and site work. Most of these costs would be contributions to HONI, as it owns each of the stations. Additional costs would be borne by THESL for low voltage switchgear, structures and exit feeders.[17] The amount of the HONI station upgrades is estimated at $44.4 million; THESL station equipment adds another $34.2 million, for a total project cost of $146 million. The $67.3 million for new feeders and tie points would occur over time, concurrent with station capacity deficiencies. Because planning, design, permitting and review activities have not started at Esplanade, the earliest the station could be in service is 2016.

Expand Strachan

The cost to expand the number of feeders and ties to Windsor from the Strachan station (2.2 km) to pick up Windsor loads also is estimated at $1.4 million per feeder. Up to 16 new feeders (about 80 MW total) would be needed at a cost of approximately $22.4 million. Strachan also contains old equipment and some of it would need to be upgraded to bring it to current HONI standards. Similar to Esplanade, most of these costs would be contributions to HONI, as they own each of these stations. Additional costs would be borne by THESL for low voltage switchgear, structures and exit feeders.[18] The amount of the HONI station upgrades is estimated at $21.8 million; THESL station equipment adds another $11.4 million, for a total project cost of $55.7 million. The $22.4 million for new feeders and tie points also would be spent concurrent with station capacity deficiencies. Because planning, design, permitting and review activities have not started, the earliest the station could be in service is 2016.

Construct New Station

Reinforcement of downtown Toronto has been under investigation for well over a decade. In 1996, THESL and HONI completed the Toronto Integrated Electrical Service (TIES) study, which identified long-term strategies to relieve John, Windsor, Esplanade and Terauley TS loadings by establishing a new station in the Roundhouse Park (also referred to as the Railway Lands Station). Subsequent studies included the construction of a new Railway Lands station (i.e., the new Bremner station) to supply customer load while the John to Esplanade transmission tie was upgraded from 115kV to 230kV (Figure 5).

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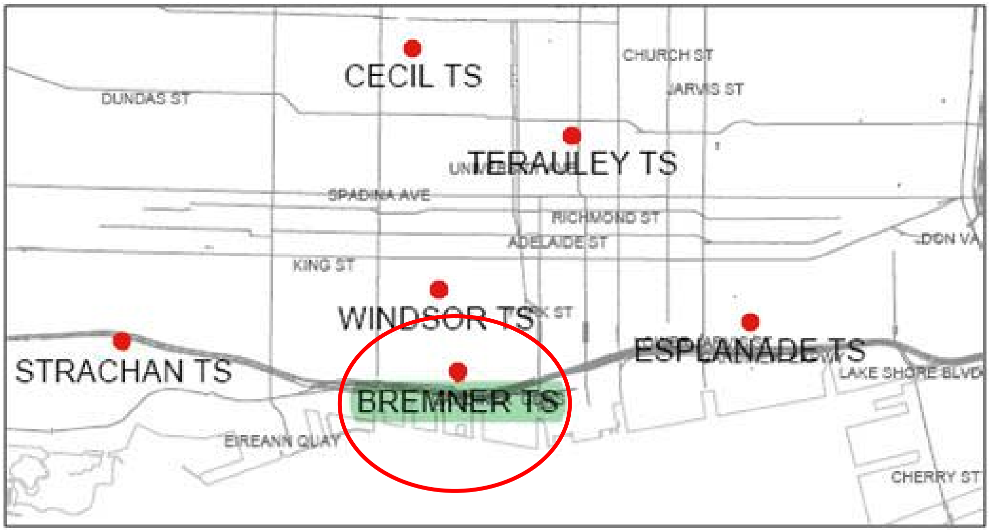
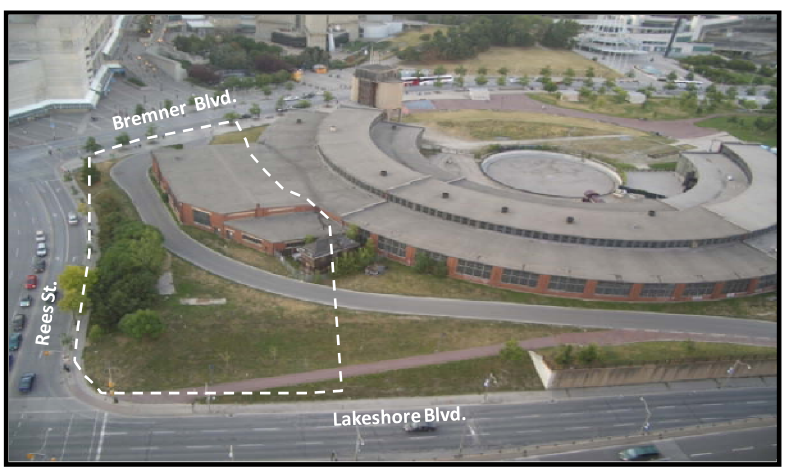
[18] Existing equipment at Strachan is very old and would be replaced as part of a capacity and refurbishment program that HONI likely would mandate.

Figure 5: Proposed Location for New Bremner Station



One of the primary challenges to constructing a new station in the downtown area is land acquisition. Land cost is usually at a premium and many sites often are not the best choice from an electrical perspective -- the best choice is to locate stations in load centers as opposed to peripheral locations. Recently, THESL purchased from HONI a parcel of land adjacent to the Railroad Round House yard, which electrically is in the downtown core where additional capacity is needed. THESL has worked closely with the City of Toronto to ensure a new substation would blend in with the surrounding area.

Figure 6: Proposed Downtown Site for New Substation



Detailed engineering is nearly complete for the electrical layout and configuration of the proposed Bremner site. Appendix A includes a depiction of the proposed layout, which includes fully enclosed structures and underground transmission and feeder exit cables. Initially, the station would be equipped to supply up to 72MVA of load, with expansion capability up to 300 MVA.

The costs of the new Bremner, and the upgraded Esplanade and Strachan stations, including distribution upgrades and HONI capital contributions, are summarized in Table 7.

Table 7: Cost Estimate – Station and Distribution Upgrade Options

Description	Cost (2012 $Million)		
	Esplanade	Strachan	Bremner
Station and Distribution System	$34.2	$11.4	$135
Capital Contribution to Hydro One	$42.5	$21.8	$60
Distribution Ties (Complete build-out)	$67.3	$22.4	
Total	**$146**	**$55.7**	**$195**

Specific components included in the Bremner estimate are highlighted below for the first phase of the project, with ultimate build-out potential in the parenthetical. The station would be designed to initially supply 72 MVA of firm demand, with expansion capability of up to almost 300 MVA. Unlike all other 115kV or 230kV supply stations (except for Cavanaugh, which is owned by THESL), THESL would own the following equipment.

- Station site and building
- 115kV switchgear
- 115kV bus within station
- 115kV/13.8kV transformers 13.8kV metalclad switchgear 13.8kV feeders (16, ultimately up to 64)
- Protection and ancillary equipment

Equipment that would be owned by HONI includes:

- 115kV breakout tap at John-Esplanade tunnel
- Underground cable circuits (2 – 115kV)
- 115kV interface equipment

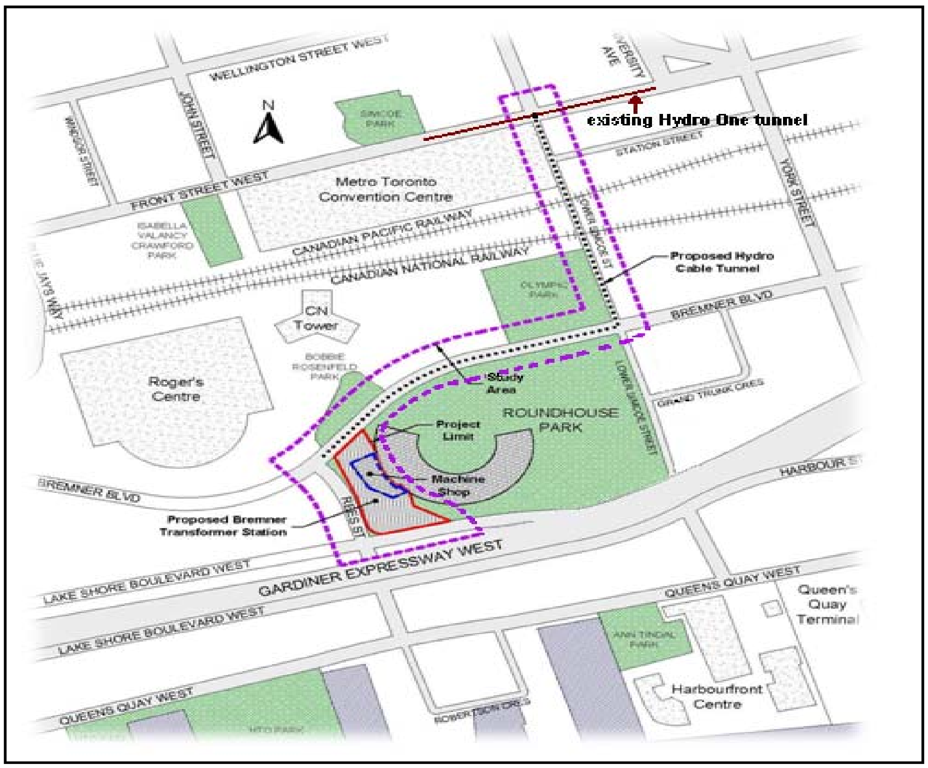
As noted, all transmission cables and 115kV switchgear and busses will be rated 230kV for potential conversion if 230kV transmission supply is later expanded to downtown Toronto.

Transmission Supply Considerations

The impact of expanded station capacity or the installation of a new station on the area 115kV system is an important consideration in the evaluation of alternatives. From a capacity standpoint, the existing 115kV system can accommodate additional station loads at each of the existing five downtown stations.[19]

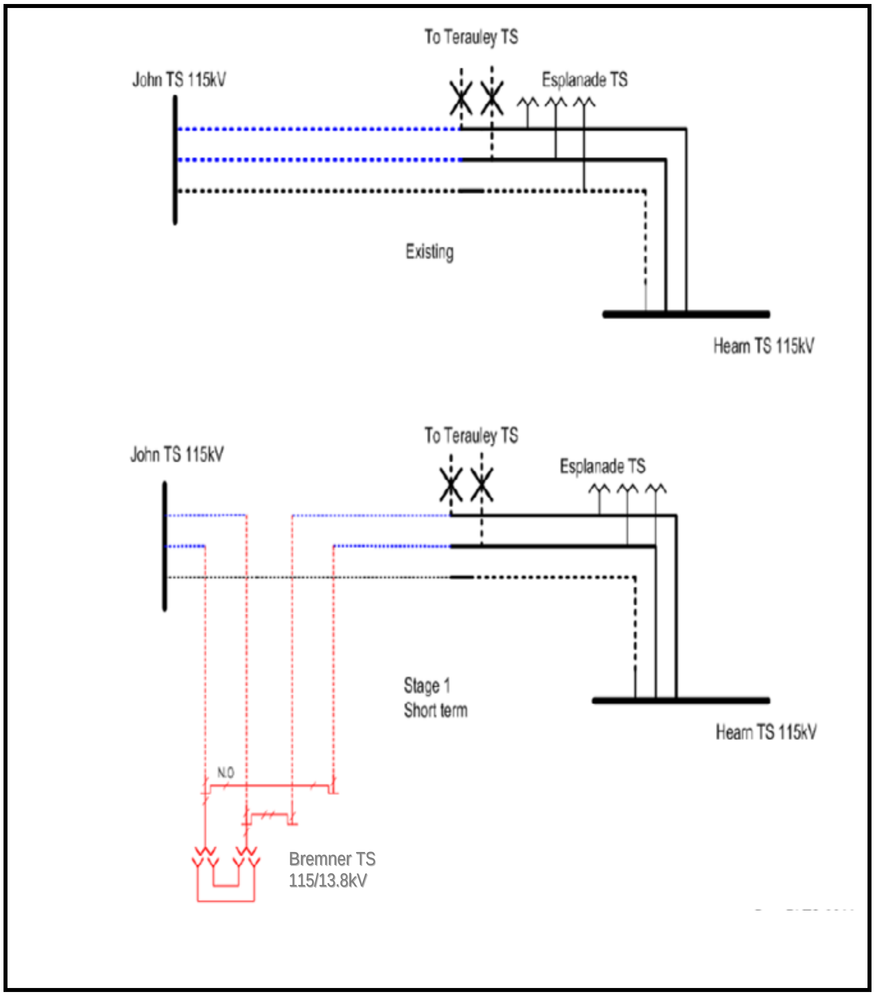
The construction of a new station at Bremner would require new 115kV lines to interconnect to the existing transmission system. The first stage of the proposed interconnection is illustrated in Figure 7. Figure 7 also presents the electric one-line diagram of the 115kV interconnection between the John and Hearn stations. Notably, the proposed 115kV cable tie between John and Esplanade is located 600 meters from Bremner. Discussions with HONI confirm the Bremner station can be fed by tapping directly into the proposed John-Esplanade line, and then routing two new 230kV cables operated at 115kV into the new station. As noted, the existing tunnel and duct bank has a break out tap designed to accommodate a tap line to a new station.

Figure 7: Transmission Interconnection



<u>Bremner Interconnection: One-Line Diagram</u>

[19] This conclusion is based solely on the ability of the 115kV system to accommodate new load. It does not address the capability of the 230kV bulk system to accommodate new load or to limit fault current to within design limits.


To Terauley TS
John TS 115kV
Esplanade TS
Existing
Hearn TS 115kV
To Terauley TS
John TS 115kV
Esplanade TS
Stage 1
Short term
Hearn TS 115kV
N.O
Bremner TS
115/13.8kV

Assessment of Supply Alternatives

Methodology

NCI performed life-cycle economic analyses of project alternatives using THESL economic and financial data. Alternative supply options considered include the proposed Bremner TS, upgraded adjacent stations (Esplanade and Strachan), distributed generation and targeted CDM. Each alternative and resulting business case was assessed using an evaluation framework comparable with other THESL capital projects. This approach ensures project ranking and evaluation factors were applied consistently among alternatives. In particular, the ability of each alternative to meet minimum reliability criteria with regard to the level of "firm, reliable" capacity over time was a key factor in the evaluation of alternatives.

Technical Evaluation

The following summarizes alternatives from a technical perspective, including an assessment of how each option impacts area reliability. In addition, the ability of each option to address the need to replace switchgear at Windsor is analyzed. Each option is evaluated based on the assumption that each must achieve minimum design and planning criteria to be viable.

Area Reliability

Of greatest concern is the Status Quo option, which will cause reliability to seriously degrade and violate the minimum reliability set forth in THESL's planning guidelines; that is, the ability to serve peak demand under first contingency conditions, a criterion that has been adopted by many urban utilities. The addition of a new substation or increased substation transformation capacity will avoid degradation in reliability, and in fact, will enhance area reliability by providing first and second contingency support for critical downtown load centers. Major utilities in North America have adopted second contingency design criteria for major urban centers similar to Toronto.

The addition of a new station at Bremner would substantially reduce outage exposure, particularly for low probability, high impact events such as the complete loss of the station. Such events have occurred with increasing frequency at other North American utilities, with profound economic consequences. A loss of a core downtown station such as Windsor likely would cause major outages lasting for more than 24 hours. The economic impact likely would be in the tens of millions of dollars, with the City's image as a leading metropolitan center tarnished by the event. The option of expanding Esplanade has higher risk than Bremner, as it would not be in service until 2016, thereby delaying critical switchgear upgrades at Windsor.

Targeted CDM may be able to defer by a few years, at most, the need for additional capacity, but not in an amount to address reliability concerns. Further, CDM does not provide the back-up support needed to replace critical switchgear at Windsor.

Distribution System Impacts

A significant advantage that would result from the installation of a new station at Bremner is the ability to provide back-up via 13.8kV underground feeders -- currently, these ties do not exist. Benefits include improved operating flexibility and maintenance scheduling. Most important, it would provide enhanced reliability -- second contingency support would be provided to key stations -- in downtown Toronto. These ties can be developed at relatively low cost, and are essential to enable timely and reliable replacement of obsolete switchgear at Windsor. The development of feeder ties is consistent with THESL's long-term plan to create ties among several downtown stations, each of which will improve operating flexibility and reliability.

Operations and Maintenance Considerations

As noted throughout this report, additional station capacity is needed to enable reconstruction and upgrade of low-voltage switchgear at Windsor. This will be accomplished via use of switchgear feeder ties to other stations in downtown Toronto, tie capacity that presently does not exist. The construction of a new station at Bremner with inter-station switchgear ties to adjacent stations (Windsor and Esplanade in the short term) also will facilitate maintenance between these stations. For example, for transformer maintenance it may be more practical to transfer load to Bremner TS switchgear from Windsor TS switchgear via feeder ties.

Assessment & Economic Evaluation of Supply Alternatives

Based on the above assessment, the only viable options to meet Windsor switchgear replacement and capacity needs are the construction of a new station at Bremner or the expansion of Esplanade in 2016, followed by capacity expansion at Strachan in 2021: the difference is one of timing based on economics as a new downtown station will be needed by 2030 even if both Esplanade and Strachan are upgraded. These two alternatives are described as Options 1 and 2, respectively. Each of these two options was compared using net present value economic analysis.[20] The capital cost of each option in 2012 dollars appears in Table 7. However, if upgrading Strachan and Esplanade in 2016 and Strachan in 2021 is selected, additional feeder capacity and tie points will be required in order to unload Windsor. Feeder upgrades are not required for the new Bremner station as existing duct banks and cables could be easily re-routed to the new station.

[20] The NPV analysis includes present worth costs for all station and distribution upgrades between 2012 and 2030.

Base Case Costs

Equipment procurement and construction costs for Bremner are based on a three-year project schedule and in-service date of 2014. Further, an additional $77 million will be needed to expand transformation capacity at Bremner from 2016 to 2030 due to load growth in the downtown core. An additional year is needed for permitting and design for an in service date of 2016 for Esplanade. A 4-year schedule also is assumed for upgrades at Strachan in 2021. Option 2 also includes approximately two new feeders (10 MVA) over each year of the study to serve core downtown load. Economic and financial assumptions are based on NCI and THESL estimates, and prior studies; including sensitivity analysis. The sensitivity cases include increasing and decreasing price escalation and discount rates by one percent and 1.5% respectively. In all cases, the total cost of each option is based on the 2012 NPV of the annual cost streams.

The results of the base cases economic analysis, summarized in Table 8, indicate that for the base case and price sensitivity analyses, Option (1) produces superior economic results with Option (2) 18 percent higher on a net present value basis. Option (2) is more expensive as additional transformation capacity would still be needed at Strachan about 5 years after Esplanade is upgraded.

Table 8: Economic Comparison of Alternatives (NPV)

Options	(1) 2014 Bremner-Phase 1 2021 Bremner –Phase 2 2030 Esplanade	(2) 2016 Esplanade 2021 Strachan 2030 Bremner	Difference (NPV) (2) – (1)	Difference (Percent)
Base case	$281	$333	$51	18%
Price Sensitivity:				
Price escalation 6%	$303	$374	$71	24%
Price escalation 4%	$262	$297	$34	13%
Discount rate 4.5%	$319	$403	$84	26%
Discount rate 7.5%	$251	$278	$27	11%

Notes:

(1) All results in millions of dollars (net present value of all investment costs over 18 years)

(2) Base case assumptions include discount rate of 6 percent and real price escalation rate of 5 percent

Sensitivity Analysis – HONI Station Costs

Because the level of certainly of cost estimates for HONI upgrades is less than the cost of THESL upgrades, additional sensitivity analysis was conducted by varying the portion of HONI costs at Strachan, Esplanade and Bremner. The sensitivity cases include a 25 percent cost reduction for HONI's portion of the Esplanade and Strachan station upgrades. Table 9 presents these results, which confirms that Option (1) – Construct Bremner in 2014, is the preferred option. As well, the risk associated with the additional time needed to design, approve and construct the

HONI stations still makes the Bremner options superior even if the results of the economic analyses are the same.

Table 9. Economic Analysis – Capital Cost Sensitivity for HONI Upgrades

Options	(1) 2014 Bremner-Phase 1 2021 Bremner –Phase 2 2030 Esplanade	(2) 2016 Esplanade 2021 Strachan 2030 Bremner	Difference (NPV) (2) – (1)	Difference (Percent)
Base case	$281	$333	$51	18%
25% reduction in cost for HONI upgrades: Esplanade & Strachan	$266	$288	$22	8%

From the base case and sensitivity analysis, NCI recommends that THESL proceed with the development of the new Bremner station. Our recommendation is based on several compelling factors, including an available site in a critical downtown location, the electrically central location of the station, the ability to back-up feeders from adjacent substations and the need to provide back-up to Windsor while switchgear is replaced.

Environmental Factors and Site Selection

This section highlights our investigation of environmental impacts associated with development of the proposed Bremner Substation. It includes an assessment of the net impacts on environmental, aesthetics, traffic, and other locational factors.

Site Selection and Aesthetics

The proposed Bremner station is located on Railway lands and adjacent to the Roundhouse station. Recognizing the historical significance of the site, THESL has created an integrated design to ensure the new station blends aesthetically with other current and proposed uses for the property. Similar to other downtown stations, most equipment at the proposed Bremner station will be enclosed, visually separate from public viewing corridors. The aesthetics of the building enclosure will improve the appearance of the area. Figure 8 illustrates the conceptual design of the proposed Bremner station, whose enclosure integrates well with the existing Roundhouse design, construction and public access. (Attachment II provides additional details.)

The site roughly measures 50 by 100 meters, and is located at the intersection of Bremner Boulevard and Rees Street. It is located opposite of the CN Tower and Rogers Centre. Notably, most electrical equipment will not be visible from the public view shed, as major equipment such as transformers, breakers and the station bus will be located at street-level, below the public walk lanes and enclosed by walled sections (lower level). Equipment installation and access for maintenance is enhanced by the adjacent roadways, which provides for easy egress for vehicles and equipment. Further, the need for noise mitigation (e.g., transformer hum) is minimized by background noise created by vehicular traffic on the nearby Gardiner Expressway.

Figure 8: Proposed Bremner Station Enclosure

Environmental Assessment

The Bremner station, unlike other HONI and THESL stations, will include gas-insulated transformers and breakers, thereby eliminating the need for oil containment equipment and enclosures. The station design and construction also will comply with all relevant sections of the Ontario Energy Board's (OEB) Distribution System Code and applicable safety codes.

The impact on area traffic will be minimal as the site is unmanned and crew visits are infrequent. Crew visits include monthly site inspections and planned maintenance of electrical equipment. Planned maintenance of major equipment typically is performed annually.

Summary Assessment and Conclusions

The construction of new 115/13.8kV stations in Toronto is uncommon, as the last new station constructed was Gerrard in 1998. The results of our investigation indicate new station capacity is needed to serve downtown Toronto by 2017. Of the options considered, the construction of a new station adjacent to the Railway yards site with an in-service date of 2014 is the best choice from an economic and technical perspective. The new Bremner TS would be located in an ideal location in the downtown core, which would improve area reliability and enhance operating flexibility. Once constructed, another new station likely will not be needed for another 25 years.

Specific results and findings supporting our recommendation include the following:

1. Installation of a new station at the proposed Bremner site will provide back-up to the Windsor station to enable replacement of equipment without compromising reliability. It will allow THESL to replace the critical station equipment at the existing Windsor station, at task which is prohibitively expensive and difficult without adequate supplemental or back-up capacity from adjacent stations.

2. The downtown Toronto area will need additional station capacity by 2017. The existing five stations serve nearly 1000 MW of critical load and cannot accommodate new demand without additional station capacity, either by expanding existing or adding new stations.

3. The upgrade and expansion of three of the five existing stations and associated underground distribution feeders in the downtown is neither practical nor cost-effective. Expansion of the Esplanade and Strachan stations and installation of feeder ties in 2016 and 2021 would meet capacity needs and provide sufficient capability to unload Windsor; however, a new station will be needed in downtown Toronto by 2030. Further, expansion of these stations in the near-term is not a cost-effective solution to meeting near-term area reliability or capacity needs.

4. Current Conservation and Demand Management (CDM) programs will not defer the need for additional station capacity in downtown Toronto. Accelerated efforts and targeted CDM also will not materially defer the need for station capacity in downtown Toronto. A large DG unit with firm capability could defer the need for new capacity; however, there is no indication at this time that firm DG in amounts needed to meet capacity deficits will be installed to prior to need dates, nor does it provide the back-up needed to replace switchgear at Windsor.

5. Of the options considered for a new station, the Railway yards site is preferred as it is centrally located in high density load area, on land which has been purchased, will have minimal noise impact, provides easy access to electric equipment, and minimizes the amount and cost of new transmission taps from HONI 115kV system.

6. Installation of the new Bremner station would enhance reliability in critical downtown load centers to be consistent with those of utilities serving other large North American urban centers. Installation of a new Bremner substation will enable THESL to achieve a level of reliability in Toronto similar to utilities that serve major urban centers in North America and cities worldwide. The other options evaluated generally do not provide the same level of reliability benefit.

7. Of all capacity expansion options considered, installation of a new station at Bremner in 2014, followed by additional transformer in 2021, and the expansion of Esplanade in 2030 is the preferred solution based on net present value economics.

8. The installation of a new station at Bremner will improve operating flexibility, including the ability to transfer load via inter-station switchgear ties, which will facilitate maintenance and reduce outage restoration time.

9. The site and enclosure where the Bremner station equipment will be located is highly desirable from an electrical standpoint, as it is located in area where load density is highest, and where electric demand is most likely to increase. Because vacant land is at a premium in the downtown area, another suitable site may not be available if the Railway land is not used by THESL for a new station.

10. The proposed Bremner site has been designed to blend favorably with the Railway Roundhouse and will improve the overall appearance and public access to proposed enhancements.

For the above reasons, NCI recommends that THESL proceed with the development of the proposed Bremner station, consistent with currently proposed design and construction time frames.

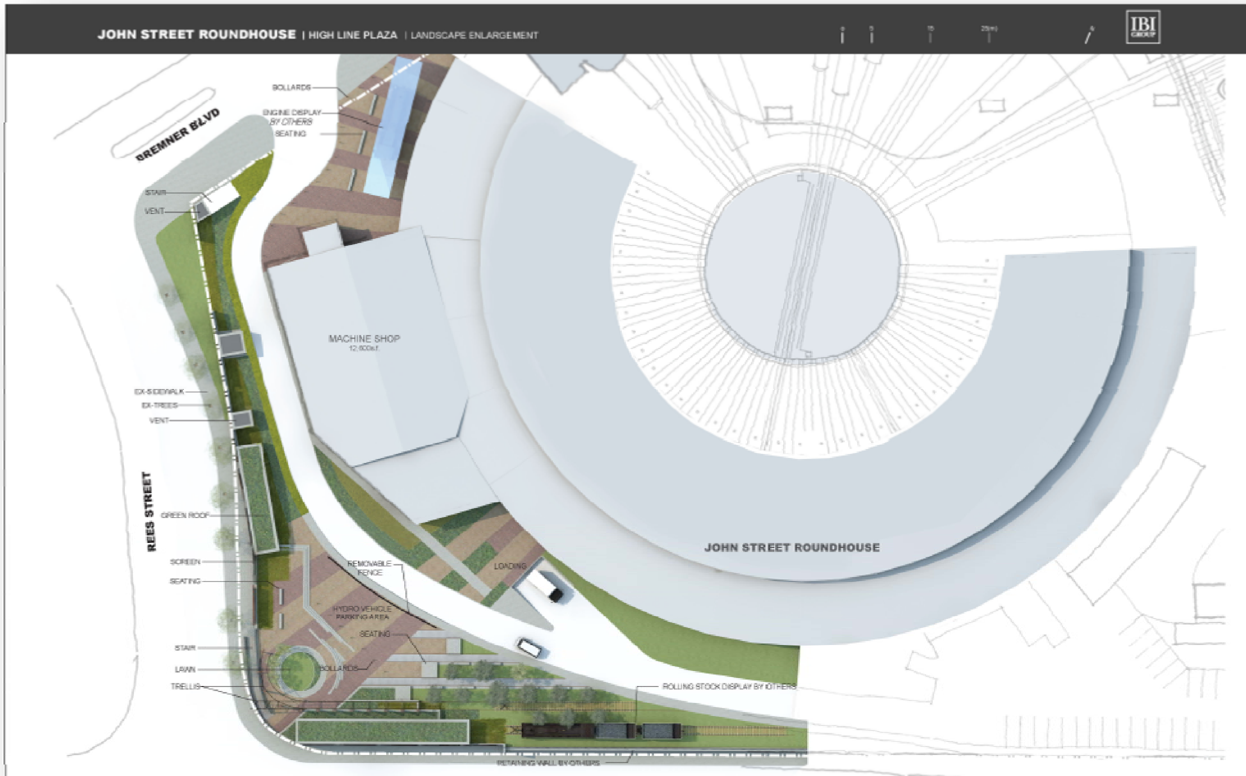
Attachment 1: Distributed Generation Potential in Toronto

Technical Potential and Expected Market Penetration of DG (MW)

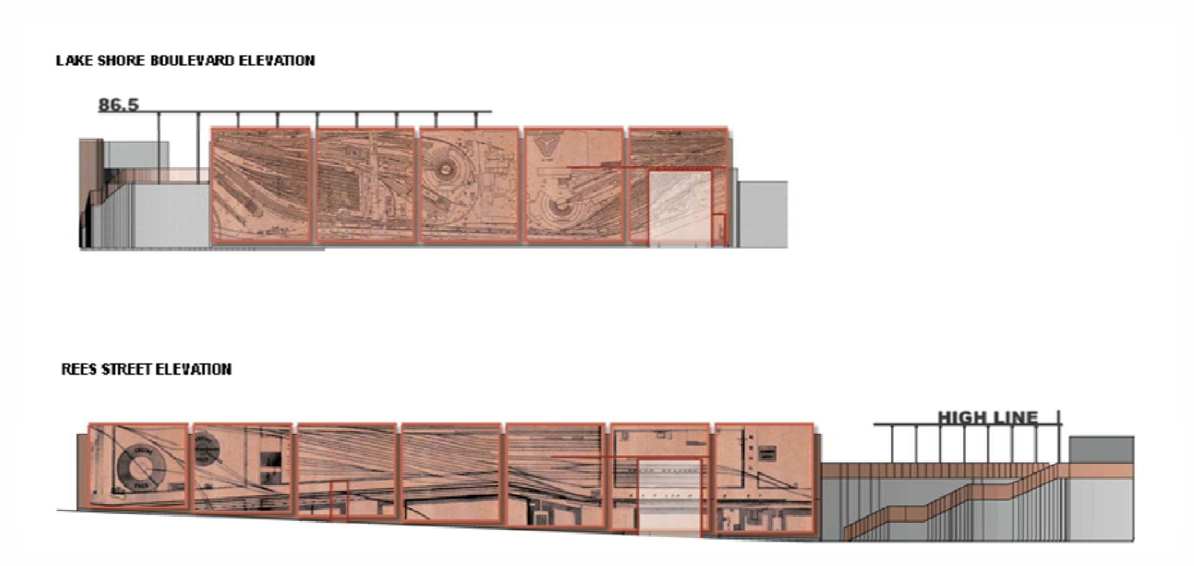
(Listed by Technology)

<table>
<tr><th></th><th colspan="8">Technical Potential (MW)</th></tr>
<tr><th>Project Size</th><th>Diesel Backup w/ SCR</th><th>Gas Engine</th><th>CHP</th><th>Fuel Cell CHP</th><th>Multi-Residential CHP</th><th>Micro-CHP</th><th>Non-Residential PV</th><th>Residential PV</th></tr>
<tr><td>100-500 kW</td><td>60</td><td>60</td><td>170</td><td>-</td><td>84</td><td rowspan="4">210</td><td rowspan="4">1,000</td><td rowspan="4">300</td></tr>
<tr><td>0.5 - 1 MW</td><td>40</td><td>40</td><td>90</td><td>-</td><td>-</td></tr>
<tr><td>1-5 MW</td><td>60</td><td>60</td><td>230</td><td rowspan="2">150</td><td>-</td></tr>
<tr><td>5-10 MW</td><td>20</td><td>20</td><td>150</td><td>-</td></tr>
<tr><td>Total</td><td>180</td><td>180</td><td>640</td><td>150</td><td>84</td><td>210</td><td>1,000</td><td>300</td></tr>
<tr><td>Expected Range on Market Penetration (MW)</td><td>36-90</td><td>12-70</td><td>31-224</td><td>4-35</td><td>5-19</td><td>3-84</td><td>2-27</td><td>1-3</td></tr>
</table>

Attachment 2: Proposed Bremner Station Site Layout



Bremner Station Site Layout – Cross-Sectional View



Attachment 3: Report Revisions

Table 10. Revision History

November, 2009	Prepared as feasibility study
March 15th, 2012	Revised/Updated
April 17, 2012	Final Report Issued

References

1. Toronto Hydro, *Distribution System Planning Guidelines*, November, 2007.
2. Toronto Hydro, *Distribution Construction Standards*, Various dates.
3. *Analysis of Failure Rates of Air Blast Breakers As A Function of Age And Usage*, 2003 IEEE Bologna PowerTech Conference, June 23-26, Bologna, Italy; George Anders, Henry KM Aciejewski, Bruno Jesus, Faruqr Emtulla.
4. Toronto Hydro Internal Report, *Interties to Provide Backup Capacity to Downtown Stations*, November, 2006.
5. Toronto Hydro-Electric System Limited, Hydro One Networks Inc. *Transformer Stations Planning Report*, December 11, 2008.
6. Navigant Consulting Inc., *Distributed Generation in Central and Downtown Toronto,* July 28, 2009.

Appendix 4

Decision on Bremner TS Site

1.0 Overview

Introduction

Since 1992, the City of Toronto has been offering alternative land options to Hydro One in exchange for the Bremner TS site (previously known as the 'Hydro Option Lands' at John Street Roundhouse). A total of 9 alternative sites have been offered and reviewed since 1992. Due to the ideal conditions of the Bremner TS land to accommodate a Transformer Station, all the options were critically evaluated based on a list of minimum criteria developed by Hydro One. Some key examples of the criteria examined are summarized below:

- Access for the movement of large trucks carrying heavy equipment
- A location away from flood plains and other hazards
- Site size ideally should be about 50 by 65 meters or larger, with a height up to 20 meters
- Access for incoming transmission lines and for outgoing distribution lines
- Easements available from the site to existing 115 kV cable circuits or to John TS

Sites Rejected[1]

The following are alternate sites that were rejected based on the aforementioned criteria:

1. Canada Malting Site – Foot of Bathurst St
2. Toronto Islands
3. 120 Pearl Street, South of Adelaide Street West between John & Simcoe (owned by EnWave)
4. S/S Bremner Blvd., East of proposed Simcoe Street Extension (Parks dedication)
5. Rear of 53 Strachan Ave & Portion of 665 Wellington Street West (former WES Transfer Site)
6. Extension of Simcoe Street, east side, south of Station Street (GO Transit lands)
7. Blocks 34 & 36 – (City Housing Sites)
8. S/S of Bremner Blvd. between Spadina & Bathurst (Future Parks Dedications)
9. Bathurst Street Bridge (lands below the bridge, south of Front Street and GO Transit R.O.W)

[1] Refer to attached letter to this appendix.

Demonstration of Discussion between City of Toronto and Hydro One

As a demonstration of the correspondences that occurred between the City of Toronto and Hydro One, the attached letter provides details regarding the consideration process for options 8 and 9.

Option 8, which was located on the south side of Bremner Boulevard west of Spadina Avenue was not supported by planning staff and was ultimately withdrawn by the City of Toronto.

Option 9, which was located beneath the Bathurst Street Bridge, South of Front Street West was restricted in both height (19 feet) and width (road allowance width is approximately 100 feet), and did not satisfy Hydro One’s minimum requirements.

Summary

In summary, the Bremner TS site is the most ideal location to accommodate the Transformer Station; it is close to the load center in the Railway Lands; it can easily access incoming transmission lines and outgoing distribution lines; it is away from flood plains and other hazards; it is located in a non-residential area; there is a route available from the site to existing 115 kV cable circuits at the intersection of Front St and Simcoe St.

TORONTO

Richard Atkinson
Portfolio Planner

Corporate Services
M. Joan Anderton, Commissioner

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August 16, 2002

Hydro One
483 Bay Street
Toronto, Ontario
M5G 2P5

Attention: Mr. Michael Sheehan
Vice President Corporate Services

Dear Mr. Sheehan:

John Street Roundhouse – Hydro Option
Proposed Optional Sites for Hydro Transformer Station

Please find the attached material, which provides property information on two sites currently proposed as replacement sites for the current Hydro Option Lands at John Street Roundhouse. Also listed below are the sites reviewed at the May 28, 2002 meeting, which were either rejected as being unworkable or having limited feasibility.

Proposed Sites

Option 1: S/S of Bremner Blvd. between Spadina & Bathurst (Future Parks Dedication)
Option 2: Bathurst Street Bridge (lands below the bridge, south of Front Street and GO Transit R.O.W)

Sites Rejected

- Canada Malting Site – Foot of Bathurst St
- Toronto Islands
- 120 Pearl Street, south of Adelaide Street West between John & Simcoe (owned by EnWave)
- S/S Bremner Blvd., east of proposed Simcoe Street Extension (parks dedication)
- Rear of 53 Strachan Avenue & portion of 665 Wellington Street West (former WES transfer site)
- Extension of Simcoe Street, east side, south of Station Street (GO Transit lands)

- Blocks 34 & 36 - (City housing sites)

We have made a sincere effort to locate as close as possible potential relocation sites. We asked that you give these sites due consideration and advise whether or not you have interest in either of the above two options as soon as possible. It should be clear if you are interested in one or both of these options, further discussions with the Departments which have jurisdiction over these lands will be necessary.

Should you require additional information, please do not hesitate to contact Richard Atkinson at (416) 392-1861 or Luba Tymkewycz at (416) 392-7207.

Yours truly,

Doug Stewart
Director of Real Estate Services

DS/LT/RA

c: Joan Anderton
Bruce Bowes
Joe Halstead
Rita Davies
Glenn Garwood

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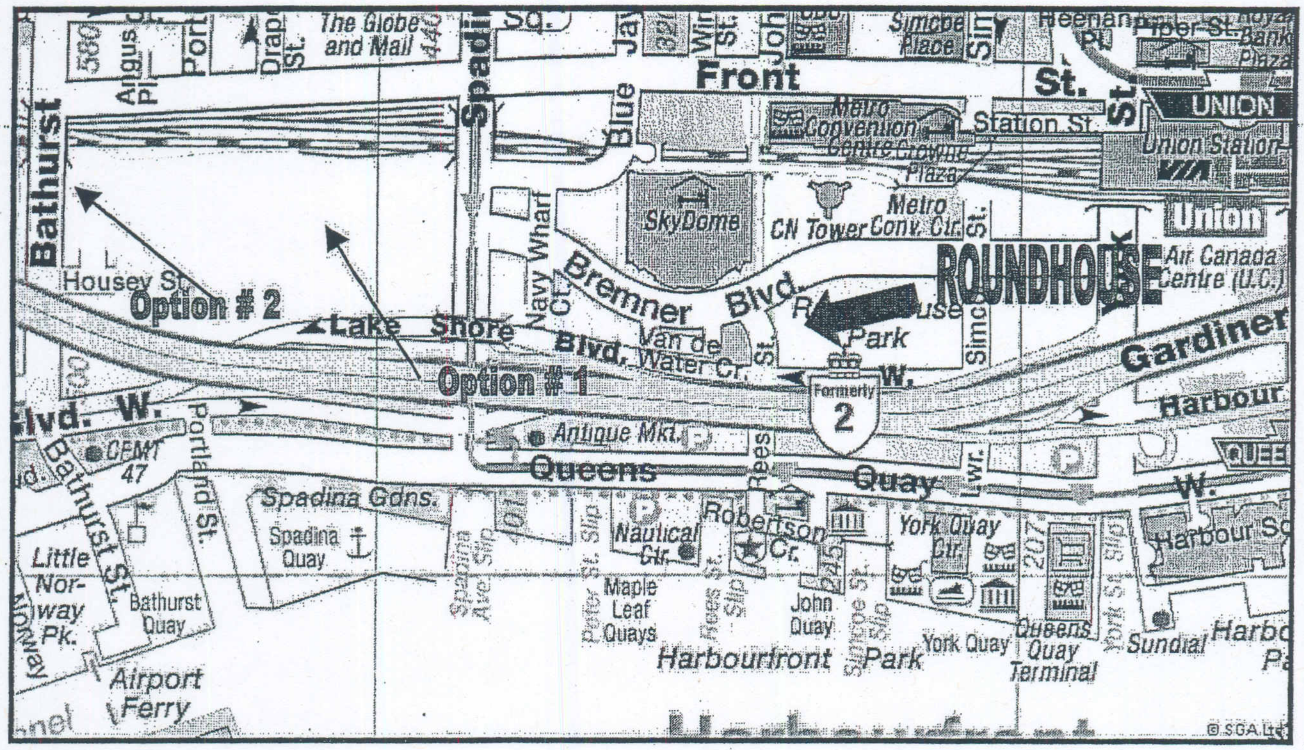
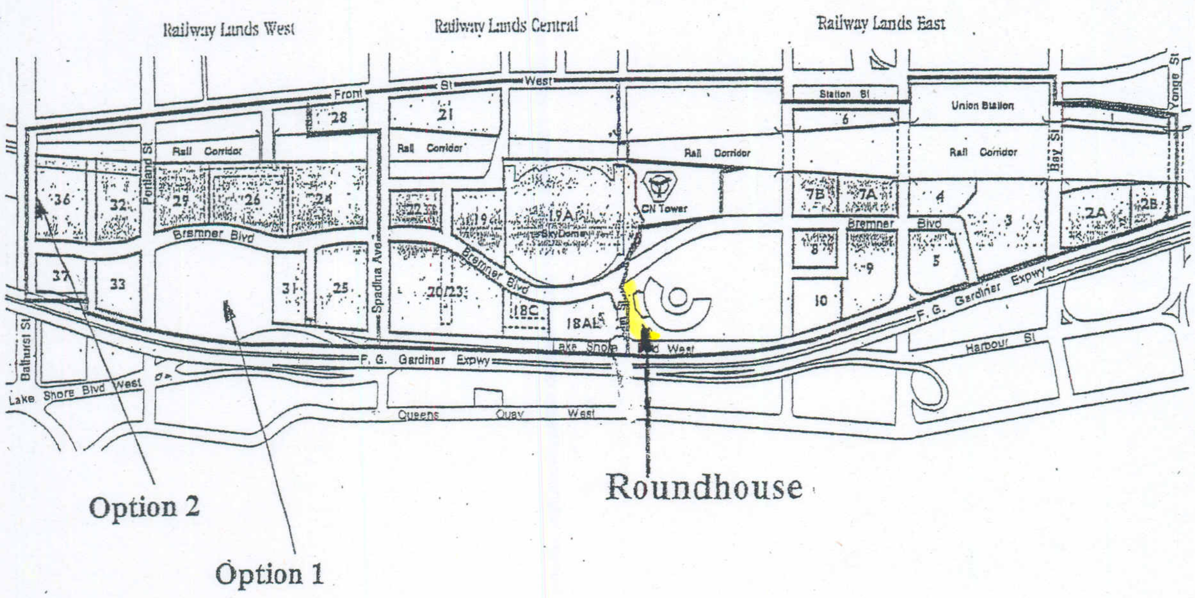
SITE OPTIONS

Roundhouse - Hydro Option Lands





HYDRO OPTION LANDS

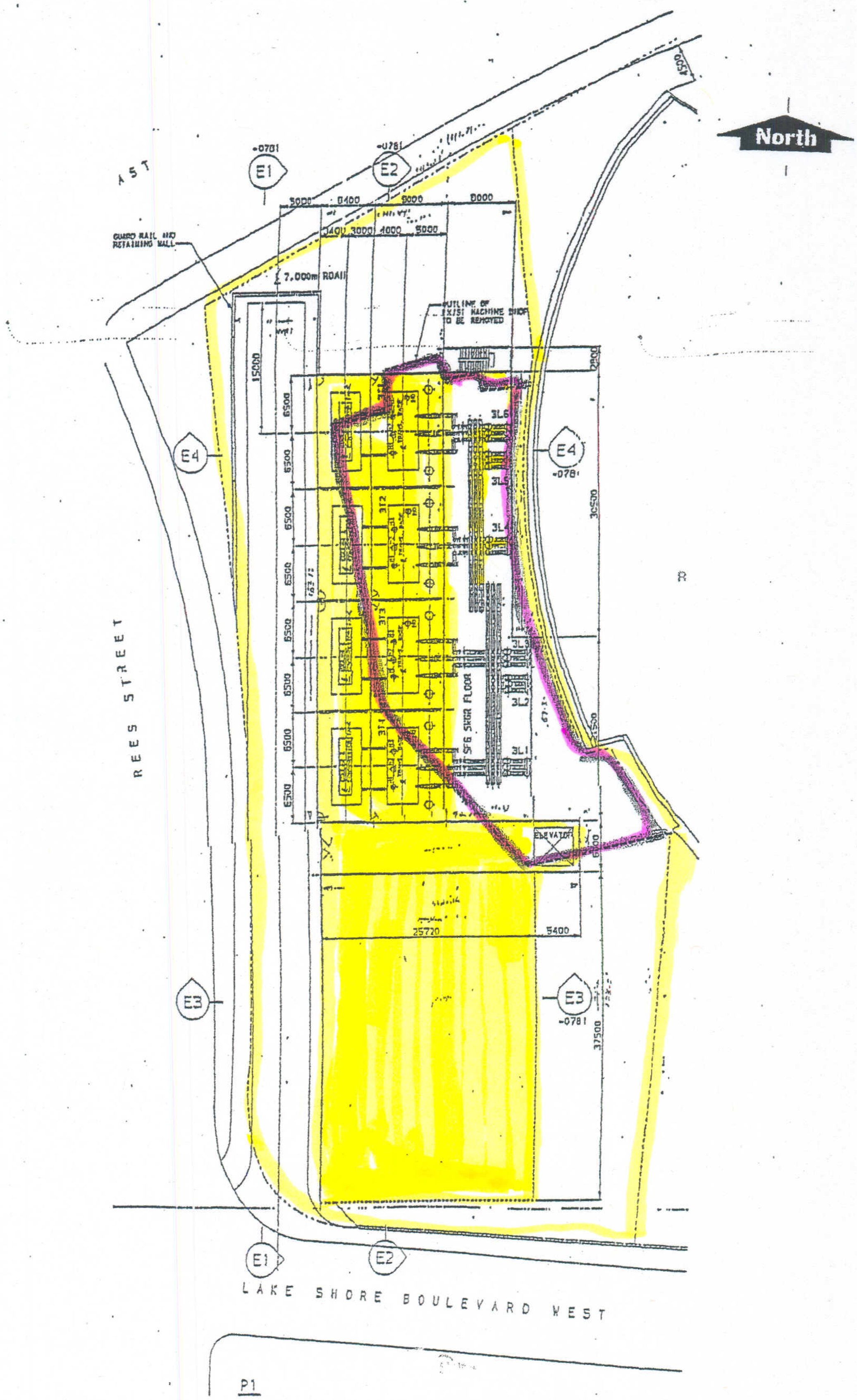
John Street Roundhouse Site

Site Location:	s/e/c Bremner Blvd & Rees St
Site Area:	1.264 acres
Legal Description:	Part Blk C , Plan 536-E, Part Lake & John Streets Also designated as Parts 1 to 9, inclusive on 64R-13541
Zoning:	Parkland
Official Plan:	Railway Lands East Study "Major Parks
Ward No.:	20 - Trinity-Spadina

Comments:

- ❑ Current proposal by Olympia & York to integrate a commercial component to the existing John Street Roundhouse is in jeopardy due to previous plans to construct a "transformer station" on the west side of the Roundhouse.
- ❑ Hydro Purchase Option Agreement allows for replacement sites to be proposed as an alternative to the west side of the Roundhouse site.

Roundhouse - Hydro Option Lands



Machine Shop

Hydro Transformer Stn.

Hydro Option Lands

Site Relocation

Option 1

Site Location:	s/s Bremner Blvd, west of Spadina
Site Area:	7.85 acres (6.25 acres for Parks, 1.6 acres for school/community centre)
Legal Description:	Part Lot 20, Section Index Plan D-970 Also designated as Part 5 on 66R-15355
Zoning:	"G" (Parkland)
Official Plan:	Railway Lands West - Secondary Study "Major Parks"
Ward No.:	20 - Trinity-Spadina

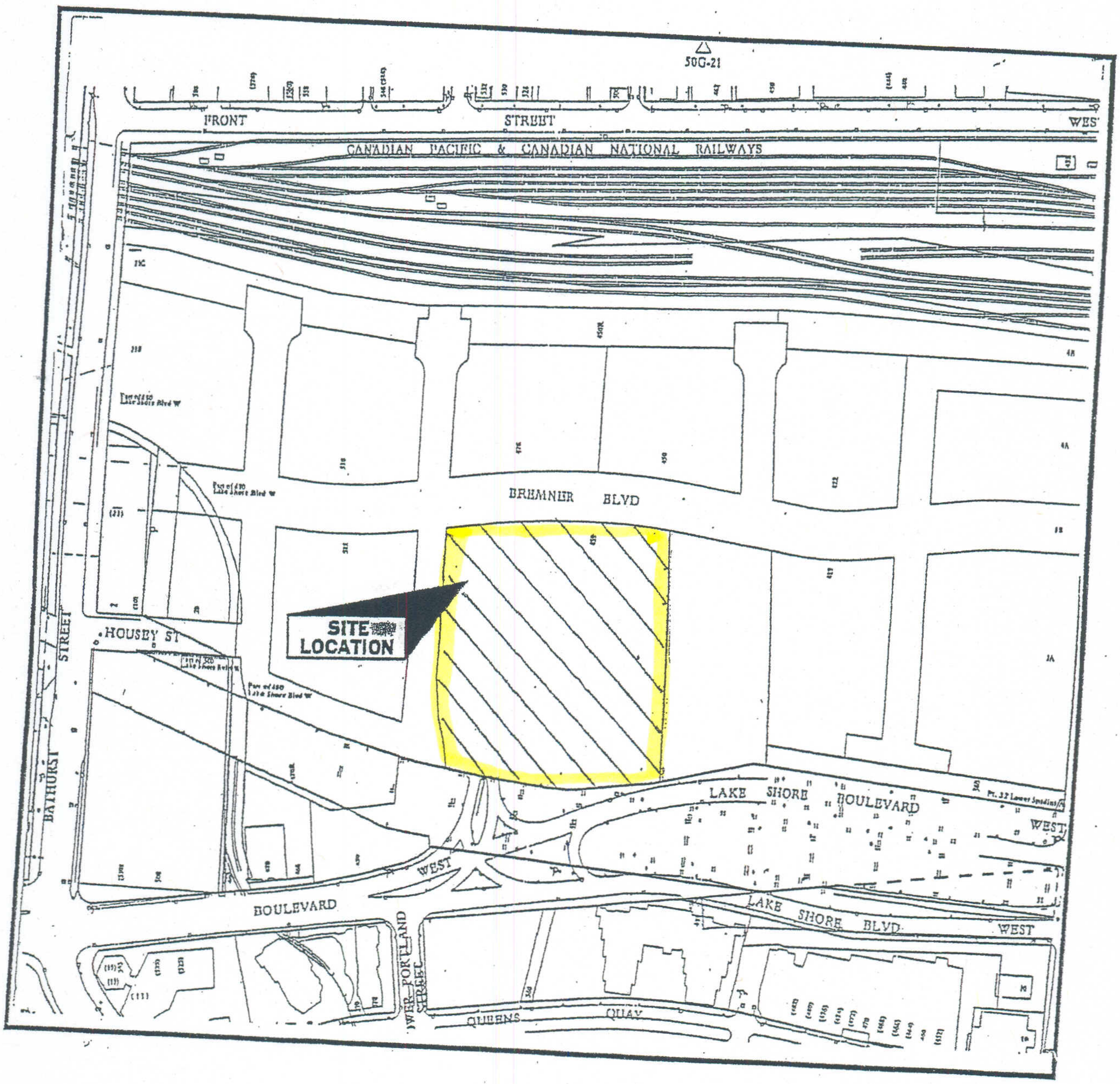
Comments:

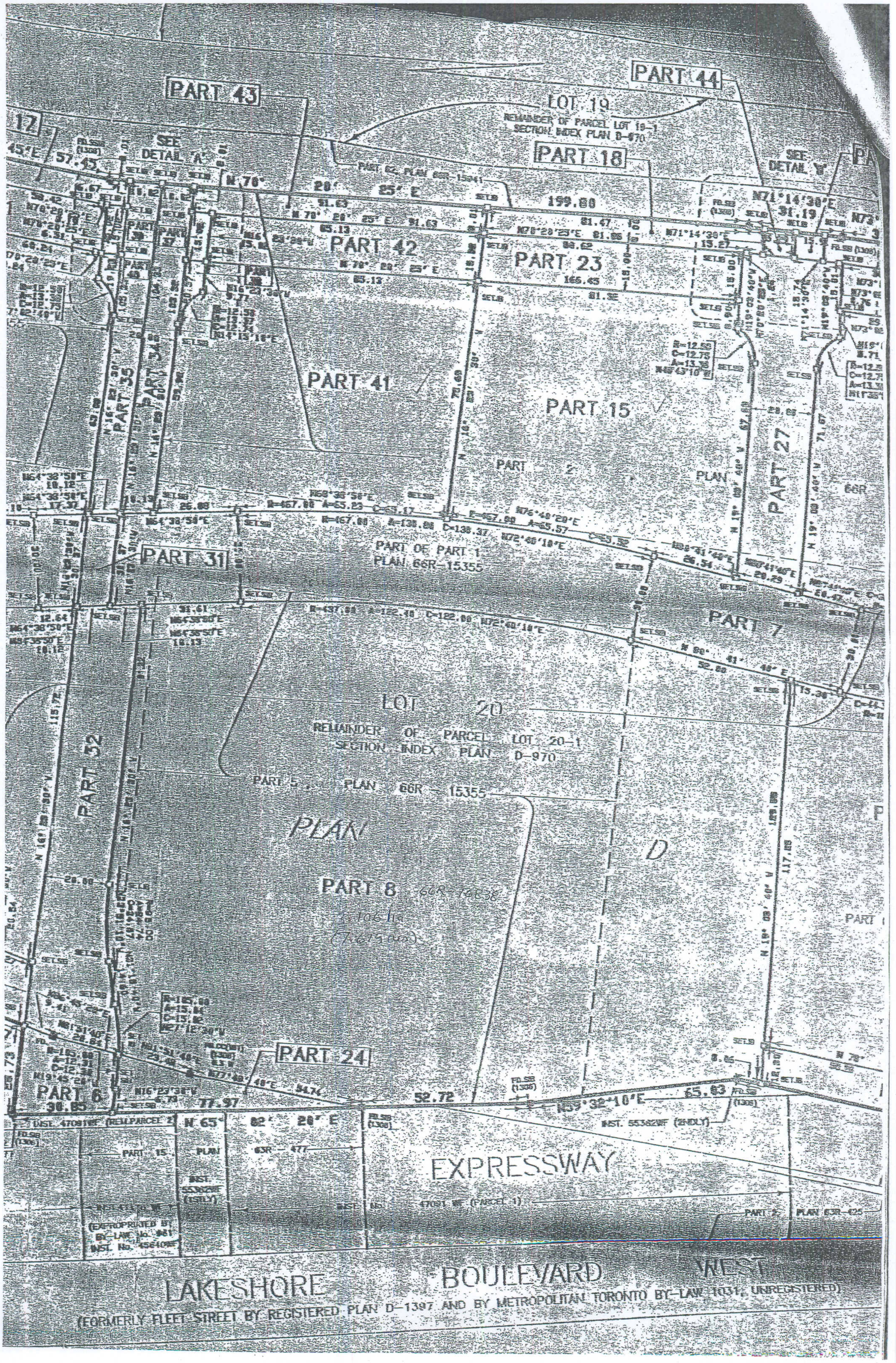
- ❑ EDCT - Parks have not discouraged the concept of a Transformer Station as long as it is does not sterilize the site and is either underground or built into a berm.
- ❑ This may be a candidate for the "green roof program".

OPTION # 1

South side of Bremner Boulevard west of Spadina Avenue

(Future large parks allocation, Hydro installation would have to go underground.)




PART 43
PART 44
LOT 19
REMAINDER OF PARCEL LOT 19-1
SECTION INDEX PLAN D-970
PART 18
SEE DETAIL 'A'
SEE DETAIL 'B'
199.80
PART 42
PART 23
PART 41
PART 15
PART 35
PART 34
PART 27
PART 31
PART OF PART 1
PLAN 66R-15355
PART 7
LOT 20
REMAINDER OF PARCEL LOT 20-1
SECTION INDEX PLAN D-970
PART 5 PLAN 66R 15355
PART 32
PLAN
D
PART 8
PART 24
PART 6
77.97
52.72
65.63
EXPRESSWAY
LAKESHORE BOULEVARD WEST
(FORMERLY FLEET STREET BY REGISTERED PLAN D-1397 AND BY METROPOLITAN TORONTO BY-LAW 1031, UNREGISTERED)

Site Relocation

Option 2

Site Location:	Lands beneath the Bathurst Street Bridge, south of Front Street West
Site Area:	2 potential parcels: 0.207 acres & 0.172 acres (Total: 0.378 acres)
Legal Description:	Dedicated Road Allowance
Zoning:	w/s "G"(park) Fort York and "T" (transportation) e/s "T"
Official Plan:	Railway Lands West Part II Plan "Bathurst –Spadina Neighbourhood" Medium Density Residential/Commercial
Ward No.:	20 - Trinity-Spadina

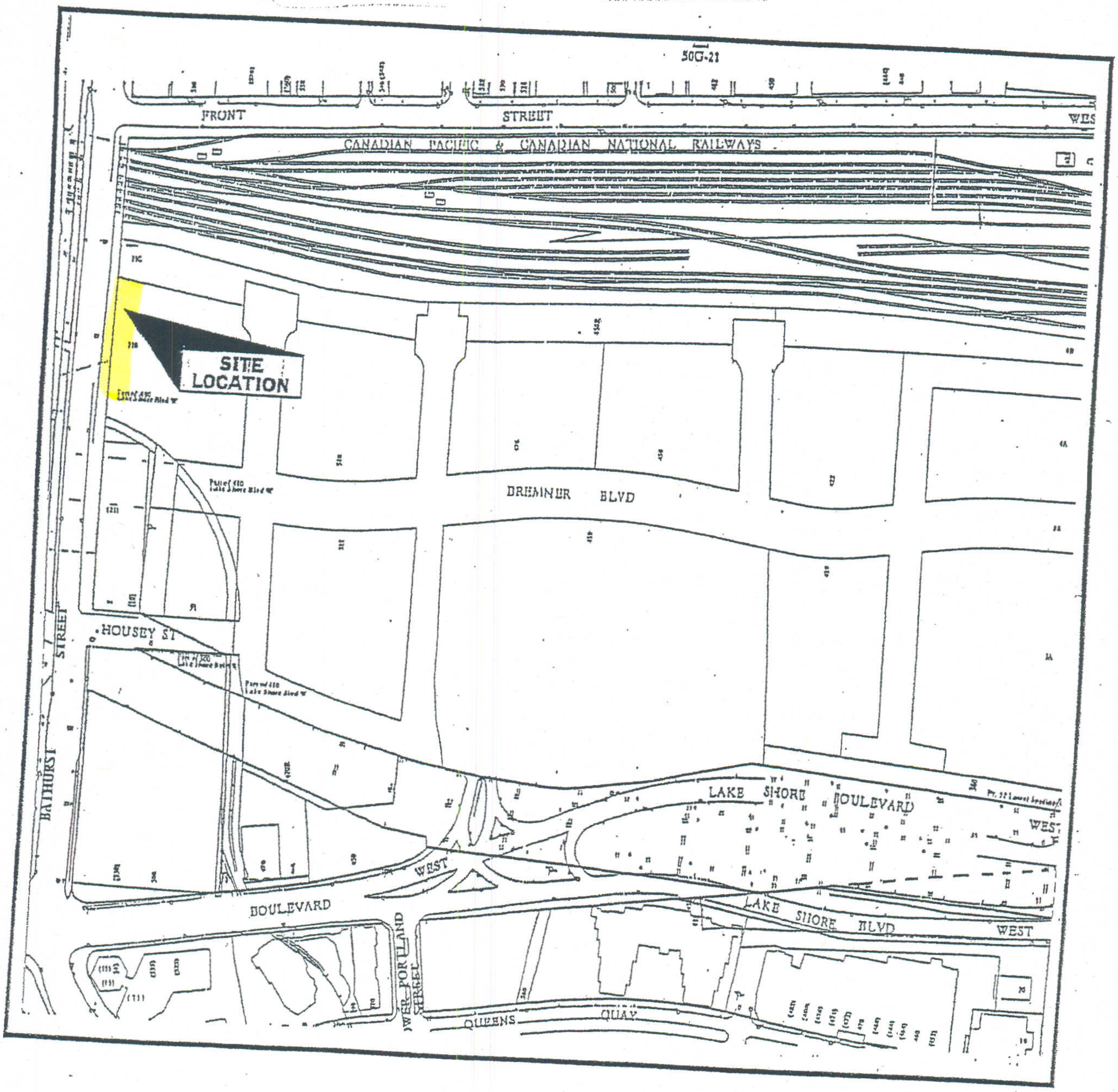
Comments:

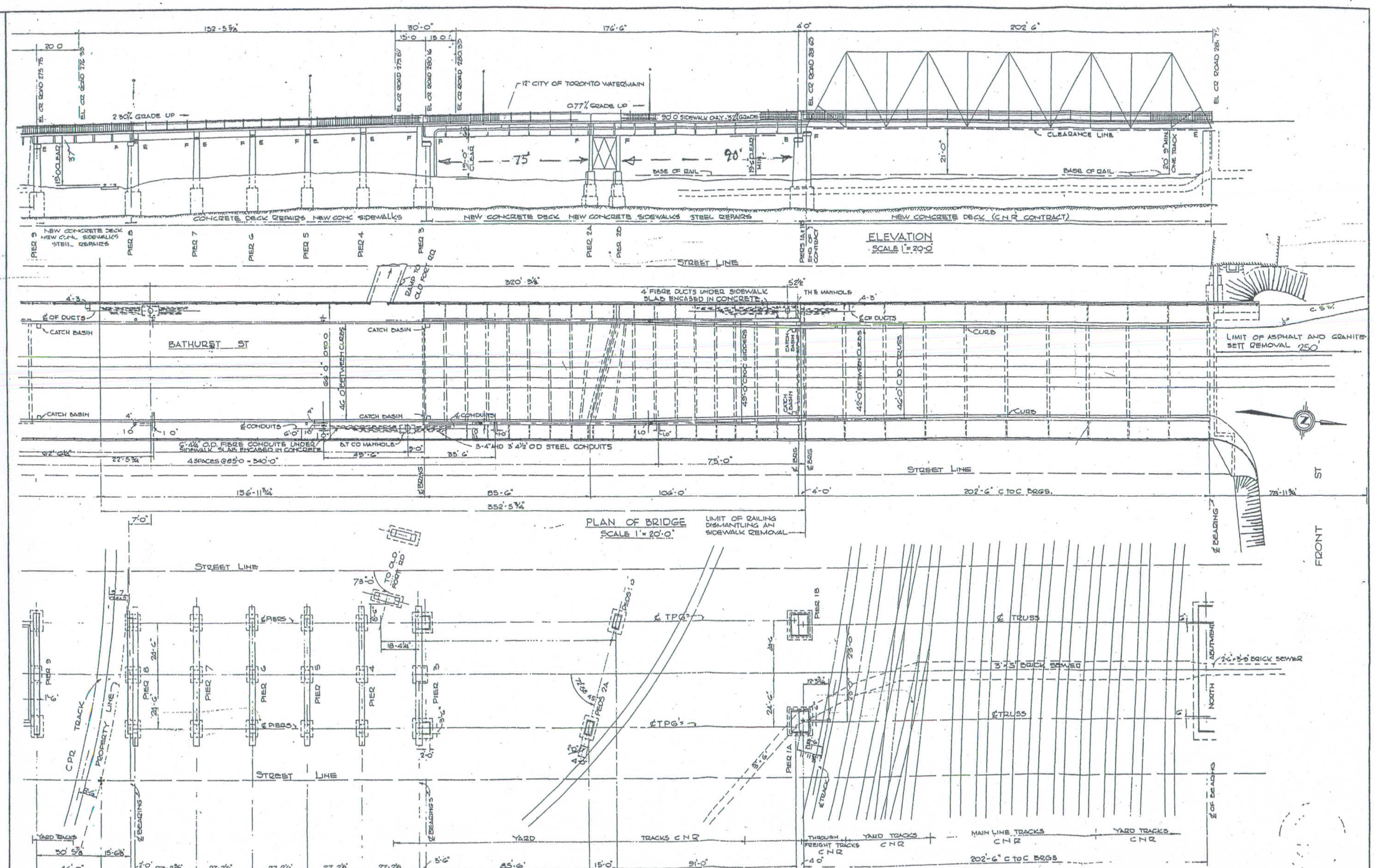
- ❑ Restricted Height: 19 feet (majority of the transformers would have to be buried).
- ❑ Restricted Width: road allowance width is approximately 100 feet.
- ❑ Due to limitations, this site is offered as a secondary choice alternative.

OPTION # 2

Under Bathurst Street bridge South of Front Street

(Possible location utilizing vacant lands under bridge. Backup location only)





NOTE: C.N.R. AND C.P.R. TRACKS AND RAILWAY TRAFFIC EAST OF BATHURST ST BRIDGE COME UNDER THE CONTROL OF THE TORONTO TERMINALS RAILWAY COMPANY

REF DWG	TITLE
AA545-C9 4.1	BATHURST ST BR PLAN AND ELEVATION

MUNICIPALITY OF METROPOLITAN TORONTO ROADS DEPARTMENT

APPROVED — Chief Design Engineer; Commissioner of Roads; Consultants

BATHURST STREET BRIDGE
GENERAL LAYOUT SHEET 1

DESIGN	JMW	DRAWN	RJS	CHECK	DR	GWS
SCALES	1" = 20'-0"					

Appendix 5

Bremner TS Site Integration

1.0 Background

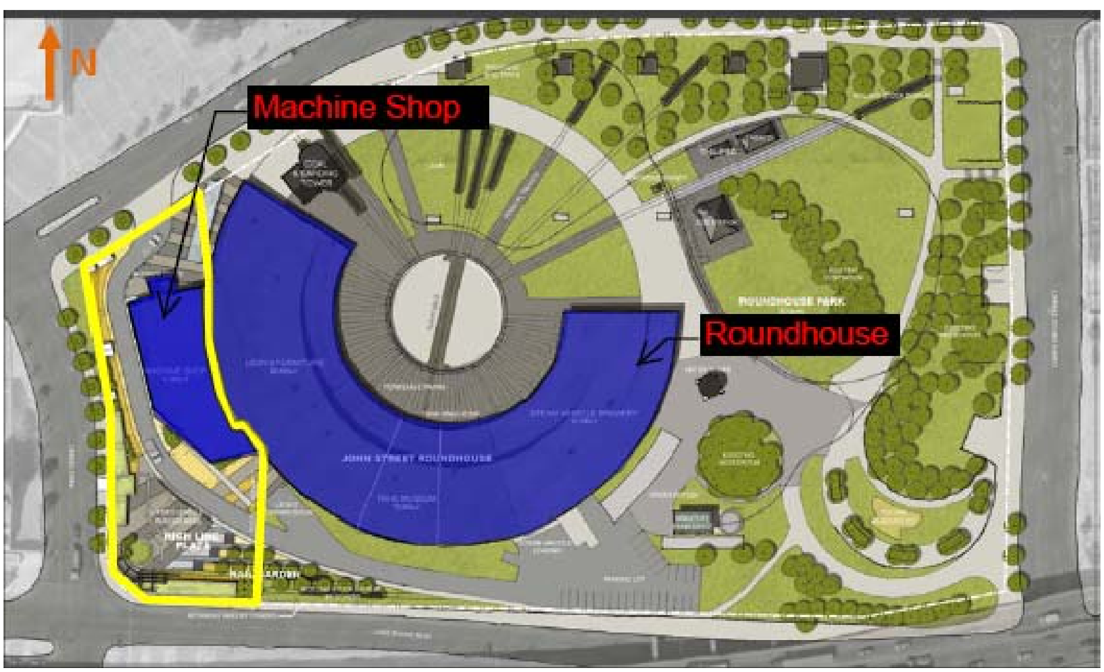
In the early stages of conceptual design for Bremner Transformer Station, the decision was made for the facility to be a site-integrated structure (i.e., a structure able to be integrated it into its surroundings). This approach would simultaneously honour the heritage designation of the site and accomplish adherence to best practice for transformer station design in urban areas.

2.0 Heritage

<u>Heritage Designation</u>

The Bremner TS site (indicated in Figure 1 below) is located within Roundhouse Park, which is recognized by Parks Canada as a National Historic Site[1]. The Roundhouse structure was built in 1929 by the Canadian Pacific Railway Company to service their locomotives. The structure directly to the west of the Roundhouse (and within the Bremner TS site) was constructed in 1931 to serve as a supplementary "Machine Shop" to the Roundhouse facility.

Figure 1: Plan view of Bremner Site (outlined in yellow)



[1] http://www.historicplaces.ca/en/rep-reg/place-lieu.aspx?id=12781

Site Approvals

As a result of the site's heritage designation, the municipal and provincial site planning authorities require a detailed assessment of potential heritage impacts to the site, by way of a Heritage Impact Assessment (HIA) document. The detailed HIA has been included as Appendix 6 to this ICM.

Municipally, the heritage impact is reviewed by the Heritage Preservation Services department at the City of Toronto[2]. Provincially, the heritage impact is documented and reviewed as part of the Class Environmental Assessment for Minor Transmission Facilities[3]. Both authorities would ultimately have to sign off on the HIA in order for the project to proceed to the construction phase. The status of this signoff is captured in Appendix 8 to this document.

3.0 Transformer Stations in urban areas

Transformer Stations in other metropolitan jurisdictions

In urban areas, it is a common approach to integrate transformer stations into their surroundings. When compared to the 'open air'[4] approach, the site-integrated solutions have the benefit of better aesthetic integration into the surrounding urban architecture and reduced noise impact to the surroundings. Many metropolitan utilities have utilized this approach in their transformer station implementations. Examples have been summarized in the Table 1 and Figures 2 to 6 below:

[2] http://www.toronto.ca/heritage-preservation/
[3] http://www.hydroone.com/Projects/Midtown/Documents/class_ea.pdf
[4] The 'Open air' approach involves installation of high voltage components and transformers in open air. This approach is usually reserved for rural or suburban areas where ample space exists to implement such a solution.

Table 1: Metropolitan Utilities that have implemented site-integrated substations

Location	Utility	Station	Year Completed
New York City, USA	Con Edison	Mott Haven Substation[5]	2012
Sydney, Australia	Transgrid	Haymarket Substation[6]	2004
Nagoya, Japan	Chubu Electric Company	Meijo Substation[7]	1999
London, England	EDF Energy	Leicester Square Substation	1989
Vancouver, British Columbia	BC Hydro	Cathedral Square Station[8]	1984

Figure 2: Mott Haven Substation (New York City, USA), enclosed within building

Figure 3: Haymarket Substation (Sydney, Australia), enclosed within building

[5] http://cityroom.blogs.nytimes.com/2009/01/16/why-not-bury-ugly-substations/
[6] http://www.energy.siemens.com/nl/pool/hq/energy-topics/living-energy/downloads/Social_acceptance_substations_that_embelish.pdf
[7] http://www.manhattan-institute.org/pdf/crd_neighborly_substation_emb.pdf
[8] IEEE PROCEEDINGS, Vol. 134, Pt. C, No. 1, JANUARY 1987

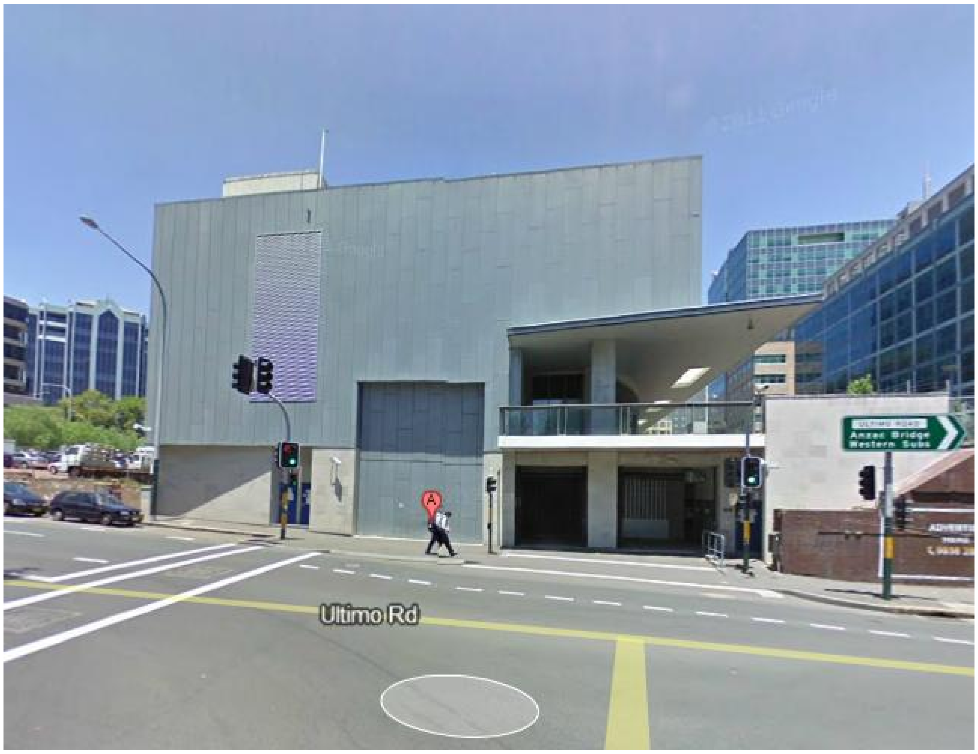


Figure 4: Meijo Substation (Nagoya, Japan), totally underground (beneath park)

Figure 5: Leicester Square Substation (London, England), totally underground (beneath Leicester Square, through opening in foreground)

Figure 6: Cathedral Square Substation (Vancouver, Canada), totally underground (beneath pond)

In order to better understand the planning and execution of a similar project, THESL staff has visited the Cathedral Square Station belonging to BC hydro. Key decisions and lessons learned were reviewed. A report detailing this visit is attached in Schedule 1 to this Appendix.

The most germane recommendations made by BC Hydro and THESL staff were the use of Gas Insulated Switchgear (GIS), use of crosslink polyethylene (XLPE) high voltage cable, use of Gas Insulated Transformers (GIT), provision for transformer removal and strategically located cranes. The integration of the transformer station into its urban environment was the most distinct characteristic of the project and was achieved by constructing the station underground at Cathedral Square.

<u>Existing Site-integrated THESL Substations</u>

In the past, THESL have utilized the site-integrated approach for a number of municipal substations located in the downtown core. Key examples of these are Glengrove Station and Carlaw Station. THESL's efforts to build hidden electrical facilities have been acknowledged by public media. Toronto Star published an article in 2011 in this regard (attached as Schedule 2 to this appendix), and Wikipedia[9], when defining Electrical Substations, uses a picture of a THESL distribution substation in Scarborough, that has been disguised as a house.

4.0 Options for Building

The Bremner TS Project team decided in the early stages of the project design to proceed with a site-integrated station design. The purpose of this section is to elaborate upon the approach that was ultimately decided upon (Option A) and to conduct due diligence by evaluating an alternate to that approach (Option B) based on the knowledge gained from the detailed design.

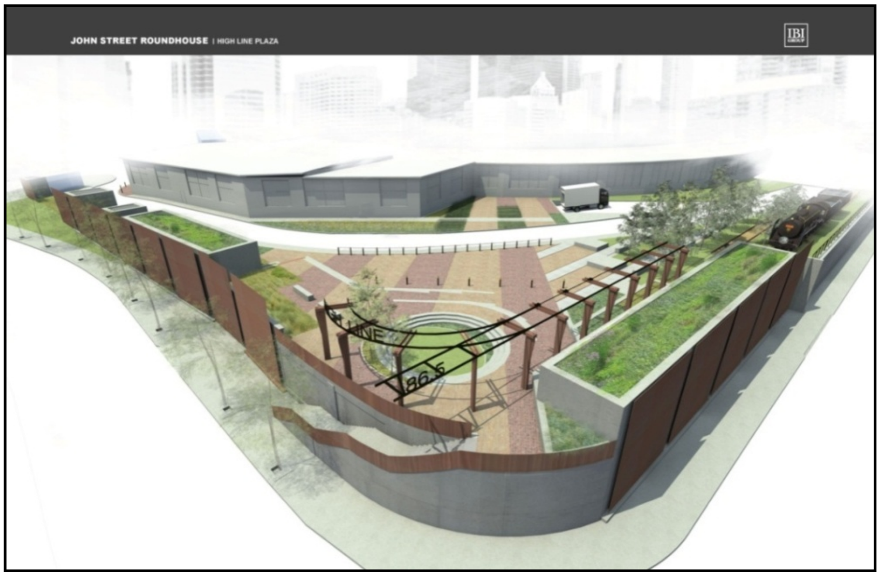
Option A - Current option, site-integrated solution

The Bremner Transformer Station will be a site-integrated facility, consisting of a structure bounded at the north at Bremner Boulevard and to the south at Lakeshore Boulevard, above which the existing Machine Shop will be re-assembled. The Machine Shop will house the protection and control and station service equipment, while the major equipment (transformers, switchgear, cabling, etc) will be housed below.

The original intent was to underground the entire facility; however space restrictions led to the reassembled Machine Shop being used to house equipment. As a result, the Machine Shop has had to be redesigned as a post-disaster facility (i.e. a facility able to withstand seismic disturbances).

[9] http://en.wikipedia.org/wiki/Electrical_substation

Figure 7: Rendering of completed building, viewed from North East intersection of Rees St and Lakeshore Blvd



The cost associated with construction of the structure has been estimated at $53.3 million based on a completed design. This cost is higher than originally anticipated for the structure and can largely be attributed to the underground component of the station, as well as the unique disassembly and reassembly process for the Machine Shop.

<u>Option B – Alternate option, fully enclosed solution</u>

A number of alternatives to the current proposed design were completed by IBI Group and reviewed by THESL. Each alternative was designed based on the following key constraints:

- The Machine Shop would be preserved
- The Transformer Station would be a mostly above-grade structure
- The footprint would maintain the existing access roadway[10].
- The equipment requirements would be the same as Option A

Of the alternatives examined, this Option B was deemed most feasible from a constructability standpoint, given the aforementioned design constraints.

[10] The existing access roadway is the only means by which delivery vehicles can access the loading docks of Roundhouse tenants (businesses such as Steam Whistle Brewing Company, Leon's furniture store).

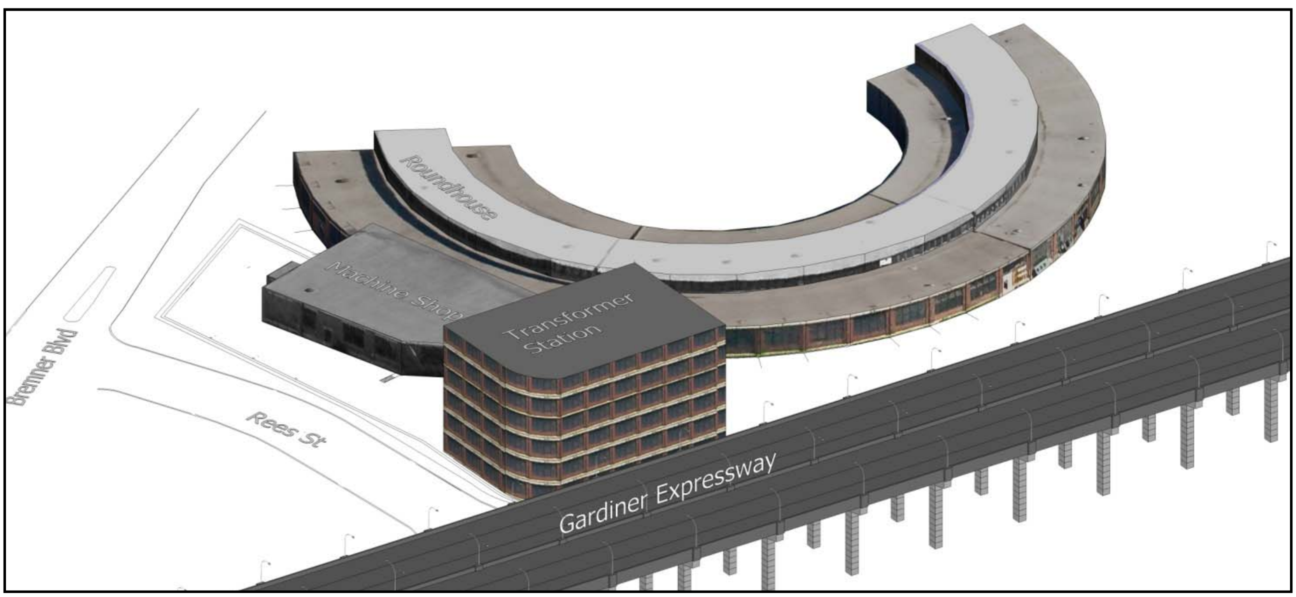
For Option B, alterations to the Machine Shop were avoided by decreasing the footprint of the Transformer Station structure and confining it to the southern portion of the property. This footprint was further decreased in order to accommodate an access roadway for the Roundhouse tenants. A plan view of this scenario is depicted in Figure 8 below.

Fig 8: Plan View of Option B

With a significantly smaller footprint (approximately 25%) than that of Option A, Option B is still required to house exactly the same electrical equipment. This is possible only if a 26 metre (approx 85 ft) structure is constructed on that footprint. This structure would be a dominant feature over the existing Roundhouse Park and exceed the height of the nearby Gardiner Expressway. An elevation view of this is demonstrated in Figure 9 and an isometric depiction of the site is depicted in Figure 10.

Fig 9: Elevation View of Option B from South of the Gardiner Expressway

Fig 10: Isometric rendering of Option B as viewed from south of the Gardiner Expressway



Based on an 'order of magnitude' cost estimate from IBI Group, the cost to construct the Option B building has been estimated at $41.8 million.

5.0 Cost Comparison of Options

The costs for Option A and Option B have been summarized in Table 3-2. The costs for Option A are a 'Class B' estimate and based on a 95% complete design. The costs for Option B are a 'Class D' or 'order of magnitude' estimate and based on a design concept only and will therefore have a relatively higher margin of error.

Table 2: Comparison of Costs for Options

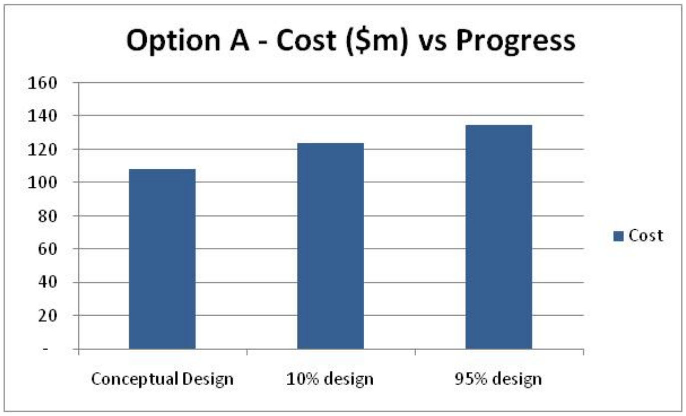
Task	Cost ($ million)		% Variance from Option A
	Option A	Option B	
Land acquisition	**5.6**	**5.6**	
Distribution Modification	**2.3**	**2.3**	
Procurement of Major Equipment	**52.6**	**52.6**	
Detailed Design / Construction PM	**6.7**	**9.0**	**34.3%**
Construction of Building			
Machine Shop Disassembly/Reassembly	8.8	0.8	
Shoring & Excavation	16.7	10.0	
Structural Work	21.5	24.8	
Finishes	2.2	1.8	
Mechanical	4.0	4.4	
Sub-Total	**53.3**	**41.8**	**- 21.6 %**
Construction of Cable Tunnel	**14.0**	**14.9**	**6.4 %**
Total*	**134.5**	**125.7**	**-6.5 %**

* Totals are exclusive of Hydro One capital contribution costs for the project. For Option B, Hydro One costs are expected to increase due to an increased length of high voltage cabling (as a result of the longer cable tunnel).

Based on Table 3-2, the total cost of Option B (at $125.7 million) is 6.5% less than that of Option A (at $134.5 million). However, the costs for Option B do not take into consideration the potentially extensive architectural costs that will be incurred on the 26 metre high building in order to uphold the heritage character of the Roundhouse site.

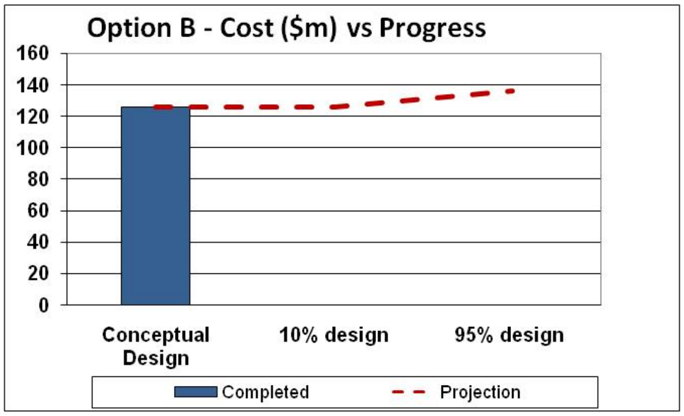
For Option A, the increase in cost due to heritage requirements was substantial and it is expected that this will also be the case for Option B. A demonstration of the increases in construction cost estimates that were realized for Option A is detailed in Figure 11.

Fig 11 Increase of construction estimates with design progress for Option A



Option B, by comparison, will be sure to realize similar increases upon initiation of detailed design. Examples of such cost increases would be the additional construction and cabling costs for the high voltage cable tunnel being linked to the station (due to an increase in length), as well as the re-design and environmental assessment costs for the transformer station itself. The cost for Option B, complete with a projected cost increase, is detailed in Figure 12.

Fig 12: Increase of construction estimates with design progress for Option B



Due to the ‘order of magnitude’ status of the costs associated with Option B and the ‘detailed design stage’ status of the costs associated with Option A, it may be reasonably inferred that a 6.5% cost differential (when comparing the options) may be considered negligible.

6.0 Stakeholder Acceptance

Based on stakeholder acceptance, Option A is superior to Option B. This is based on the fact that, for Option A, significant effort has been put into incorporating the station into the existing site. These efforts have already gained stakeholder approval from the relevant heritage authorities of the site, such as the Heritage Preservation Services department at the City of Toronto and the Heritage department at Parks Canada. Option B, however, involves incorporation of a substantially more invasive building (26 metres high) to the site, making it questionable as to whether the heritage requirements can be met at all.

To further investigate this, THESL acquired a professional opinion on Option B from IBI Group’s heritage architect. This opinion is summarized in Schedule 3 to this Appendix. The conclusion stated is that it would be very difficult to gain the support of the heritage authorities for Option B.

7.0 Conclusion

Option A and Option B are comparable in cost, but Option A is more likely to gain stakeholder acceptance due to its superiority as a heritage integrated solution for the site. In addition, Option A has undergone acceptance testing and approvals and is already proven through these stages whereas option B will need to traverse the same path, thereby impacting schedule and cost. On this basis, Option A is the more practical option of the two.

Schedule 1

Visit to BC Hydro's Cathedral Square Station

Review of Key Decisions and Learning

Visit by:

Mario Arruda John Fletcher John Trezise Suzanne Yelle

February 17, 2011

2011

Visit to

BC Hydro's Cathedral Square Station

Review of Key Decisions and Learning

Prepared for Mr. Ivano Labricciosa, VP Asset Management

Executive Summary:

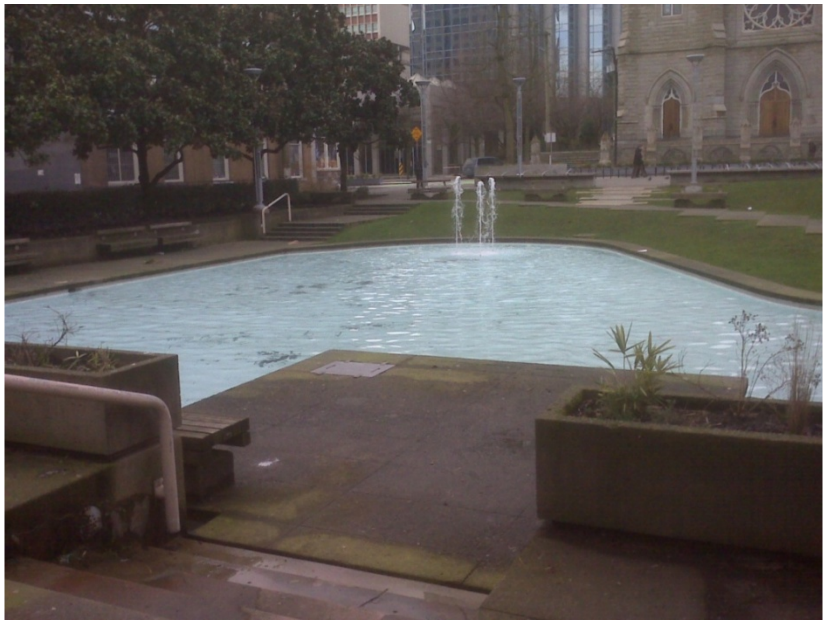
Cathedral Square Station went into commercial operation in 1984, 25 years ago. It has since gone through some substantial upgrades such as adding a third transformer, substantial upgrading of protection and controls to the Schweitzer product, replacement of some 12kV breakers and removal of the CO2 fire protection system in order to address safety concerns, meet new regulations and to upgrade to new BC Hydro standards.

This report will review the key decisions made at the time the station was built. While the station took into consideration the 1980's state-of-the-art technology, many advances have become available to the industry since. The report includes key learnings based on discussions with BC Hydro, downtime occurences and from the team's observations in the station.

Cathedral Square Station

The City of Vancouver owns and maintains the park which is siutated above BC Hydro's Cathedral Square Station. A large pool is the main attration at the park as shown in Photo 1 below.

Photo 1 – Cathedral Square Location



The view of the opposite side of the park shows massive air vents which are worked into the landscape with the use of a steel structure as shown in Photo 2 below. At first glance, unless someone knew there was a station below, Cathedral Square Park does not give any clues. A closer look indicates there is more to this than a park. There are various grills camouflaged into the stairs and walls in a number of places as well as an access hatch indicating a structure exists below.

Photo 2 – Station Air Inlet and Outlet Vent Stacks

BC Hydro would prefer to own this property since approvals for one, would be easier, however the city has retained ownership.

Interior Design

The building consists of three levels: 1) Bottom floor (and part of middle floor) contains the 230 kV HV GIS switchgear by Mitsubishi, three transformers (2 Westinghouse and 1 ABB), each encased in steel explosion-proof enclosure and an area for removing the transformers and major equipment leading to a roof access hatch; 2) Middle floor contains the control room, battery room and some of the 12 kV Medium Voltage (MV) open bus and metal-clad AIS breakers, mainly by FPE (some replacements have taken place with Alstom, Fuji, CH); 3) Top floor consists of more MV open bus and metal-clad AIS breaker rooms and station service room. The interstitial space above the station includes the nitrogen system for the fire protection system, some compressors for air and nitrogen and the entry of the 3rd feeder for the station. The truck entrance door is located on the top floor and has space for three vehicles and a welcoming room. A freight elevator services all floor for movement of the larger equipment.

Key Decisions

When asked what they would do differently, BC Hydro brought up a number of items. Electrical equipment has progressed significantly over the last quarter century and if this station was to be built now, the following would be done differently:

1. Install GIS switchgear instead of the AIS for the MV. MV GIS would provide better safety and reliability. They mention AIS was state-of-the-art back in 1984 but their standard is now GIS. The main reason is due to considerably more stringent safety requirements that include arc resistant gear to prevent arc-flash. MV GIS provides these features and other advantages that include a reduced footprint and more flexible configurations. The low amount of maintenance required is proven by the last 25 years with the Mitsubishi equipment. Photo 3 shows the Mitsubishi GIS switchgear for the 230 kV. Portholes are available providing visible isolation.

Photo 3 – Mitsubishi Lineup 230 kV GIS Switchgear

2. **Primary Cables**

   The primary cables installed for Phase 1 (two of three transformers) were oil filled. BC Hydro became concerned in early 2000 with the possibility of a fire starting from the SF6/oil cable terminations and initiated some studies on the subject. The fire in Barcelona re-enforced the concern, however, a decision was taken to remove the CO2 system. Since the fire in the

Barcelona underground station destroyed that station completely (photos in Exhibit 1), BC Hydro is very concerned and the Phase 2 (installation of the third transformer) utilized XLPE cable instead of the oil-filled cables. Photo 4 shows the incoming XLPE 230 kV cables entering the interstitial level.

Photo 4 – Incoming 230 kV Cables for 3rd Transformer at Interstitial Level

3. Transformers 230 kV/12 kV

The transformers are insulated with mineral oil. Given this, an explosion-proof enclosure and venting was required. Photo 5 shows the enclosure which contains the transformer.

Photo 5 – Explosion-proof Enclosure for 230 kV/12 kV Transformer

Photo 6 shows the inside of the enclosure. The transformer has been sprayed with fire-resistant foam to further reduce the occurrence of a fire. BC Hydro is very concerned with fire in the transformer enclosure since the Barcelona Station fire. To further avoid an explosion causing a fire, the enclosure is pressurized with nitrogen gas.

Photo 6 – Inside of Explosion-proof Transformer Enclosure

If the transformers are to be installed indoors BC Hydro recommends installing a gas-insulated transformer (GIT) such as manufactured by Hitachi. GITs have been installed overseas and are seen as reliable and cost effective since an explosion-proof enclosure is not required. With the present installation at Cathedral Square, removal of the existing transformer from its enclosure, out of the station and installing a new transformer would take several months. BC Hydro also recommends, if at all possible, installing transformers above ground.

4. Removal of Transformer

The station was designed with a hydraulic lift to remove the transformer from the station. The lift has been removed and stored after the installation of the first two transformers. It was not re-installed for the 3rd unit due to lack of technical support. When the station was updated in 2009, a 500-tonne crane was utilized to lower the new tranformer through the hatch. Photo 7 shows the hatch looking up from the lower level of the station while Photo 9 shows the lowering of the new transfomer into the station. It is recommended to avoid a costly lifting system and to plan on using a crane. The lifting height is approximately 80 feet.

Photo 7 – Station Hatch for Major Equipment Removal

Photo 8 – Installation of New Transformer in 2009

5. Fire- Protection Systems

The station was designed with different fire protection systems: CO_2, compressed air/foam and sprinklers. Originally, the fire suppression system was based on flooding the GIS room with massive amounts of CO_2, which represented a safety hazard for personnel working in the station. The CO_2 system has since been replaced given the safety issues and the cost to clean up. The new system consists of nitrogren for transformers only, foam and sprinklers for the 230kV GIS room and MV areas. The nitrogen is generated at site and consists of a redundant system. The system seems complicated and is difficult to maintain. Photo 9 shows the new nitrogen system.

Photo 9 – Nitrogen System for Fire Protection and Transformer Cooling

Observations by Team - To be Avoided

The following items were observed which Toronto Hydro would want to avoid repeating:

1. There is only one battery and charger room. It is recommended to have a second separate room with 100% backup system.
2. There is only one washroom in the Control Room. It is recommended to have a second one.
3. A pool (large fountain) is on top of the station. This pool has leaked into the station and though not considered major, it is recommended not to have a water vessel over the station. BC Hydro are not concerned with the pool as the roof of the station must be water-proof in any case to avoid rain getting into the station.
4. The station is built with exposed bus for the 12 kV. This exposes crews and equipment to unnecessary hazards. It is recommended to have metal-clad switchgear instead of open-bus concept.
5. There are limited cranes in the station to move equipment around. It is recommended to have cranes in strategic locations, even if manually operated.

6. The transformer cooling system is very complex. This has been one of the reasons for several outages of the complete station in recent years. It is recommended to design a simpler more compact cooling system as much as possible with the space available.

Observations by Team – To be Repeated

The following items were observed which Toronto Hydro would repeat:

1. The station cannot be seen from the street.
2. A 230 kV ring bus is installed complete with all disconnect switches equipped with a viewport to visualize the switch position. This increases reliability of the station.
3. The 12 kV feeders are compartmentalized into six rooms. Though the THESL project team had previously opted to have an open area free of compartments, it is now our recommendation to use compartments for various feeder groups. This will limit damage to the station in case of a fire or an explosion, thereby increasing reliability in such instances.
4. Camera system and voice intercom system for the station increases safety. It is recommended to install a camera system for remote monitoring and the voice intercom at all strategic locations.
5. The HV GIS switchgear at CSQ has one view port, however modern GIS would have two viewing ports: one for viewing and one for a flashlight.
6. The station service consists of two 1500 kVA transformers each fed from two different transformers plus a third supply from a different substation. It is recommended to duplicate this arrangement.
7. The station ventilation is well designed. A building is naturally ventilated through large vent stacks. Refer to Photo 2 above for the outside view of the air vents. Photo 10 below shows the air vent from the inside of the chamber.

Photo 10 – Air Vent Stack with Filters

Observations – Operations, Maintenance and Reliability

The station was built with the provision of being "unmanned". On the day of the visit, there were several individuals completing various activities at the station: maintenance crews and operators in the control room. BC Hydro confirms it is a high-maintenance station.

The reliability of the station is low with four (4) complete station outages in the past few years:

1) Cable chamber fire approximately 250 metres from the station, caused by the failure of a 600 amp elbow, resulted in a 3-day outage in 2008 when 14 feeder cables burned;

2) There have been three different incidences of transformer cooling trips. The transformer cooling system is very complex. The rating of 200MVA requires three heat exchangers to be in operation; with two heat exchangers operating, the output drops to 150 MVA. Nitrogen in the enclosure also accounts for some additional cooling.

The station was designed to minimize initial costs but this course may not have proven to be the best choice over time given the level of maintenance and operations required to maintain the present reliability level. There have also been several upgrades to the station in recent years to bring the station closer to BC Hydro's present standards and in order to comply with new regulations.

To the BC Hydro Asset Management Team, Toronto Hydro Electric System Limited (THESL) express our sincere thanks for your hospitality during our recent visit. THESL would be pleased to return the favor.

PREPARED BY:

_____________________________ Date: ______February 22, 2011________

Mario Arruda

_____________________________ Date: ______February 22, 2011________

John Fletcher

_____________________________ Date: ______February 22, 2011________

John Trezise

_____________________________ Date: ______February 22, 2011________

Suzanne Yelle

Exhibit 1 – Result of Barcelona Spain Station Fire

Schedule 2

thestar.com

Back to Hume: Hydro facilities hidden in plain sight

Hume: Hydro facilities hidden in plain sight

April 29, 2011

Christopher Hume

Practised in the art of architectural deception and masters of design disguise, Toronto Hydro has built an infrastructure that extends invisibly to every corner of the city.

Hydro worker Tom Papaiskovou stands at the doorway of the Gothic-style Glengrove substation on Yonge St. south of Lawrence.

RICHARD LAUTENS/TORONTO STAR

For more than a century, the utility has been quietly constructing substations on main streets, busy downtown intersections and in sleepy residential neighbourhoods. Some of Hydro's facilities are large, others small. Some resemble Georgian mansions, others modest post-war bungalows. In any case, most of us never notice them.

Which is exactly how it was meant to be.

The logic is simple: Given a choice, most of us would rather not live beside dangerous, ugly and intrusive industrial installations of any sort. They don't make good neighbours and are bad for property values. Or so you might think. But enlisting the power of architecture, Toronto Hydro has managed, often brilliantly, to turn what many would consider a liability into an extraordinary civic asset.

Keeping in mind that there are nearly 200 substations throughout the city, that's no mean feat. Indeed, when the history of architecture in Toronto is written, it will have to include a chapter on Hydro's remarkable contribution to the urban landscape.

Most impressive of all, perhaps, is the Glengrove Substation in leafy North Toronto. Sitting on the east side of Yonge St. south of Lawrence Ave., this magnificent castle-like structure must be seen to be believed. Far and away the grandest building in the neighbourhood, it is a Gothic revival beauty that dates from 1930. Despite the ravages of the Great Depression, then in full swing, this building is endowed with a nobility of purpose rarely found in contemporary architecture. It speaks of the vast public works program that would transform Toronto and Canada from a former colonial outpost into one of the world's most advanced nations.

That program included much more than substations. Think of the train stations built at this same time, which like Union Station were positively pharaonic in scale, the post offices, high schools and city halls.

Today, by contrast, we tend to take infrastructure for granted; it is something we simply assume. But earlier generations saw it in more heroic terms. It was appropriate, therefore, that Toronto Hydro should set their architectural and material standards so high. Constructed of rough-cut stone and organized symmetrically, Glengrove boasts oak doors, leaded glass windows and decorative loopholes, those long, narrow openings used in medieval times by archers.

The only thing being defended here is an idea; ironically, an idea about Toronto as a progressive city that was, quite literally, coming in from the dark to the modern age. Over time, such conspicuous displays of civic pride would be more muted. Where Glengrove consciously stands out from its surroundings, many that followed would seek to blend in.

An earlier station from 1889 at 532 Bay St., just south of Dundas St., presents a different image of Toronto Hydro. Built as the Toronto Hydro-Electric Dynamo House, it is a utilitarian structure with red-brick walls that rest on a sandstone foundation reminiscent of E.J.Lennox's Old City Hall. A series of arched openings — windows and entrances — enliven the main façade and allow it to fit in this important downtown streetscape.

The facility at 369 Carlaw Ave. in the east end dates from 1916, a difficult period in Canadian history. Nevertheless, it is an enormously optimistic building, one that in its very shape seems to anticipate a future city that has yet to appear. With its arched windows, classical flourishes and exquisitely curved façade, it conjures visions of the City Beautiful, the planned metropolis designed for our pleasure and uplift.

Tucked away in the inner core around John and Richmond streets, the 1910 substation at 29 Nelson St. is the city's oldest. This four-storey brick box is brought to life by the very ornate masonry effects Edwardian Torontonians liked so much. Not only do its busy exterior surfaces engage passers-by, they hide, as do all these substations, an interior empty of everything but equipment. Windows were always as large as possible, to allow for maximum daylight.

to that as a hydro substation can come.

One of the most convincing examples, 555 Spadina Rd., appears to be a full-fledged Georgian house, complete with a fanlight above the front door, horizontal rows of mullioned windows and a nicely carved wooden entrance. Set well back from the street behind a typical Toronto front lawn, you have to look closely to notice anything out of the ordinary. The windows, with their white-painted shutters, are the final touch, the utterly realistic detail that informs the whole. Needless to say, the windows are real, as are the shutters and all the other details. The house itself, though, is an empty shell.

In other neighbourhoods, where mock Georgian villas are not the norm, Toronto Hydro took its cues from the local landscape. The tiny postwar cottages at 386 Eglinton Ave. E. and 640 Millwood Rd. are modest though dignified examples of the kind of residential development that happened in Toronto's north end from the 1950s on.

What's equally interesting, however, was Hydro's attention to detail. The two-storey houses, each with a pair of dormers pointing out and stone-framed front doors, belong entirely to their context. Indeed, they could soon become timepieces, perfect representatives of an age that has long disappeared beneath a wave of monster homes and condo complexes that have altered the face of the city.

Little wonder Hydro's bungalows inspired Toronto artist Robin Collyer to photograph them in the 1980s. What fascinated him were the questions raised by architecture that all isn't as it appears. According to Collyer, who devoted years to the project, "there are about 100 of these structures located on residential streets in central and suburban parts of the Greater Toronto Area." Collyer's stark black-and-white images are masterful evocations of the enormous period of growth and the low-density housing that spread from the urban core. Unlike some earlier substations, these tend to be small and local in their feel.

More recently, Toronto Hydro has taken a different approach. The substation at 51 Blackburn Rd., an unobtrusive dead-end street on the south side of Gerrard and the Don Valley Parkway, is an unusually handsome industrial facility that makes no secret of its purpose. Opened in 1988, this compact masonry and glass-brick structure hugs the side of the Don Valley as if it had been put there by natural forces. It is a postmodernist set piece, modest but surprisingly elegant.

On the other hand, the substation on John St. at Front has become an instance of architecture as billboards. It helps that its neighbour on John is the CBC Broadcasting Centre. That makes a perfect fit; Hydro has the space, CBC the content. But as the area is gentrified, and condo towers pop up on every nearby corner, the pressure to disguise the facility will increase. As Hydro has demonstrated many times, it can accomplish that feat.

Though Torontonians, like people across Canada and the U.S., have struggled to maintain the infrastructure, there are encouraging signs it will once again emerge as a social and civic issue. The advent of Sherbourne Common on the waterfront is one of the first indications of a new approach. Though the project doesn't involve Hydro, the Common offers a glimpse into how infrastructure — in this case, sewers and water treatment facilities — can be integrated seamlessly into a new public park.

Up on Sheppard Ave. near Jane, there's a decommissioned substation built, like many others, to look like a typical suburban house. Now people are starting to wonder whether the three-sided structure could be reused as an architectural feature in a neighbourhood garden.

The scheme may never be realized, but it hints at the vast potential of Toronto Hydro's real-estate inventory.

The fact the corporation went to the effort to build such a rich and varied legacy is something about which it and the city can rightly take pride.

From the start, Toronto Hydro understood that any building constructed here — big or small, important or not — represents an act of city-building.

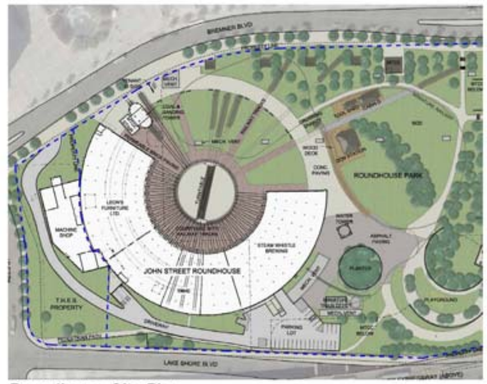
That means it is part of something larger than itself, and must look beyond its own limits of purpose and place. The successful city is one in which the whole adds up to more than the sum of its parts. Architecture doesn't exist in a vacuum and nothing demonstrates that more convincingly than these substations.

Schedule 3


IBI GROUP | APRIL 20, 2012
Roundhouse
Bremner Transformer Station Option B: Heritage Impact Opinion
IBI GROUP

A. Introduction

THESL has considered a range of development options for their proposed Bremner Transformer Station (TS), located at the west side of Roundhouse Park within a site bounded on the north by Bremner Boulevard, on the west by Rees Street, on the south by Lake Shore Boulevard and on the east by the John Street Roundhouse. We have been asked to provide an opinion as to the impact of the proposed scenario referred to as Option B, addressing the heritage character and value of the adjacent John Street Roundhouse, Machine Shop and Park. The following Background History section and the Heritage and Policy Status will provide the context for the comments and conclusions on the impact of this option.



Roundhouse Site Plan

B. Background and History

The John Street Roundhouse and Machine shop were built by the CPR in 1929-31 as a state-of-the-art facility to service steam passenger locomotives. At its peak it serviced an average of 65 locomotives a day. After the switch from steam to diesel in the 1950's until the doors were finally closed in 1988 the Roundhouse continued to operate servicing rolling stock. The site was designated as a National Historic Site in 1990 and the redevelopment and adaptive reuse of the 120,000 sf occurred over the next 20 years. Today the Roundhouse contains a brewery, a furniture showroom and three engine repair bays for the Toronto Rail Heritage Centre. Roundhouse Park includes the functioning turntable, display trackage and restored railway buildings and structures.

C. Heritage Status, Policy Context

1. NATIONAL HISTORIC SITE DESIGNATION

Designated a National Historic Site in 1990, it was described, in the Statement of the commemorative intent as "the best surviving example of a roundhouse in Canada".

2. PROVINCIAL POLICY STATEMENT (PPS)

The purpose of the PPS, issued under the Planning Act, is to provide municipalities in Ontario with policy direction on matters related to land use, planning and development. As it relates to the Union Station Heritage Conservation district Plan, Section 2.5 of the PPS states:

Roundhouse 1930s

- Significant built heritage resources and significant cultural heritage landscapes shall be conserved.
- Development and site alteration may be permitted in adjacent lands to protect heritage property where the proposed development and site alteration has been evaluated and it has been demonstrated that the heritage attributes of the protected property will be conserved.

3. CITY OF TORONTO OFFICIAL PLAN

The new 2002 Official Plan recognizes the importance of protecting stable neighbourhoods and heritage resources for their contributing qualities to the character of the city. The OP states:

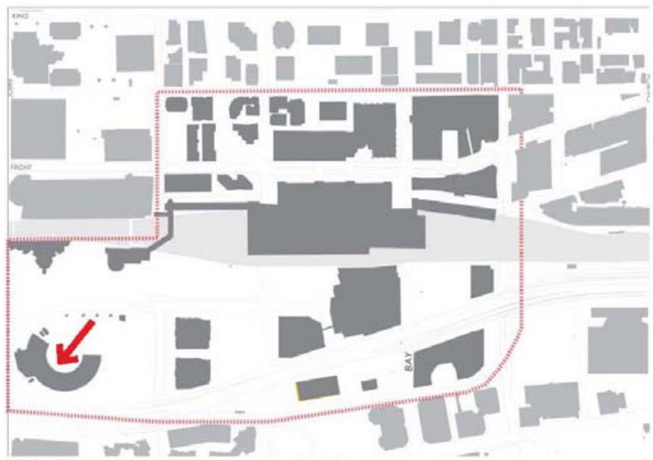
- Development will respect and reinforce the physical pattern and character of established neighbourhoods, with particular regard to the conservation of heritage buildings, structures and landscapes.
- Significant heritage resources will be conserved by designating areas with a concentration of heritage resources as Heritage Conservation Districts and adopting conservation and design guidelines to maintain and improve their character.

4. CITY OF TORONTO HERITAGE DESIGNATION

Under City of Toronto By-Law No.1996-0385 the property at 222 Bremner Blvd. was designated under Part IV of the Ontario Heritage Act.

5. UNION STATION HCD

Completed in 2006, the Union Station Heritage Conservation District Plan identified the heritage attributes of this district (see plan for boundaries of the HCD). Based on these attributes the plan details a set of district guidelines to direct the management of change in the Union Station HCD. They are written with a view of preserving the architectural integrity and heritage character of the district while creating an integrated public realm that recognizes the area's cultural significance and accommodates Union Station's evolving role within the city.



Union Station Heritage Conservation District

Buildings like the John Street Roundhouse and Union Station, both National Historic Sites, remain as reminders of the area's past use and are " Contributing Buildings".

The following excerpts from the relative guideline sections directly relate to the heritage issues relative to Option B;

New structures:

- The new structure respects the general size, shape and scale of features associated with the adjacent properties and the district as a whole.
- The site plan respects the general site characteristics associated with the property or district.
- The design respects the general historic and architectural characteristics associated with the property or district.
- The materials chosen are considered in context with those of adjacent contributing properties and with the district as a whole.

Compatible Alterations:

- Alterations that enhance rather than compromise the appearance and character of the buildings and surrounding buildings and contribute to the heritage character of the district.
- Any addition is to be connected to the property in a way that does not alter, change, obscure, damage or destroy any significant building features.

Public Realm:

- Maintain open spaces.
- Open spaces, such as Roundhouse Park, serve critical functions by helping to maintain the environmental quality of the district, in addition to providing a calm gathering space.
- Open spaces should be properly protected and maintained.

6. OPTION B

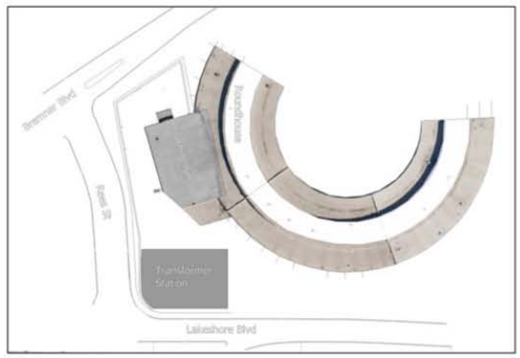
Option B consists of a 26 metre high structure that is located in the south west portion of the site. The footprint and volume of this above-grade structure is intended to house all the required electrical equipment of the earlier Option A, without utilizing or altering the Machine Shop. (See plan, elevation and isometric view of Option B)

7. HERITAGE ASSESSMENT AND FUNCTIONAL ISSUES

Many of the characteristics of this option are contrary to the spirit and intent and of the Union Station Conservation District Plan and are in opposition of the Union Station Heritage Conservation District principles and guidelines with respect to the compatibility of New Structures, Alterations, and the Public Realm.

The scale, footprint and volume, the location, the apparent materiality and exterior appearance of the above grade Transformer Station Option B, severely detracts from the heritage attributes and character of the Roundhouse, Machine Shop and Park. Thematic consistency of the brick, wood sash, multi-paned glazing, the clerestory will be negatively impacted by the intrusion and close proximity of the proposed, above-grade hydro facility.

The visibility of the iconic curving structure of the Roundhouse will be reduced from the heavy volume of Gardiner and Lake Shore traffic to the south. The visual connections between the thematic and character-defining-elements of the whole site, the Coal and Sand tower, Water Tower ancillary railway buildings and the Roundhouse will be broken by the 26 metre high bulk of the proposed facility.



Plan View of Option B

Isometric rendering of Option B from south of Gardiner Expressway

Elevation View of Option B from South of the Gardiner Expressway

The view to the Roundhouse and Park from the Rogers Centre, the CN Tower and the south end of the John Street cultural and entertainment corridor will be inappropriately terminated by the blank north face of the Bremner TS as it rises above the heritage structures to exceed the height of the Gardiner Expressway. The intermediate scale and appearance of Option B is not part of the surrounding backdrop of condominium towers, nor is it part of the heritage building and site. This visual disruption will reduce the consistency and visual legibility of the roundhouse, ancillary buildings and park.

View from Gardiner Expressway looking north. Approximate volume of Transformer Station shown.

The park development and pedestrian access to Roundhouse Park from Rees and Lake Shore that was proposed for the south west section of the site will be eliminated by this option. This will significantly reduce the amount , character and quality of open space available to adjacent residents and visitors.

The layout of Option B appears to compromise the safe and efficient use of the service road by the Roundhouse tenants, Leon's furniture and Steam Whistle Brewery as well as raising concerns about security. The truck traffic to these businesses will have to pass through or under the north-east corner of the proposed hydro facility. Site-lines and truck movements may be adversely affected.

D. Conclusions

The entirely above-grade Option B is completely incompatible with the heritage attributes and character of the adjacent roundhouse, a designated National Historic Site, the intent and spirit of heritage conservation in the PPS and the City of Toronto Official Plan and contravenes many of the most significant principles in the Union Station Heritage Conservation District Plan and Guidelines.

We find it would be very difficult to get positive acceptance of this option by the City of Toronto approval agency or the heritage community, nor do we expect that the Planning / Urban Design arm of the City of Toronto would support Option B.

Appendix 6

Heritage Impact Assessment

IBI Group - Toronto

BREMNER TRANSFORMER STATION AND MACHINE SHOP HERITAGE IMPACT ASSESSMENT

REPORT

NOVEMBER 25, 2011

IBI GROUP ARCHITECTS

TABLE OF CONTENTS

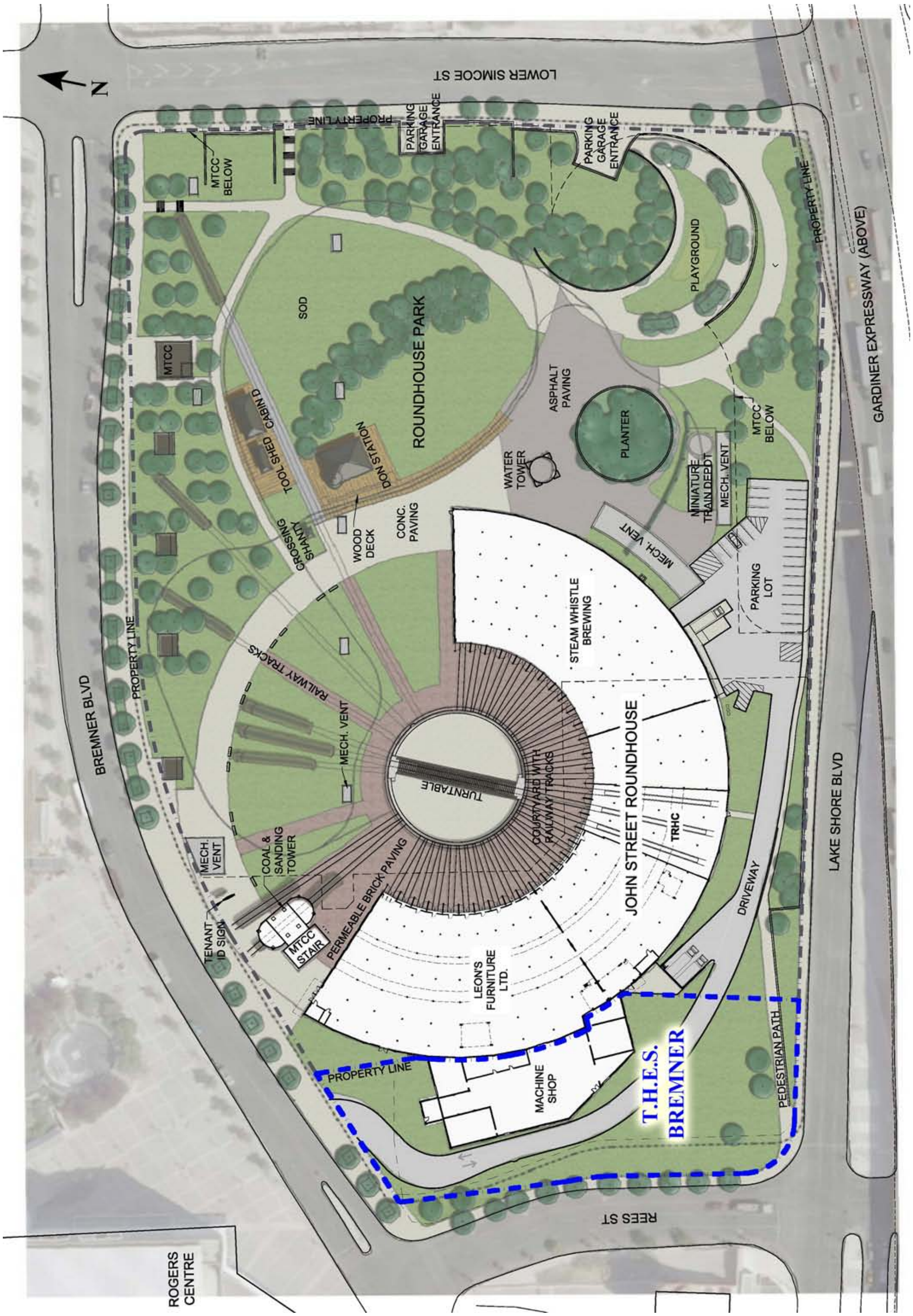
1. INTRODUCTION

1.1 Location

The John Street Roundhouse and Machine Shop complex is located in downtown Toronto – a short distance from the waterfront on the former Railway Lands, near the base of the CN Tower across Bremner Boulevard, from the south entrance to the Metropolitan Toronto Convention Centre (MTCC).

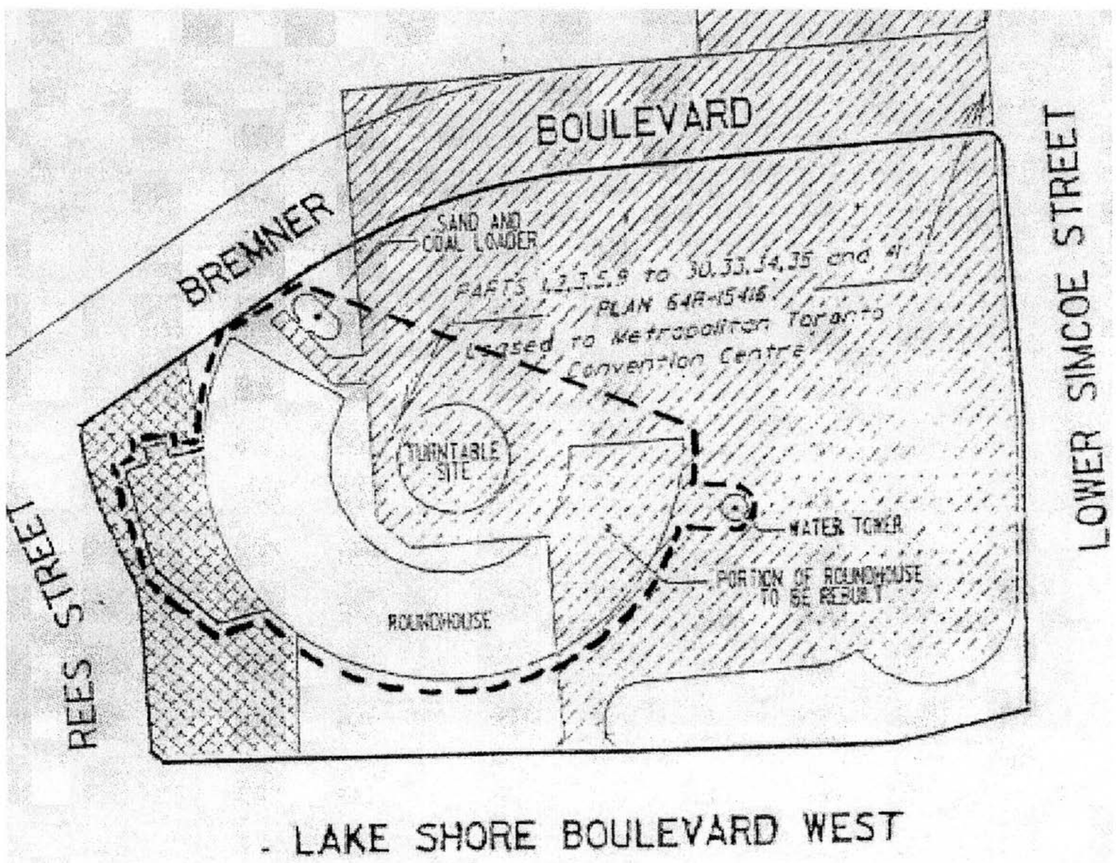
The 12,600 square-foot Machine Shop is attached to the southwest elevation of the John Street Roundhouse between Bays 22-28. The immediate Machine Shop site is bounded by Bremner Boulevard on the north, Rees Street on the west, Lake Shore Boulevard on the south, and the Roundhouse on the east.

SITE PLAN


N
LOWER SIMCOE ST
PROPERTY LINE
PARKING GARAGE ENTRANCE
PARKING GARAGE ENTRANCE
MTCC BELOW
SOD
ROUNDHOUSE PARK
PLAYGROUND
GARDINER EXPRESSWAY (ABOVE)
ASPHALT PAVING
PLANTER
MTCC BELOW
MTCC
CABIN D
TOOL SHED
DON STATION
WATER TOWER
MINIATURE TRAIN DEPOT
MECH. VENT
CROSSING SHANTY
WOOD DECK
CONC. PAVING
MECH. VENT
PARKING LOT
STEAM WHISTLE BREWING
RAILWAY TRACKS
MECH. VENT
TURNTABLE
COURTYARD WITH RAILWAY TRACKS
JOHN STREET ROUNDHOUSE
TRHC
BREMNER BLVD
PROPERTY LINE
LAKE SHORE BLVD
MECH. VENT
COAL & SANDING TOWER
PERMEABLE BRICK PAVING
DRIVEWAY
TENANT ID SIGN
MTCC STAIR
LEON'S FURNITURE LTD.
PROPERTY LINE
MACHINE SHOP
T.H.E.S. BREMNER
PEDESTRIAN PATH
REES ST
ROGERS CENTRE

1.2 Federal Heritage Recognition

The John Street Roundhouse is significant as one of the last of its type. In 1990 the Roundhouse, turntable, sand and coal loader, and water tower were recognized by the Historic Sites and Monument Board of Canada as important examples of Roundhouse technology built during the "era of big power". "… is the best surviving example of a Roundhouse in Canada". The complex survives as important evidence of the historical development of Toronto's Railway Lands and the role of the railway in the economic and social evolution of Toronto and Canada.



An integral component of the Roundhouse was the Machine Shop annex, attached to the south wall of the building behind stall # 25. The shop contained lathes and drills, boiler tank and boiler washer room, compressor room, fan room, blacksmith shop and worker's facilities.

"The designated place of the John Street Roundhouse NHS consists of the property one metre outside of the footprint of the Roundhouse/Machine Shop/turntable, and extending at both ends of the Roundhouse to meet and encompass a similar one-metre boundary around the two ancillary structures, the water tower and the coal and sanding tower," (HSMBC Minutes, 1990). This will encompass all of the designated site resources within a single contiguous national historic site property.

1.3 Municipal Heritage Recognition

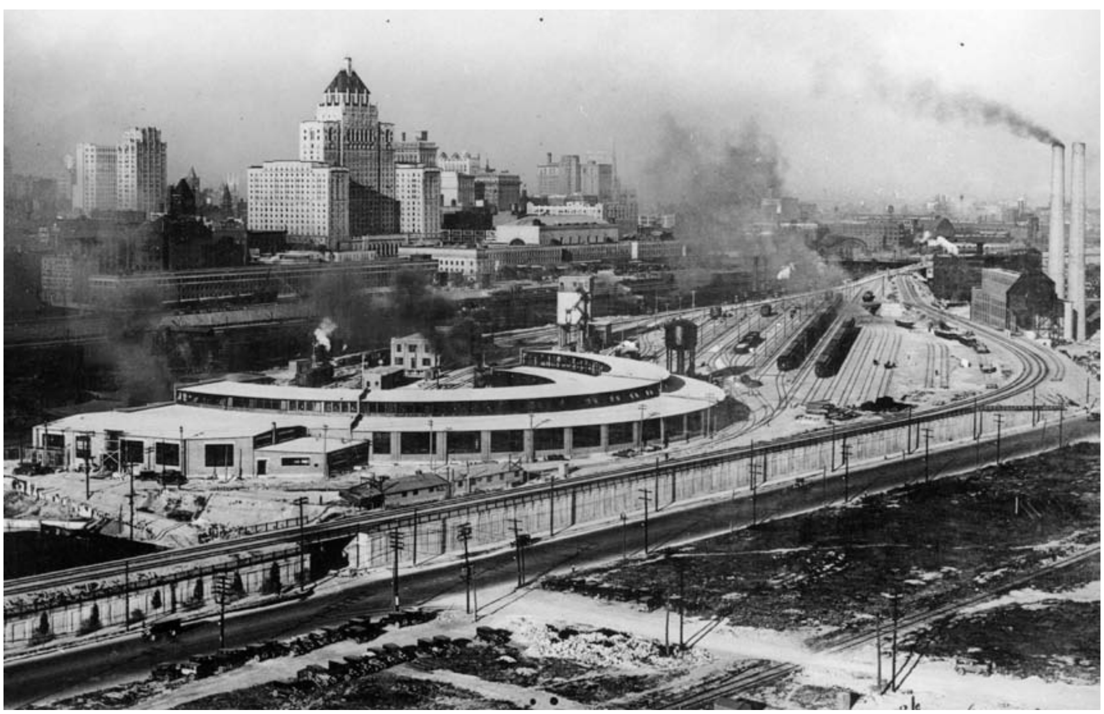
The Roundhouse was designated and placed on the City of Toronto Inventory of Heritage Properties on September 4-7, 1984. City of Toronto By-Laws, dated 1996, No. 1996-0385, describes the heritage significance of the Roundhouse site and ancillary structures as follows;

“The property at 222 Bremner Boulevard is identified for architectural and historical reasons. In this location, the Roundhouse (with Machine Shop), turntable, sand and coal loader and water tower, are the surviving core components of the John Street Yard. This facility was developed by the Canadian Pacific Railway Company and opened its doors in 1931. The complex was operated for over half a century, continuing after the conversion from steam to diesel.”

The CPR John Street Roundhouse, which includes the Turntable, Sand and Coal Loader and Water Tower, was designated as being of architectural and historical interest under Part IV of the Ontario Heritage Act (OHA) by City of Toronto By-Law No. 1996-0385 passed in 1996;

City of Toronto By-Law 1996-0385 was subsequently partially repealed and amended in 2008 by the City of Toronto By-Law No. 1143-2008, to remove references to the Machine Shop from the By-Law;

The entire study area is located within the Union Station Heritage Conservation district, designated under Part V of the OHA by the City of Toronto By-Law passed in 2006.



View of John Street Roundhouse and Rail Yard, 1930’s from S.W. looking N.E.

2. BACKGROUND

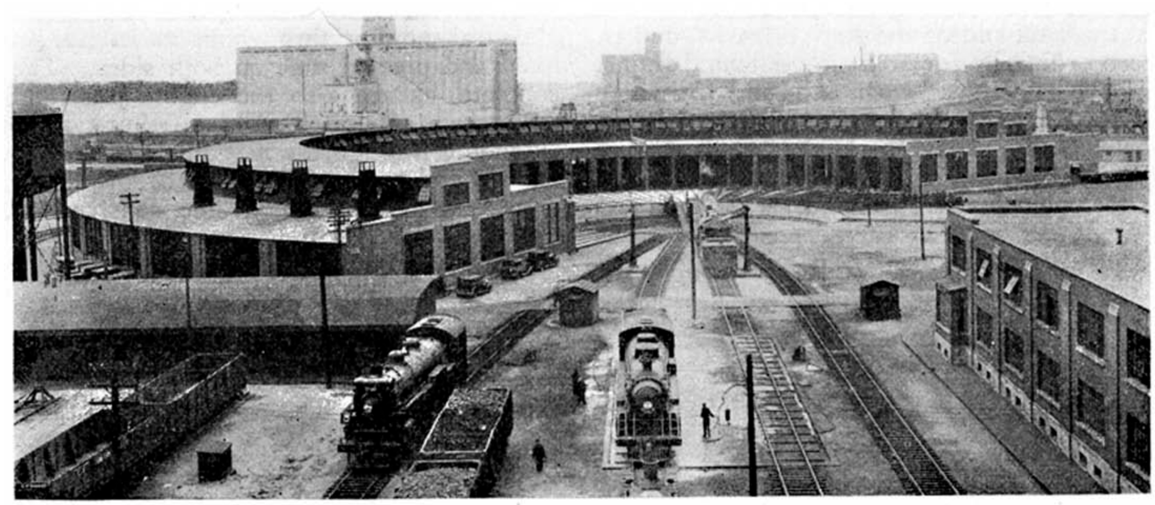
The need for the Roundhouse was reduced as diesel locomotives began to be introduced in the late 1940's. Diesel locomotives needed less maintenance than steam locomotives but required the addition of concrete block fire walls that subdivided the interior space to reduce the risk of fire. By 1960 steam locomotives no longer operated on the CPR system though the John Street Roundhouse remained in service with a greatly reduced workload and workforce. In Oct. 1978, VIA Rail took over the operation of the Roundhouse to store and service diesel passenger locomotives. The last locomotive was serviced in the Roundhouse in Sept. 1982 after which it was used for storage until it was closed in August 1986.

In March 1994, the MTCC received permission for a subsurface conference space extension and parking garage under the eastern sector of the 16.8 acre Roundhouse property, directly under the eastern portion of the Roundhouse and the turntable. This work, carried out from 1994-97, required the recording and disassembly of Bays 1-11 of the Roundhouse along with the removal and storage of the turntable in the remaining Roundhouse. Once the excavation for the MTCC extension and its construction was complete, Bays 1-11 were re-assembled and the exterior of the Roundhouse and Machine Shop was stabilized, the roof membrane replaced, windows replicated and engine doors rehabilitated.

Many of the associated structures, including the ash and cinder pit house, the stores building and the diesel washing facility were demolished. The Coal and Sand Tower was relocated to the west end of the Roundhouse and the Water Tower was temporarily relocated and then returned to its original location once construction was complete.

View from the CN Tower of excavation for the MTCC Extension Project 1994.
(Note – Roundhouse Bays 1-11 have been disassembled)

Two years after the completion of the MTCC extension and the re-assembly and stabilization of the Roundhouse, Steam Whistle Brewing occupied Bays 1-11. In 2007 after a lengthy redevelopment and leasing process, the City came to an agreement with a head lease for a long-term lease for the entire Roundhouse complex and a commercial tenant was selected for Bays 18-32. The Toronto Railway Heritage Association was given a lease for Bays 12-14 as part of their railway museum facility that was proposed to also occupy the Machine Shop as well as the restored ancillary buildings in Roundhouse Park. The base building and tenant fit-out work was completed in 2009 and the turntable was restored and re-installed, and display track was installed within the turntable courtyard and the park. The ancillary structures, the Coal and Sand tower, Cabin D, the Don Station, Crossing Shanty and Tool shed were also rehabilitated at that time.



Roundhouse 1931

Views of Roundhouse Machine Shop today

View of Roundhouse Park with Associated Rehabilitated Heritage Buildings

The City of Toronto is the owner of the Roundhouse complex and the current Head Lessee is The John Street Roundhouse Development Corp.,
Barry Zagdanski, 416-787-0256.
Sub-tenants to the JSRDC include;
Steam Whistle Brewing, Toronto Railway Heritage Association and Leon's Furniture Ltd.

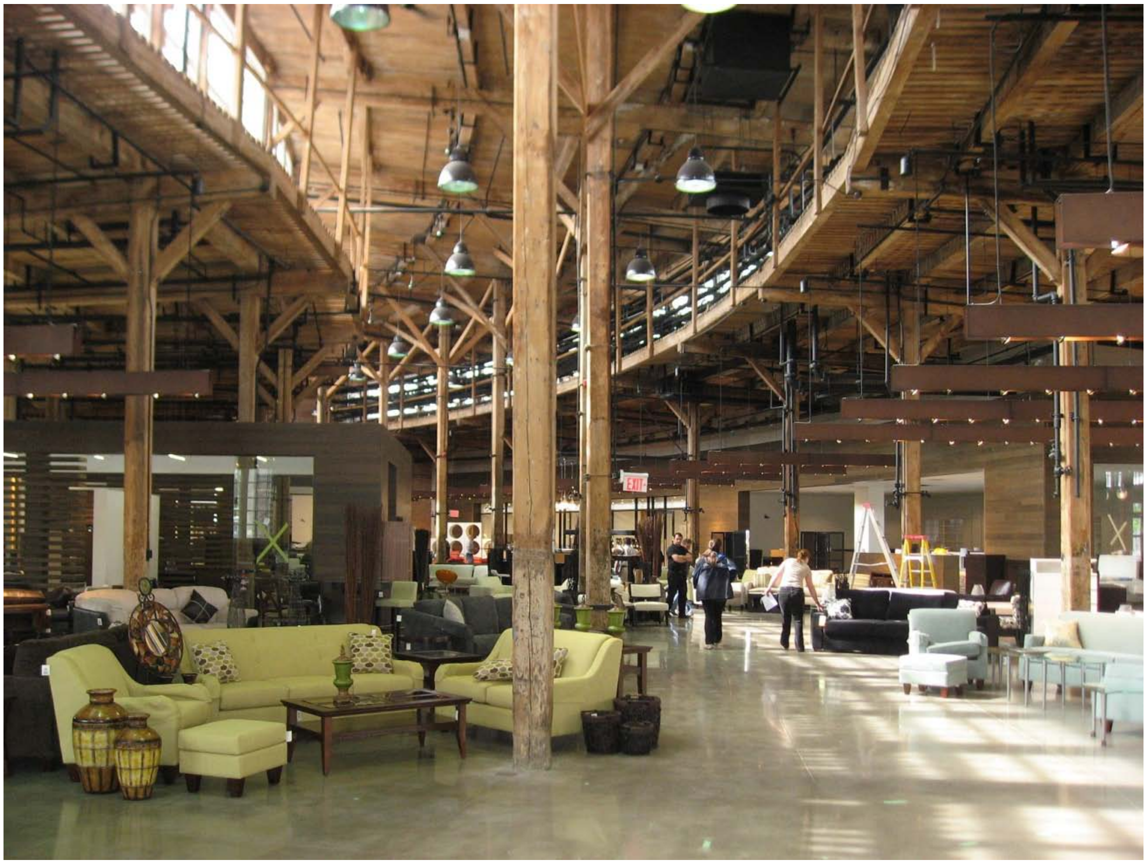
3. STATEMENT OF SIGNIFICANCE AND HERITAGE CHARACTER

Today the Machine Shop is the last remaining element of the complete Roundhouse, steam engine repair complex that **has not** been rehabilitated and adaptively re-used. In conjunction with the turntable, associated buildings such as the Tool Shed, Crossing Shanty, Cabin D and structures such as the Coal and Sand Tower, the Water Tower, the Machine Shop completes the story of how steam engines were serviced at the John Street Roundhouse Rail Yard.

The heritage character of the Machine Shop is defined by the simple and robust industrial materials used consistently throughout. The industrial scale and repetition of these building elements, such as the steel 'I' Beam columns, beams and purlins, the mill deck roof, the expanse of wood framed, multi-pane windows, the mill type doors and the hard-fired red brick walls, together evoke the heroic scale of the steam locomotives that were repaired here.

The interior layout with its curved back wall that is shared with the Roundhouse and the scale and volume of the two storey interior spaces also speaks to its industrial character and in detail to the repair function and processes for which this annex structure was built. The heritage character is communicated as well through the extent and completeness of surviving hardware and other operational details, such as door mechanisms, pipes, duct work, direct steaming lines, the air compressor, and other *in situ* machinery.

Roundhouse Today



Interior, Bays 23-31

REASONS FOR DESIGNATION INCLUDE:

The John Street Roundhouse is significant as one of the last of its type…as an important example of Roundhouse technology built during the "era of big power"… as important evidence of the historical development of Toronto's Railway Lands and the role of the railway in the economic and social evolution of Toronto and Canada."

- "An integral component of the Roundhouse was the Machine Shop, attached to the south wall of the building behind stall # 25. The shop contained lathes and drills, boiler tank and boiler washer room, compressor room, fan room, blacksmith shop and worker's facilities.
- The Roundhouse was part of a rail yard complex and its significance is increased in part by the context of the important companion structures that surround it.
- The Level 1 historic objects (such as the Machine Shop) are valued because of their direct connection to the Roundhouse and its past operations and functional processes; they enhance understanding of the operations and functional processes of the Roundhouse.

4. ASSESSMENT OF EXISTING CONDITION

The Machine Shop was used primarily for storage after the Roundhouse facility was closed in 1986. Until very recently most of the floor area was occupied by railway artefacts, pieces of equipment, and building materials such as pallets of bricks salvaged from alterations in the Roundhouse. The TRHA has removed most of this material to off-site storage.

The fabric of the original building, the masonry walls, the steel frame, the wood mill deck roof are in fair condition and the wood sash windows, replaced in 1997, are in good condition.

There is evidence of movement or 'jacking' in the exterior masonry walls at the pilasters that enclose steel columns. There are long vertical mortar breaks and dislocation of units that suggests a history of moisture penetration, rusting and expansion. There are numerous signs of abrasion and wear at the base of walls that was the result of the movement of heavy pieces of equipment and material within the shop.

There are raised, concrete bases that were used to support heavy machinery, electrical generators and fuel storage tanks. At some point during the conversion from steam to diesel two major windows on the north and west elevation were removed and the openings filled with brick along with a person door and small window in the one storey addition on the north elevation. Windows on the east elevation of the two story block were also bricked in at some point. Within the Machine Shop there is an enclosed, one story clay block, office space, with steel sash windows, added sometime in the 1960's.

Machine Shop - View from Bremner Boulevard looking South

The original access and loading door between Bay #25 of the Roundhouse and the Machine Shop and the person door between Bay # 24 and the one storey, eastern portion of the Machine Shop were filled with concrete block wall. This was completed as part of the base building upgrading in 2008-9 and provides a complete separation between the commercial tenants within the Roundhouse space and the Machine Shop. The original doors were rehabilitated and were fixed in a closed position on the Roundhouse side of the openings.

Machine Shop Interior (Fish-Eye View from back wall looking SW towards Rees St.)

5. DESCRIPTION OF PROPOSED DEVELOPMENT AND SITE ALTERATION

To meet the increasing demands and concentration for electrical service in downtown Toronto, the THESL is proposing to construct the Bremner TS, Cable Tunnel and Machine Shop, substation project to supplement the current Windsor facility. The new substation will be an indoor/underground station ultimately accommodating five, 230KV transformers, with the lowest floor level approximately 13.3m below the surface of Roundhouse Park. Extensive air intake and exhaust vents will be located along the south or Lake Shore Blvd. elevation and in the future along the lower half of the Rees Street elevation and will project 3m above the surface of the Roundhouse Park.

To enable the piling, excavation and construction of the substation, almost 14 meters below grade on this constricted site, the Machine Shop will have to be removed. Several options for removal were reviewed. Given the masonry exterior wall, the two-storey, clear-span interior space and the annex's attachment to the Roundhouse, moving the Machine Shop intact was not considered as an option. After careful analysis it was concluded that the dismantling, storage off-site and re-assembly, was the most practical option. The precedence for this process was part of the MTCC extension project, 1995-7, when Bays 1-11 of the Roundhouse were dismantled and re-assembled. This was understood to be a 'last resort' option, as the process of taking apart and putting back together that portion of the Roundhouse did have a negative impact on the heritage fabric of the NHS. Though the "John Street Roundhouse National Historic Site of Canada, Commemorative Integrity Statement", Jan. 2005, notes; "… Bays one through eleven were recorded and dismantled during the construction of the underground parking garage. This section was subsequently reconstructed using the original fabric. While recognizing that this portion of the building is reconstructed and has been modified for a new use, for the purpose of this statement, it is considered a **valued and integral** part of the Roundhouse. It is not treated separately in this document."

The overall approach to the intensification of the west portion of the Roundhouse Park to accommodate the construction of the Bremner Transformer Station is to disassemble and adapt the reassembled Machine Shop to accommodate Hydro One and THESL requirements. Every effort will be made to minimize the visual impact of these interventions and to re-integrate the Machine Shop into the Roundhouse complex. This re-integration is intended to maintain the visual continuity of the entire National Historic Site and to continue the resource's ability to interpret the story of Toronto's rail history.

The Machine Shop will be disassembled, elements stored and cleaned off-site as the shoring and excavation is underway. Once the substation is completed a specially designed, structural concrete wall will be constructed to meet the NBC Seismic Upgrading requirements. This wall will form the core of the Machine Shop, north, west and south walls and all visible surfaces, exterior and interior will be faced with the original brick. The existing doors and windows will be re-installed, and replicated windows and doors will replace currently bricked-in openings. A concrete wall will be constructed parallel to and 300mm from the rear wall of the Roundhouse as part of the self-supporting structural system that forms the seismic upgrading as well as providing a two hour fire separation between the Roundhouse and Machine Shop. A steel roof deck will be constructed on top of the re-installed wooden mill deck roof and existing steel I-beam structure. This work will be done in confirmation with Ontario's Guiding Principles in the Conservation of Built Heritage Properties and with reference to Canada's Historic Places, "Standards and Guidelines".

There is planned space within the reassembled Machine Shop that will be dedicated to both Hydro One and THESL that includes a stair that connects the below grade substation to the surface and second floor, to accommodate a meeting room, offices, the substation control room, space for back-up power and a mechanical room. Ventilation louvers will be located within existing bricked-up window openings for exhaust and intake air supply. An exit stair from the substation will also be located at the northwest corner of the site, providing emergency access from the substation to the Bremner Street level.

The Transformer Station roof deck will be landscaped, the service road re-installed and there will be space to park (for service and emergency use by Toronto Hydro staff) on the hard surface portions of the roof landscape. Otherwise vehicle access and egress will be from a ramp from Lake Shore into an underground space within the substation. Perforated Corten steel panels will be used to screen the Transformer Station ventilation grilles. The perforations (up to 30% of the panel area) will be designed to interpret the history of the former John Street rail yards that covered this area.

6. IMPACT OF DEVELOPMENT AND SITE ALTERATION, AND MITIGATION STRATEGY

6.1 Destruction of Heritage Resource and Relationship to Heritage Context and an Adjacent Heritage Site

The removal of the Machine Shop and the construction of the Bremner substation on the site bounded by the west wall of the Roundhouse, Bremner Blvd. to the north, Rees street to the west and Lake Shore Blvd. to the south without re-assembly, would eliminate an integral portion of the Roundhouse complex and erase a critical part of Toronto's railway history. The 'story' of how the engine repair facility worked, the importance of the 'emergency repairs' provided by the equipment and workers in the Machine Shop is an essential element in understanding how the John Street Yard was able to service 60 trains a day during its peak years.

6.1.1 DISASSEMBLY AND RE-ASSEMBLY

The 'annex; form of the Machine Shop attached to the powerful curve of the Roundhouse is most clearly expressed through the exterior, physical relationship of one to the other. This continuity of form and scale, as well as the materials, the brick, concrete lintels and sills, the window and door sizes and type between the Machine Shop and the Roundhouse is one of the most significant heritage attributes of the complex.

Though the structural concrete core will increase the thickness of the walls to 510mm from 310mm, the windows and doors will be re-installed in the same relationship to the exterior face of the brick cladding as they enjoy today. By using the original materials in their original locations following a careful sequence of cleaning, dismantling, off-site storage, rehabilitation and reassembly, the potential negative impact of this project will be mitigated. The fact that it will be reassembled in its original location and configuration, as it was for the disassembly and re-assembly of the Roundhouse Bays 1-11, will be clearly identified.

Mitigation

The process of disassembly and re-assembly will reinstate the original physical relationship of the Machine Shop to the Roundhouse, using the original materials wherever possible.

6.1.2. VIBRATION CONTROL

Vibration monitoring will be undertaken throughout the duration of the project. The purpose of this vibration monitoring is to ensure that the vibration impact on the adjacent tenants, building owners, buildings and structures is minimized during construction.

Mitigation

Vibration monitoring, will provide early warning of unacceptable levels of vibration during construction to avoid damage and disruption of adjacent stakeholders 'property and activities.

6.1.3. FIRE SEPARATION

The Building Code and Fire Protection consultants have determined that as the Machine Shop is owned by THESL and the Roundhouse is owned by the City and as they will become separate buildings, they are required to be separated from each other by a firewall with a four-hour fire-resistance rating. The intent of the Code is to prevent the spread of fire to adjacent buildings. To satisfy this intent we are providing the following that will describe the impact on character defining elements and heritage fabric of both the Roundhouse and Machine Shop:

1. **Fire Extinguishing System** – an upright sprinkler system will be installed within the reassembled Machine Shop, in accordance with NFPA Standards.

2. **Fire Separation Between Buildings** – construct a new masonry wall, 300mm from the existing Roundhouse brick wall to provide a two-hour fire resistance rating that will in combination with the existing wall provide the required four-hour rating. The fire rating will extend to the new steel pan roof above the wood, mill deck roof over the Machine Shop. There will be a continuous expansion joint where the Machine Shop abuts the Roundhouse.

3. **Existing Roundhouse Wall Construction** – the existing Roundhouse brick wall is assumed to provide a minimum two-hour fire-resistance rating and will be untouched.

4. **Exposure Protection** – Openings in the Machine Shop walls, adjacent to the Roundhouse will be protected with exterior, surface mounted sprinklers to drench the exposed face in the case of fire.

Mitigation

The expansion joint between buildings will be covered in over-lapping flashing to match the existing Roundhouse flashing. The sprinkler system in the interior will be painted black and mounted on the underside of the roof deck using clamp connector systems that are reversible and that do not penetrate the existing roof and structural fabric. The new fire wall between the Roundhouse and the Machine Shop will not be visible from the main, two-storey, west portion of the reassembled building.

6.1.4. SEISMIC UPGRADING

The Machine Shop (MS), housing the main control equipment for the entire station, is the brain of the station. This equipment is typically housed inside the station and has been moved to the Machine Shop due to lack of space below grade. The Machine Shop has become an extension and an integral part of the station and as such it has been determined that it has to be upgraded to also meet the current Code requirements for seismic upgrading that the underground portion of the buildings has been designed to meet. The seismic upgrade of MS is essential to protect the electrical installations below MS and for the safety of the Hydro personnel working below grade. This upgrading will have the following impact on the reassembled Machine Shop:

1. **Wall Structure Construction** – a 510mm reinforced concrete wall will be constructed that is integral to a specifically designed portion of the station roof slab that will form the floor of the Machine Shop. This wall will also be connected to the two-hour fire wall between the Roundhouse and Machine Shop as well as the structural roof deck. This fire-rated wall will be designed to meet the same seismic upgrading requirements as the exterior walls.

Mitigation

The structural wall will be the core or a thicker wall that will have a brick veneer applied to all surfaces. The brick will be selected from the disassembled and cleaned brick to match as closely as possible, when installed, the type and pattern of brick used in that particular location. The wall will have openings that are cast into them, so that the existing windows and doors can be re-installed in their original locations and position relative to the exterior face, after the brick veneer is complete.

2. **Roof Construction –** The high roof will have 38 mm fluted steel deck above the reassembled mill deck with a ½" gypsum sheathing, rigid insulation with glued down water-proof roof membrane.

   The two low roofs (at the north and south ends of the building) will have 76 mm fluted steel deck above the reassembled mill deck with a ½" gypsum sheathing, rigid insulation, with glued down water-proof roof membrane.

Mitigation

The roof edge fascia board and pre-finished metal flashing at the roof edge will match the scale and colour of the roof edge treatment on the adjacent Roundhouse roof. Any difference in roof thickness will be minimized.

3. **Expansion Joints** - The 300mm expansion joint between the Roundhouse and Machine Shop that is required to safely separate the two structures and to allow for movement of one in relation to the other in the event of a seismic event will be covered with metal flashing. The two pieces of flashing will overlap to cover the expansion joint and be designed to move separately, at the same time maintaining covering over the joint.

Mitigation

The pre-finished metal flashing will match the roof edge flashing that is used throughout the complex to minimize its visibility.

6.1.5 ADAPTIVE REUSE OF EXISTING AND ORIGINAL WALL OPENINGS

To accommodate the requirement for mechanical ventilation, intake and exhaust for the reuse of the Machine Shop for Hydro One and THESL, a series of grilles will be installed within existing and or original openings that were bricked in at some point in the past.

To provide loading access to the one storey portion of the Machine Shop for the removal and replacement of equipment a loading door will be installed within an extended, existing window opening.

To provide a fire exit, the existing pair of doors on the west wall will be adapted to meet exiting requirements.

Mitigation

To mitigate the impact of these ventilation grilles, wood louvers will be installed that will match the current louvers that are covering mechanical ventilation grilles within openings in the Roundhouse. Installation of ventilation grilles will be limited to the two currently bricked in openings in the upper south wall and to the two existing window groups in the lower south wall.

One of the lower window groups will have two of the three panels extended to the floor slab to accommodate the installation of a loading door. This door will be mill deck construction to match the current Roundhouse loading and engine doors. The third panel will accommodate a ventilation grille with wood louvers.

The new exit assembly will have an exit door and a fixed panel. Both will be constructed to match the door type used throughout the Roundhouse for exit, loading, and engine doors.

6.2 Direct Obstruction of Significant Views to the Heritage Resource and Land Disturbances

The operational requirements of a substation of this magnitude and complexity has resulted in a structure that occupies the full site to an average depth of 13.5m and extends 4.5m above grade, 1 metre from the property line at Lake Shore Blvd. and a portion of Rees St. These operational requirements have resulted in exterior building elevations along Lake Shore and Rees that require extensive ventilation grilles, two truck entry and exit portals, two fire escapes and a stair from the Lake Shore/Rees corner up to the Park level.

This roof area will become part of the Roundhouse Park and will be landscaped as part of the whole 16.8 acre park with the option of the reinstatement of the service road. The ventilation enclosures will be 3m above the average grade of the station roof/park. This will extend the south and lower west faces or elevations to a height of 7.5m above Lake Shore Blvd. These louvered enclosures will obstruct the current views to the Roundhouse and Machine Shop, from Lake Shore Blvd. and Rees Street.

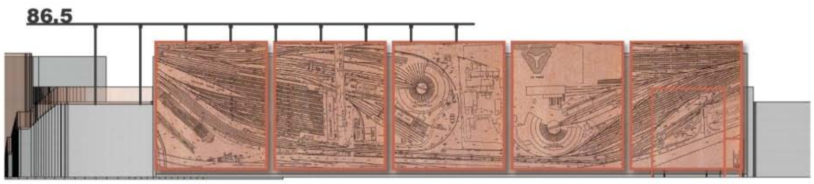
The excavation for this substation, represents a significant land disturbance and grade change under and adjacent to the Machine Shop. Currently there are sloped landscape areas from the Park level, west to the Rees Street sidewalk and South to Lake Shore Blvd.

6.2.1 EXTERIOR TREATMENT LAKESHORE AND REES ELEVATIONS

It is proposed to utilize Corten steel screens that will have a pattern of solids and voids/perforations cut through them that achieve a number of objectives. The screens will protect the exhaust vents in the wall behind. The consistency of the material, colour and size of the screens will cover and protect the variety of openings, grills, exhaust vents and wall treatments of the south and west substation exterior walls. The pattern and size of the voids and solids created by the perforations will facilitate air movement and will be based on historic plans of the John Street Rail Yard. The Lake Shore Blvd. screens will depict the 1931 plan of the yards and the Rees Street screens will show the 1890 plan of the same yards. Roundhouse Park is the last remnant of these same rail yards and the consistent use of these steel panels will provide an opportunity to tell this story to people walking, biking, and driving by the corner of Lake Shore Blvd. and Rees Street.

A pedestrian stair will be constructed from the sidewalk level of elevation 76.8, at the corner of Rees and Lake Shore, to the south west corner of Roundhouse Park at elevation 81.5. From the park level, pedestrians will be able to access the rest of the Roundhouse complex and Park.

At the park level, there will be a hard surface plaza with a sunken, circular seating area and an overhead sculpture to express the idea and reference the historic High Line that ran east west parallel to what is now Lake Shore Boulevard. This elevated reference will have the name 'High Line' and the elevation number 86.5, in cut-out, Corten steel letters.



LAKESHORE BOULEVARD ELEVATION

REES STREET ELEVATION

Mitigation

From the perspective of the experience of the urban space along the south and west building elevations, as well as that of security and maintenance, a series of industrial scaled screens will be installed to create a consistent building edge and treatment to the south-west corner of Roundhouse Park. This treatment acts as a continuous screen to cover the various ventilation grilles, access doors for both vehicles and pedestrians and different roof heights. The surfaces of the screens also provide an opportunity to tell the story of Toronto's John Street Rail yard.

6.3 Change in Land Use

The Machine Shop will be re-assembled in its current location, after the substation roof is complete. THES is planning to purpose-build above grade facilities within the re-assembled Machine Shop that includes stairway access to the substation, offices, a meeting room, the control room, backup power and mechanical and electrical facilities. This space represents approximately 50 to 60% of the ground floor area.

This major change in land use will also alter the vehicle and pedestrian traffic over the site.

Mitigation

The adaptive re-use of the Machine Shop, after its disassembly and reassembly, is a continuation of the approach to the preservation of the John Street Roundhouse NHS that began with the disassembly and reassembly of Bays 1-11, in 1994-97. This inevitable change of use will support the conservation of the site and its historic significance and provide an opportunity to display and interpret this history.

7. CONSERVATION STRATEGY FOR CHARACTER-DEFINING ELEMENTS

The conservation strategy for the Machine Shop will be based on the “Standards and Guidelines for the Conservation of Historic Places in Canada” Second Edition. Though the strategy is based on the reconstruction of the original structure, as discussed in the preceding Section 5, rehabilitation is the primary treatment as the disassembly and reassembly of the Machine Shop will involve alterations and additions to the historic place for new and continued uses. There are as well, aspects of restoration proposed for significant character-defining elements.

Given that the Machine Shop will be reconstructed the following three Standards relating to rehabilitation will establish the principles under which all work will be done:

> “10. Repair rather than replace character-defining elements. Where character-defining elements are too severely deteriorated to repair, and where sufficient physical evidence exists, replace them with new elements that match the forms, material and detailing of sound versions of the same elements. Where there is insufficient physical evidence, make the form, material and detailing of new elements compatible with the character of the historic place.
>
> 11. Conserve the heritage value and character-defining elements when creating any new additions to an historic place or any related new construction. Make the new work physically and visually compatible with, subordinate to and distinguishable from, the historic place.
>
> 12. Create any new additions or related new construction so that the essential form and integrity of an historic place will not be impaired if the new work is removed in the future.”

7.1 Relationship to Roundhouse and Site

See 6.1

7.2 Blacksmith Shop

The reassembly of the one storey Blacksmith Shop in its original location on the east side of the Machine Shop, will complete the reassembly of the Machine Shop “annex” structures and will provide an opportunity to reuse this space for station equipment.

7.3 Brick Envelope

Though the three brick wide exterior wall will be replaced with a thicker wall with a reinforced concrete core, the characteristically hard-fired exterior brick and cement-rich mortar, favoured by CPR at that time, will be used as a veneer on all exposed surfaces. The reinstatement of this brick will match in appearance the adjacent Roundhouse brick envelope and the continuity of ‘look’ will complete the story of the engine repair complex as an integral part of the John Street Roundhouse facility.

To disassemble the masonry walls we are proposing a combination of careful disassembly, similar to the process used for the disassembly and reassembly of Bays 1-11 of the Roundhouse. A tagging methodology for each palette of bricks will ensure the bricks are re-assembled in their original location. Careful sorting of bricks will provide a stock of exterior and interior type for patching, finger-jointing and repair work.

7.4 Reversibility

Second to the reassembly of the Machine Shop and the completing of the Roundhouse complex through the visual connection and the continuity of materials and elements, reversibility is a significant approach and asset for the structure. The ability of the space to be adapted for a variety of uses in the future depends on the creation of, " …any new additions or related new construction so that the essential form and integrity of an historic place will not be impaired if the new work is removed in the future." This approach will attempt to conserve the character-defining elements and make all alterations reversible.

7.5 Steel structure

CPR design engineers used a Douglas Fir structure of columns, beams and purlins in the Roundhouse, while two years later riveted steel I-Beam columns, beams and purlins where used in the Machine Shop. Between the design and the start of construction of the Roundhouse in 1929 and the erection of the Machine Shop in 1931, the designers made the transition from timber structure, to steel.

The disassembly, cleaning and re-assembly of the steel structure, with stiffening plates and rivet heads where required, will reinstate an important aspect of the history of railway industrial design and is an important part of the story of evolving railway technology. A tagging methodology will ensure that the structural elements are reassembled in their original locations. If the steel is unusable for any reason the original element will be replicated.

7.6 Mill Deck Roof

Based on the diagonal spiking method used originally to assemble the 2"x3" red pine mill deck and the difficulty of salvaging re-useable sections after disassembly, it will not be possible to take it apart without extensive damage. It will be necessary to remove and recycle the mill deck roof and replace it in kind. This replication method was used in the envelope and base building rehabilitation of the Roundhouse and the loss of the original fabric is mitigated by the use of the same material and construction method. The material/physical relationship between the original roof structure and the new roof deck is the same.

7.7 Exterior Windows

The extensive, multi-paned, wood sash windows, replaced in 1997 as part of the MTCC expansion project, will be removed, stored, and rehabilitated before they are re-installed in the re-assembled envelope. A wood sash exterior storm window will be fabricated to match the Roundhouse storm windows and installed to reduce heat loss and noise penetration from the Gardiner Expressway.

Cast concrete sill and lintels will be fabricated off-site during the interim phase to replace those damaged during disassembly.

7.8 Doors and Hardware

The original doors and hardware will be removed, stored and rehabilitated off-site during the interim phase and will be re-installed and adapted where required, during the reassembly phase.

7.9 Disassembly

As discussed, the Conservation Strategy for the Machine Shop is based on a rehabilitation approach that involves the recording, disassembly and re-assembly of the original materials. An outline of the process is as follows:

Elements to be Demolished:

- Roof deck
- Specified Interior Partitions

Elements to be, Disassembled, Transported, Cleaned, Stored and Rehabilitated off-site:

- Steel Structure
- Remove Windows Intact
- Remove Doors Intact
- Disassemble Brick Walls
- Weather-proof Exposed Exterior Wall from Bay 22 to Bay 28 for duration of subsurface transformer station construction

7.10 Re-assembly

The following re-assembly outline is based on the construction of the foundation wall, reinforced floor slab at finished elevation and all required base-building services.

Elements to be Re-assembled:

- Steel Structure
- Mill Deck Roof
- Exterior Wall Brick Veneer
- Interior Walls, Brick Veneer
- Hydro Space
- Windows and Doors

APPENDIX

REFERENCES

REFERENCES

- “Standards and Guidelines For the Conservation of Historic Places in Canada - Second Edition”. A Federal, Provincial and Territorial Collaboration, 2010
- “Ontario Heritage Tool Kit”. Ministry of Culture, The Province of Ontario, 2006
- “‘Well-Preserved’, The Ontario Heritage Foundation’s Manual of Principles and Practice for Architectural Conservation”. Mark Fram, 1988
- “Principles of Heritage Conservation - Technical Paper Series 9”. British Columbia Heritage Trust, Judy Oberlander, Harold Kalman, Robert Lemon, 1989
- “John Street Roundhouse, National Historic Site of Canada, Commemorative Integrity Statement”. City of Toronto & Parks Canada Agency, January 2005
- “GM19.8 Roundhouse Heritage, Committee Recommendations - Meeting #19 - Minutes”. Government & Management Committee, November 21, 2008
- “PB13.3, 222 Bremner Blvd. – Partial Repeal and Amendment of Designating By-law - Meeting #13 - Minutes”. Toronto Preservation Board, April 18, 2008

Appendix 7

Architectural Renderings of completed Bremner TS

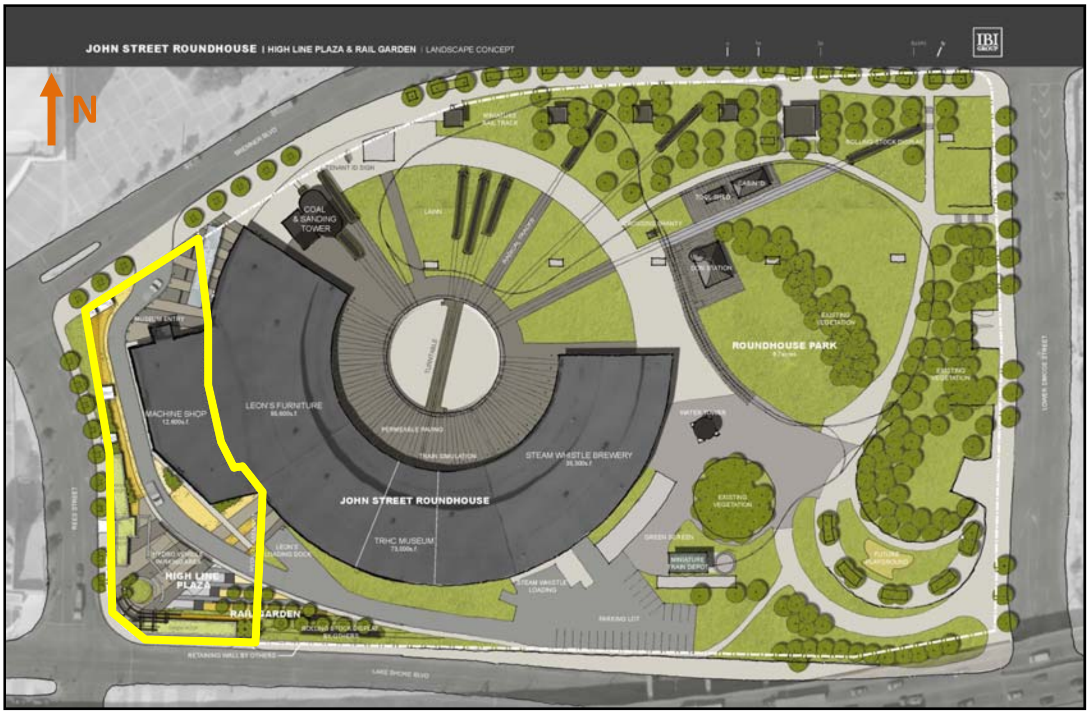


Figure A1: Plan Layout of Roundhouse Park, including Bremner TS site (highlighted in yellow)

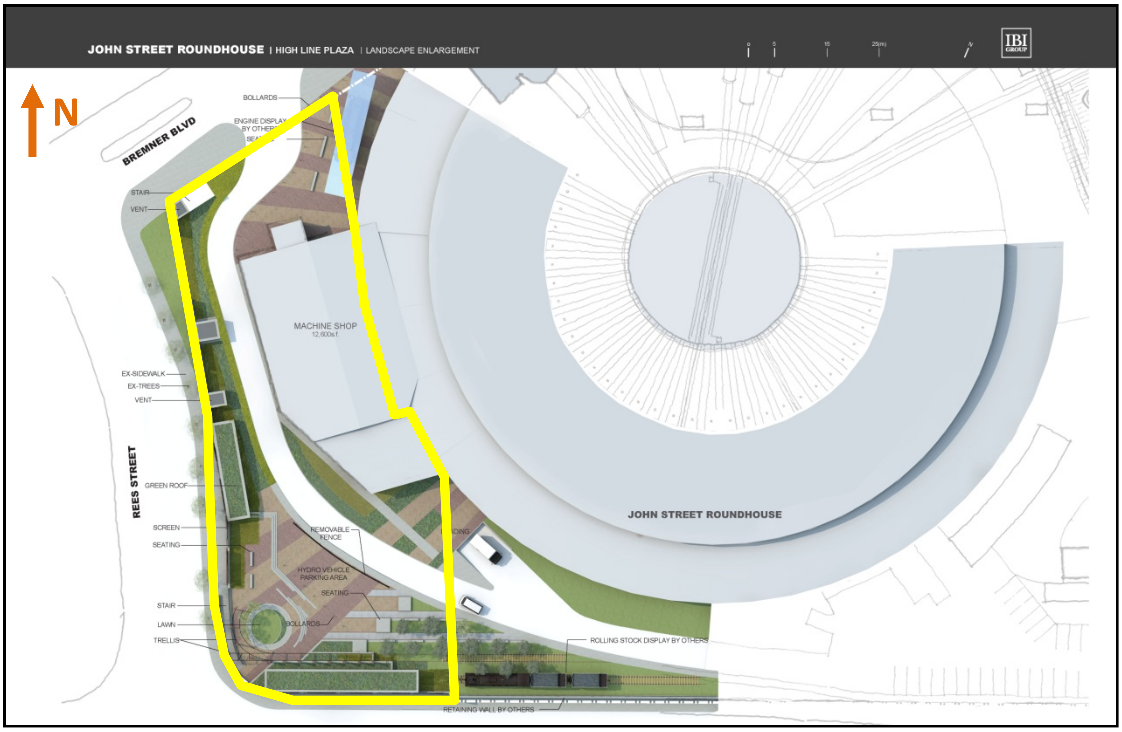


Figure A2: Plan Layout of Bremner TS Site (highlighted in yellow)

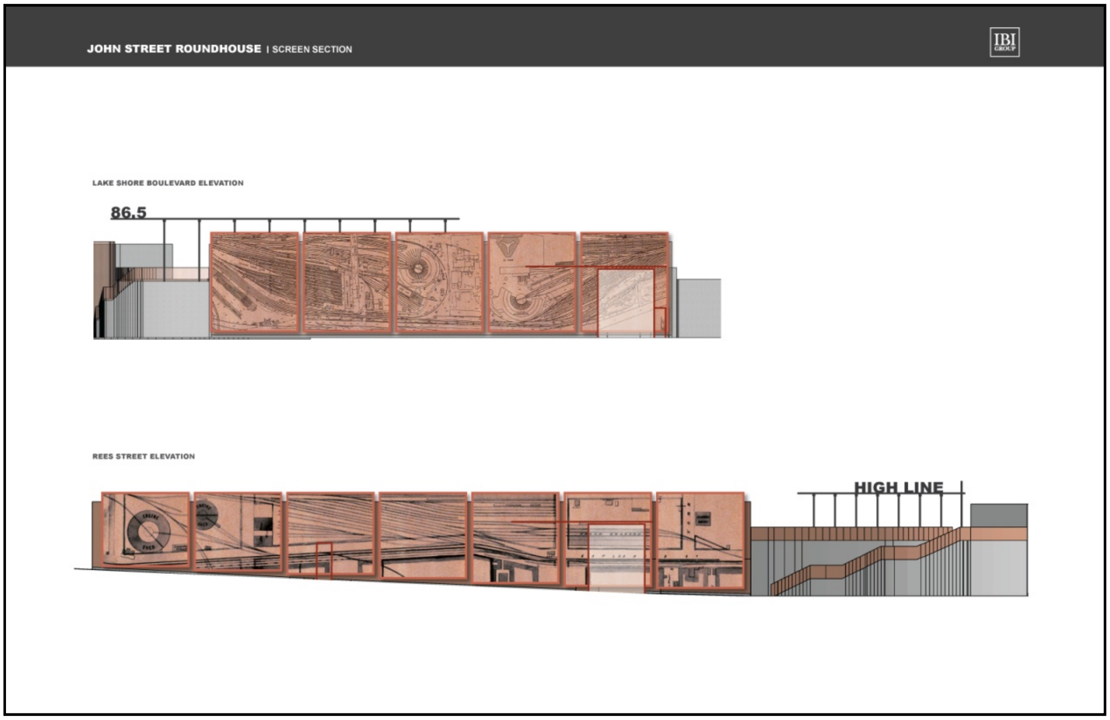


Figure A3: Elevation Layout of Bremner TS Site; View from Lakeshore Blvd (top) and Rees St (bottom)

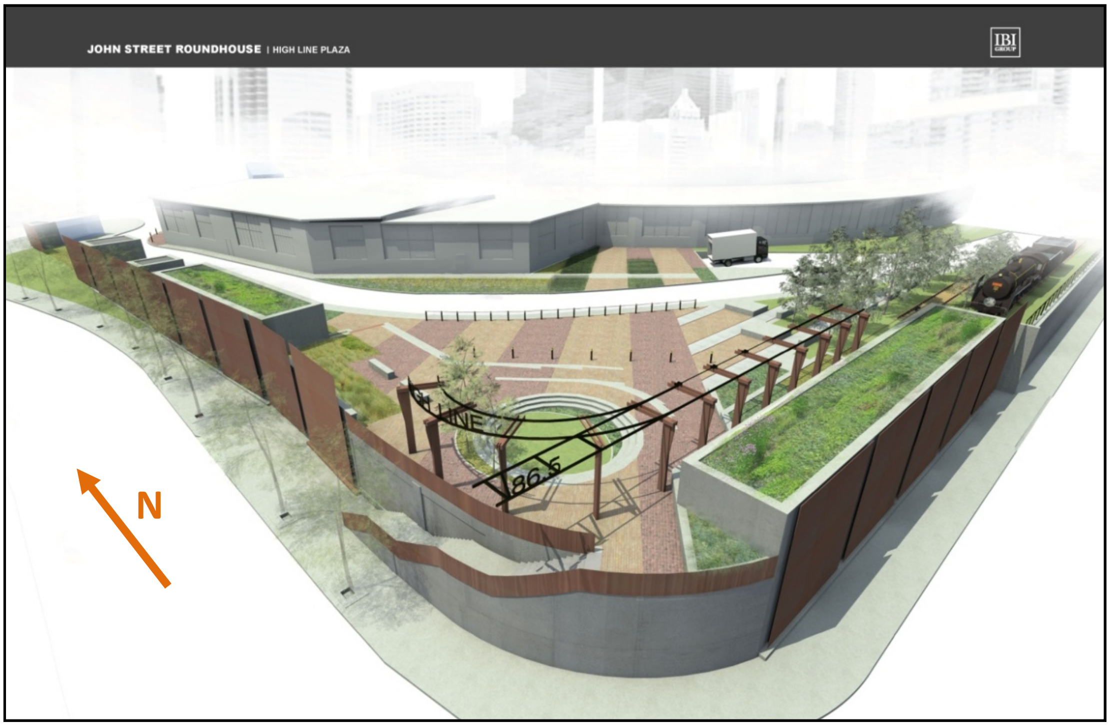


Figure A4: View of Bremner TS from Corner of Rees St. and Lakeshore Blvd (looking North East)

Figure A5: View of Bremner TS from Rees St (looking East)

Appendix 8

Ministry of Environment decision for

Bremner TS Environmental Assessment

Summary:

In order to proceed with the proposed construction of Bremner TS, THESL is required to obtain approval of a Class Environmental Assessment for Minor Transmission Facilities.

THESL developed a stakeholder engagement plan, finalized in early 2011, as part of the Class Environmental Assessment. The plan engaged First Nations, Federal Government Agencies, Ontario Government Agencies, Conservation Authorities, Local Business Stakeholders, Toronto City Council and City agencies. Public information centres, regular stakeholder meetings and meetings with city representatives were held. THESL has also created a dedicated website for the project:

http://www.torontohydro.com/sites/electricsystem/powerup/Pages/BremnerStationProject.aspx

Heritage Accommodation:

A Heritage Impact Assessment was conducted to ensure that the heritage structure (Machine Shop) adjacent to the Roundhouse will be preserved in order to uphold its culture and heritage value.

Ministry of Environment (MOE)'s Decision:

The MOE decided that an individual environmental assessment is not required for new Bremner TS, and authorized THESL to proceed with the project.

Ministry of the Environment

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Ontario

TORONTO HYDRO CORPORATION

APR 1 2 2012

ANTHONY M. HAINES
PRESIDENT & CEO

APR 0 4 2012

ENV1283MC-2011-2884

Mr. Anthony Haines, President & CEO
Toronto Hydro Corporation
14 Carlton Street
Toronto ON M5B 1K5

Dear Mr. Haines:

On August 31, 2011, I received one Part II Order request, asking that the Toronto Hydro-Electric System Limited be required to prepare an individual environmental assessment for the proposed Bremner Transformer Station and Machine Shop (Project).

I am taking this opportunity to inform you that I have decided that an individual environmental assessment is not required. This decision was made after giving careful consideration to the issues raised in the request, the Project documentation, the provisions of the Class Environmental Assessment for Minor Transmission Facilities (Class Environmental Assessment), and other relevant matters required to be considered under subsection 16(4) of the Environmental Assessment Act. The reasons for my decision may be found in the attached letter to the requester.

Despite my not requiring an individual environmental assessment be prepared, to ensure that all interested parties are kept apprised of updated Project information, I am imposing the following condition on the Project:

1. Toronto Hydro-Electric System Limited shall send the Environmental Study Report (August 2011) and the revised Heritage Impact Assessment Report (November 2011) to all parties identified as having a potential interest in or that may be affected by the Project for their information.

With this decision having been made, Toronto Hydro-Electric System Limited may now proceed with the Project, subject to any other permits or approvals required. Toronto Hydro-Electric System Limited must implement the Project in the manner it was developed and designed, inclusive of all mitigating measures proposed by the City of Toronto's Plan Review Manager and Building Engineer on October 6, 2011, and environmental and other provisions therein. In accordance with the Class Environmental Assessment, any commitments made to affected agencies or members of the public must be fulfilled and implemented as part of the proposed Project. It is my understanding that Toronto Hydro-Electric System Limited is working with the City of Toronto Heritage Preservation Services in order to ensure that the historic environment of the Machine Shop is maintained in order to obtain Site Plan Approval from the City of Toronto Planning Division prior to construction.

Lastly, I would like to ensure that Toronto Hydro-Electric System Limited understands that failure to comply with the Act, the provisions of the Class Environmental Assessment, and failure to implement the Project in the manner described in the planning documents, are contraventions of the Act and may result in prosecution under section 38 of the Act. I am confident that Toronto Hydro-Electric System Limited recognizes the importance and value of the Act and will ensure that its requirements and those of the Class Environmental Assessment are satisfied.

Yours sincerely,

Jim Bradley
Minister

Attachment

c: Mr. Andreas Houlios, Environmental Planner, IBI Group
EA File No. EA02-06 Bremner Transformer Station and Machine Shop
Requester

ICM Business Case Evaluation

HONI Capital Contributions

Toronto Hydro-Electric System Limited (THESL)

ICM Project | HONI Capital Contributions

I EXECUTIVE SUMMARY

THESL is required to provide capital contributions to Hydro One Network Inc. (HONI) for non-contestable work on the transmission system to install new transmission assets or replace existing ones to support THESL work on the distribution system. The main driver for THESL work is the need to increase supply capacity to connect new customers and to meet current and future load growth.

A total capital contribution of $113.40 million is required for 2012-2014, consisting of $25.28 million in 2012, $52.12 million in 2013, and $36.00 million in 2014. Detailed work descriptions appear in Section III of this document.

There are two major jobs with large capital contribution required over the next three years. The first is the Bremner TS job with an estimated capital contribution requirement of $60 million. The second is the Leaside-Birch transmission reinforcement job with an estimated capital contribution requirement of $32.88 million. The third segment of estimated capital contributions totalling $18.55 million is required to support THESL switchgear replacements at four transformer stations. The last segment of capital contribution totalling an estimated $1.97 million is required for HONI to perform engineering feasibility studies to expand capacity at six transformer stations.

The urgent need for these capital contributions, the prudence, the costs, and the details of these jobs are described below.

1. Project Description

1.1. Overview

HONI connection work on the transmission system is necessary to allow electricity to flow from the HONI transmission system to THESL's distribution system to provide power service to customers. This work will provide improved supply reliability for Toronto and is essential for providing increased system capacity. In particular, capacity is needed in the densely loaded financial core district of Toronto. Each capital contribution cost is examined and agreed between THESL and HONI through a Connection and Cost Recovery Agreement.

Capital Contributions to Hydro One (HONI) are necessary investments for HONI to install equipment on the transmission system to support THESL projects on the distribution system. HONI is the only supplier permitted to perform non-contestable work on transmission system assets to address THESL capacity issues. The capital contributions to HONI in 2012-2014 are summarized in Table 1 below:

Table 1: Summary of Capital Contribution to HONI in 2012-2014

Project Title	2012 Estimated Cost ($, millions)	2013 Estimated Cost ($, millions)	2014 Estimated Cost ($, millions)
Bremner TS Capital Contribution	$6.00	$27.00	$27.00
Leaside-Birch Transmission Reinforcement	$17.60	$15.28	-
Wiltshire TS switchgear replacements and engineering studies	$0.07	$3.17	$3.00
Strachan TS switchgear replacements and engineering studies	$0.07	$3.07	$3.00
Windsor TS switchgear replacement and engineering Study	-	$0.10	$3.00
Duplex TS A5-6 switchgear replacement and engineering study	$0.07	$3.00	-
Malvern TS 2 new CBs and engineering study	$1.30	-	-
Leslie MS switchgear replacement and engineering Study	$0.18	-	-

Project Title	2012 Estimated Cost ($, millions)	2013 Estimated Cost ($, millions)	2014 Estimated Cost ($, millions)
Horner TS second bus expansion engineering study	-	$0.15	-
Runnymede TS second bus expansion engineering study	-	$0.15	-
Bridgman TS transformer upgrade engineering study	-	$0.10	-
Esplanade TS second bus expansion engineering study	-	$0.10	-
Capital Contribution by year:	**$25.28**	**$52.12**	**$36.00**
Total Capital Contributions to HONI:	**$113.40**		

Cost estimates have been based upon agreed studies or the cost of previous similar work adjusted for changes in scope of work.

1.2. Segment Description

1.2.1. Bremner TS Supply

There are immediate, short-term, and mid-term needs for additional capacity in the downtown Toronto core. THESL has investigated a number of possibilities to address this need, such as bus-to-bus load transfer and additional buses at existing Windsor TS, expansion of adjacent transformer stations (Esplanade TS and Strachan TS), or construction of a new transformer station (Bremner TS). Of these possible options, the expansion of adjacent transformer stations (Esplanade TS and Strachan TS) and construction of the Bremner TS were identified as the most practical solutions to meet the identified need. Detailed economic comparisons of these alternatives were conducted and are outlined in the ICM Project for Bremer TS. The evidence presented in that document shows that having Bremner TS in service by 2014 is the preferred approach to address the supply needs for the downtown core.

An estimated total capital contribution to HONI of $60 million is required over 2012-2014, consisting of $6 million for 2012, $27 million for 2013, and $27 million for 2014.

1.2.2. Leaside-Birch

Additional transmission line capacity is required from Leaside TS to Bridgman TS to meet load growth for the Toronto Midtown area. The work was proposed in previous HONI rate filings and received regulatory approval in June 2010. Construction started in 2011 and will be continued in 2012 with completion scheduled for 2014. An estimated total capital contribution of $32.88 million is required, consisting of $17.60 million in 2012 and $15.28 million in 2013.

1.2.3. Wiltshire, Strachan, Windsor, Duplex TS Switchgear Replacements

Replacements of incoming circuit breakers and engineering studies by HONI are required to improve safety and reliability, and to meet current and future load growth. An estimated capital contribution in total of $18.55 million is required over 2012-2014, consisting of $210K in 2012, $9.34 million in 2013, and $9 million in 2014.

1.2.4. Malvern, Leslie, Horner, Runnymede, Bridgman and Esplanade TSs

Capital contributions are required for HONI to perform engineering feasibility studies to expand station capacity to meet load growth. A total capital contribution of estimate of $1.97 million is required, consisting of $1.47 million in 2012 and $500K in 2013.

2. Why These Project Are Needed Now

The projects are needed now to install additional capacity on transmission system to meet the load growth on the THESL distribution system.

2.1. Bremner TS job

The distribution system requires additional capacity to meet load growth in downtown financial district, the new loads from waterfront developments, and to allow replacements of heavily loaded switchgear at Windsor TS. The Bremner TS project is described at Tab 4, Schedule B17.

2.2. Leaside-Birch job

The current load of the Midtown area exceeds transmission line capacity during the summer peaks under the first contingency. To avoid rotating outages to customers during summer peak load, an additional 115kV circuit is required now. This project has already been approved by the Board and THESL's capital contribution is required in accordance with the Transmission System Code.

2.3. Wiltshire, Strachan, Windsor, and Duplex TS

Replacements of HONI incoming circuit breakers are required now in tandem with THESL replacements of switchgear. THESL's switchgear replacement projects are described at Tab 4, Schedule B13.2.

2.4. Malvern, Leslie, Horner, Runnymede, Bridgman and Esplanade TS

Engineering feasibility studies are required now from HONI to expand station capacity to meet load growth on the THESL distribution system. Due to the long lead times needed for station expansion and installation of new busses, the engineering feasibility studies are required now to provide enough time to carry out the projects in time to meet the needs.

3. Why the Proposed Project Is the Preferred Alternative

3.1. Bremner TS job

See separate ICM Business Case Evaluation for Bremner TS at Tab 4, Schedule B17. Bremner TS is an important enabling job for other area stations.

3.2. Leaside-Birch job

This transmission project has already been approved by the Board and the capital contribution follows from that approval.

3.3. Wiltshire, Strachan, Windsor, Duplex TS Replacements

The alternative option is operating the existing equipment on a "run to fail" basis. However, the outage impacts of that option on customers is intolerable because emergency repair of the equipment would likely take a week and replacement of the equipment would likely take 24 months. In addition, the cost of replacement under emergency conditions after the equipment has failed is much higher than under planned replacement conditions.

3.4. Malvern, Leslie, Horner, Runnymede, Bridgman and Esplanade TS

The alternative option is to transfer load to adjacent stations before connecting new customers until there is no available capacity at adjacent stations. However, since load has nearly reached the maximum capacity at several stations, this alternative option is not feasible due to lack of available capacity at adjacent stations such as Horner TS, Runnymede TS, Bridgman TS, and Esplanade TS.

II SEGMENT DESCRIPTIONS

1. Bremner TS Capital Contribution to HONI

1.1. Why is this project needed now?

The need for the Bremner TS reinforcement is fully detailed in the evidence for Bremner TS.

The construction of a new station at Bremner would require new 115kV lines to interconnect to the existing transmission system. The first stage of the proposed interconnection is illustrated in Figure 1Figure 1. Figure 1 Figure 2 presents the electric single-line diagram of the 115kV interconnection between the John and Hearn stations. Notably, the proposed 115kV cable tie between John and Esplanade is located 600 meters from Bremner TS. Discussions with HONI confirm that the Bremner station can be fed by tapping directly into the proposed John-Esplanade line, and then routing two new 230kV cables operated at 115kV into the new station. As noted, the existing tunnel and duct bank has a break out tap designed to accommodate a tap line to a new station.

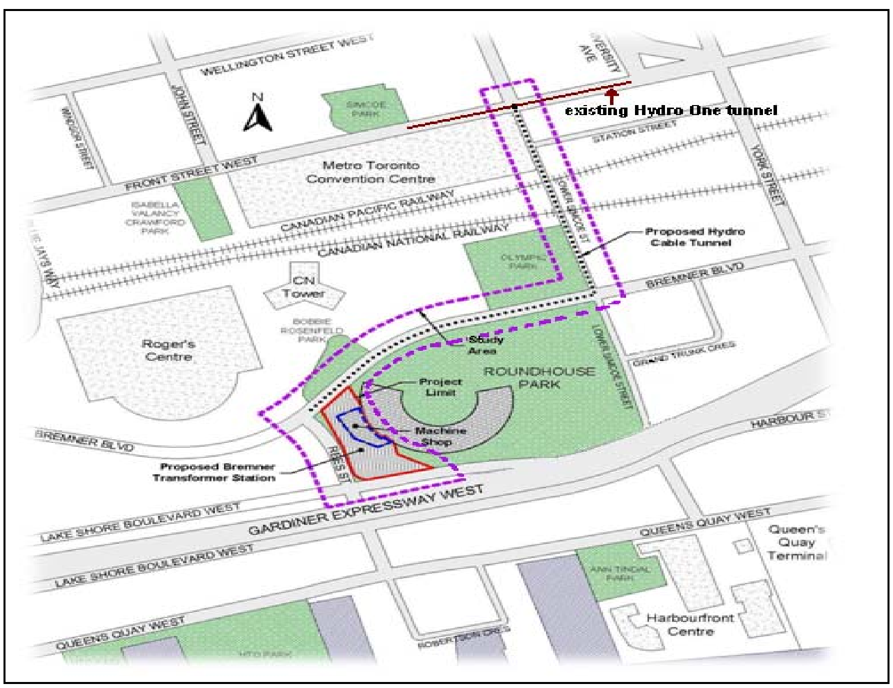

Figure 1: Transmission Interconnection Area

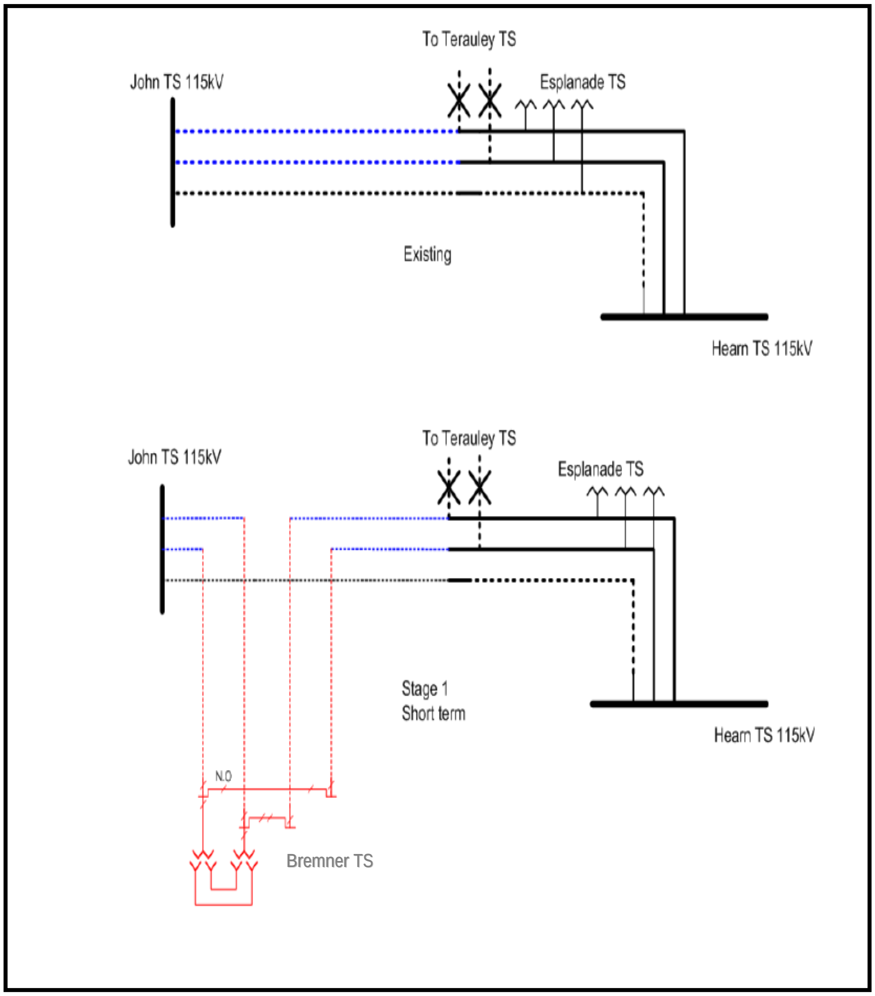

Figure 2: Bremner TS Interconnection: Single-Line Diagram

Since connection work from HONI transmission lines is necessary to supply power to THESL equipment at Bremner TS, and this connection work is non-contestable, the only available option is for HONI to carry out the work on transmission assets, and for THESL to pay the corresponding capital contribution to HONI. HONI has informed THESL that an estimated capital contribution of approximately $60 million is required, which consists of $6 million in 2012, $27 million in 2013, and $27 million in 2014.

If funding for THESL's capital contribution is not available, THESL expects that the work on connection from HONI transmission line to the Bremner TS would not be completed by HONI, creating a potential stranded investment at Bremner TS.

2. Leaside-Birch Transmission Reinforcement Capital Contribution to HONI

2.1. Why is this needed now?

On June 17, 2010 the Board approved HONI's proposal to construct and/or renew approximately 5.3 kilometres of overhead and underground transmission line facilities in the City of Toronto together with the associated transformation and connecting assets described in its application, and granted HONI leave to construct the facilities.

The Board's conclusion, expressed at page 14 of its Decision and Order was that, "in consideration of the effect of the project on prices, and the safety, quality and reliability of the transmission of electricity in the province, the project is in the public interest".

HONI was required as part of its leave-to-construct application to demonstrate to the Board the need for the work. The following is an excerpt of the Board's Decision and Order on need.

> "The Applicant states that the project is needed for the following reasons:
>
> First, to replace an aging underground cable section of the 115 kV L14 W circuit between Bayview Junction and Birch Junction. The application indicates that the cable referred to is an oil filled cable which was installed some 55 years ago, and is one of the oldest cables in Hydro One's transmission fleet. It was damaged by a contractor in 2002 and was tested at that time. This testing revealed that there was significant deterioration of the cable jacket and that the cable had aged significantly. Testing also found that the overburden was providing poor heat dissipation, increasing the possibility that the cable could overheat and fail particularly under heavy load. This would make the entire

area load vulnerable during outage conditions if another circuit fault occurred. Hydro One has concluded that this cable is at the end of its useful life.

Second, the application is intended to address overloading of the transmission facilities under single contingency conditions and to provide for future load growth. The condition of the L14 W cable raises the prospect that with a single outage of one line and a single contingency on another, the area could be subject to blackout. As the load in the area increases, this scenario becomes more likely.

Third, the application is designed to enable the electrical supply for the midtown area to maintain the existing level of reliability. In response to Board staff interrogatory No. 13, the Applicant identifies an end of life condition associated with the overhead section of the line between Leaside and Bayview junction, in addition to the end-of-life condition of the cable referred to above.

Fourth, the application is designed to meet long-term load growth. Hydro One suggests that the increasing load would result in early tripping of the remaining supply in the standard outage and contingency scenario. This last rationale attracted considerable attention through the interrogatory process. It is well-known that very recent economic conditions have resulted in an erosion of load generally. The load forecasts associated with this application suggest that there was no load growth from 2009 to 2010 and that thereafter a 1% per annum growth is assumed. The 1% load growth is described as an historical rate which has proven to be reliable over many years.

Hydro One also notes, in response to Board staff interrogatory No. 2, that in the past five years there have been twelve occasions when there has been a forced outage during a period when a companion circuit was out of service. These conditions occurred outside of peak load period. If they had occurred during peak load period there would have been a black-out condition for the area

> and/or a requirement to reduce the load to prevent blackout. The Board is satisfied that Table 1 at Exhibit B, Tab 1, Schedule 4, page 5 demonstrates that under existing peak load conditions there would be an excess flow over the existing facility. This condition will only deteriorate with the reasonably anticipated increases in total load over time.
>
> The Applicant also did some analysis respecting the effect of conservation and demand management activities. It is clear from that analysis, which was not challenged in the course of this proceeding by any party, that the projected amount of reduced load brought about by conservation and demand management programs will not be sufficient to mitigate the risks to reliability of service identified by the company if the project were not to proceed.
>
> Accordingly, for the reasons outlined here, the Board concludes that the company has demonstrated that the reinforcement proposed by the Applicant is in the public interest."

The need for this project has also been detailed in Hydro One Transmission's 2007 rates filing, EB-2006-0501, in which the company requested that the OEB to approve the need for the Leaside TS x Birch Junction Transmission Reinforcement Project (currently re-named the "Midtown Project"). The Board in its subsequent decision, dated 16 August 2007, accepted Hydro One's need for the project and stated:

> "The Board finds that the need to relieve loading on the existing lines between Leaside TS and Birch Junction TS has been demonstrated." (page 45).

The existing facilities between Leaside TS and Wiltshire TS consist of three 115 kV circuits L13W, L14W and L15W as shown in Figure 3 below. These circuits supply Bridgman TS and Dufferin TS from Leaside TS and also provide load transfer capability between the Leaside TS and Manby TS.

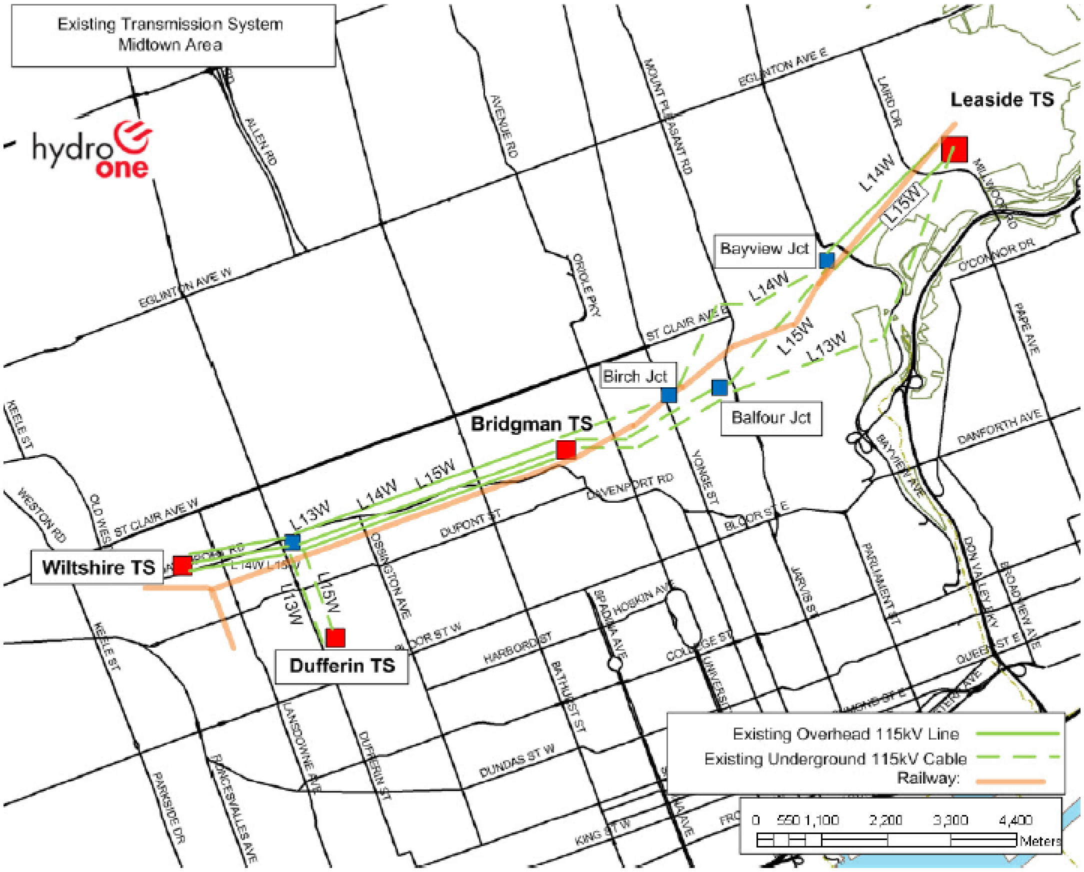

Figure 3: Leaside-Birch Transmission Reinforcement Project location

The Leaside-Bridgman transmission lines supply the service area of the Bridgman TS and Dufferin TS as shown in Figure 4 below.

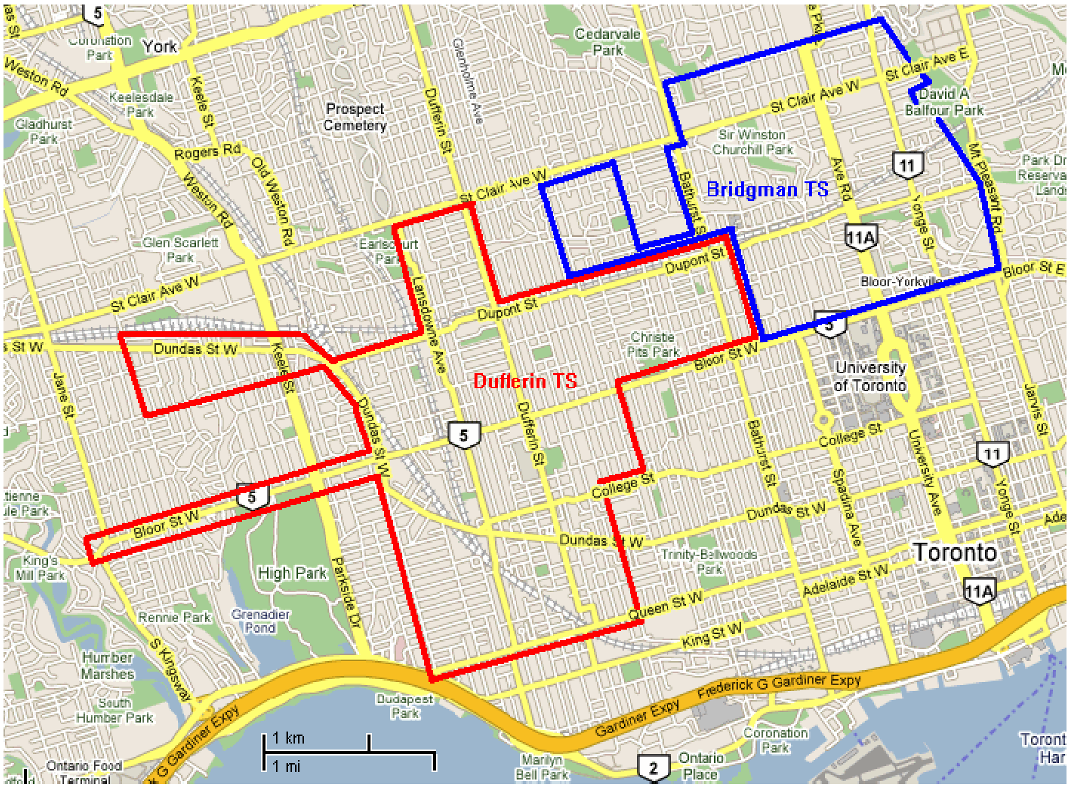

Figure 4: Service Area of the Bridgman TS and Dufferin TS

In this ICM filing, THESL is seeking funding for a capital contribution in total of an estimated $32.88 million, which consists of $17.6 million in 2012 and $15.28 million in 2013. This amount is consistent with the January 2011 CCRA and will be made to fulfill an existing obligation to make a capital contribution to HONI for the Leaside-Birch transmission upgrade work.

The work is already underway and HONI continues to proceed with construction based on the executed CCRA agreement. Construction of this project was delayed by approximately one year, due to delays in getting City approval, causing setbacks in construction work. HONI has informed THESL that additional capital contributions may be required and the increase is expected to be in the range of 10 percent to 15 percent for the whole project. HONI has not informed THESL of the exact amount of increase but this could impact 2013 project costs, consistent with the existing CCRA agreement.

3. TS Switchgear Replacements and Engineering Studies

3.1. Wiltshire TS Switchgear Replacements and HONI Capital Contributions

The main drivers for Wiltshire TS A3-4 and A5-6 switchgear replacements are safety (existing switchgear is non-arc-resistant), aging, high maintenance, increased capacity for future load growth, and mitigation of the risk of significant customer outages. The loads on Wiltshire TS A3-4 and A5-6 switchgear in 2012 are 20MVA and 22MVA respectively. An estimate for a major outage duration is between eight hours to 168 hours (one week) to repair and put switchgear back in service. The need to replace Wiltshire A3-4 and A5-6 switchgear is described separately in the evidence for TS Switchgear.

Since the incoming circuit breakers connected to the A3-4 and A5-6 switchgears and HONI transformers connected to A11-12 at Wiltshire TS are owned by HONI, there is no option for work to be performed by companies other than HONI. The work to be performed by HONI at Wiltshire TS is non-contestable according to the Transmission System Code and HONI is the only supplier.

To initiate the Wiltshire TS A3-4 and A5-6 switchgear replacements THESL is required to fund HONI engineering studies to determine project feasibility, and to provide the estimated amount of the required capital contribution for HONI to replace the incoming circuit breakers connected to the existing A3-4 and A5-6 switchgear and to upgrade HONI transformers connected to A11-12 at Wiltshire TS. This transformer upgrade is required to increase capacity and to provide 4-wire system configuration to the A11-12 bus for conversion of 4 kV system. The estimated costs of capital contribution to HONI for Wiltshire TS are as shown below:

Table 3: Capital Contribution for Wiltshire TS

Job Description	Capital Contribution Estimate ($, millions)	Year
Wiltshire TS, A3-4 switchgear replacement engineering study	$0.07	2012
Wiltshire TS, A5-6 switchgear replacement engineering study	$0.07	2013
Wiltshire TS, transformers upgrade for A1-2 bus engineering study	0.10	2013
Wiltshire TS, A3-4 replace incoming circuit breakers capital contribution	$3.00	2013
Wiltshire TS, A5-6 replace incoming circuit breakers capital contribution	$3.00	2014
Total:	**$6.24**	

If funding for THESL's capital contributions is not available, THESL expects that HONI will not carry out the engineering study needed to determine project feasibility and the required capital contribution for HONI to replace HONI's incoming circuit breakers and upgrade HONI's transformers. This could result in delay or possible cancellation of THESL A3-4 and A5-6 switchgear replacements. THESL has already invested $95,000 in the planning and design of Wiltshire TS A3-4 switchgear.

The ultimate system impact will likely be increased risks of outages as THESL continues to rely on the non-arc resistant A3-4 and A5-6 switchgear at Wiltshire TS, and new capacity of 4-wire configuration is not available if HONI transformers are not upgraded, preventing THESL from proceeding with conversion of 4kV bus load to 13.8kV system at Wiltshire TS. This increased risk is expected to impact approximately 17,000 customers connected to Wiltshire TS, currently relying in whole or in part on the A3-4 and A5-6 switchgear for electricity distribution service.

3.2. Strachan TS Switchgear Replacement and HONI Capital Contributions

The main drivers for Strachan TS A7-8 and A5-6 switchgear replacements are safety (existing switchgear is non-arc-resistant), aging, high maintenance, increase capacity for future load growth, and mitigation of the risk of significant customer outages. The loads on Strachan TS A7-8 and A5-6 switchgears in 2012 are 37 MVA and 31 MVA respectively. An estimate for a major outage duration is between eight hours to 168 hours (one week) to repair and put switchgear back in service. The need to replace Strachan TS switchgears is described in the evidence for TS Switchgear.

Since the incoming circuit breakers connected to the A7-8 and A5-6 switchgears at Strachan TS are owned by HONI, there is no option for work to be performed by companies other than HONI. The work to be performed by HONI at Strachan TS is non-contestable according to Transmission System Code and HONI is the only supplier.

To initiate the Strachan TS A7-8 and A5-6 switchgear replacements THESL is required to fund HONI engineering studies to determine project feasibility and to provide the estimated required capital contribution for HONI to replace the incoming circuit breakers connected to the existing A7-8 and A5-6 switchgears at Strachan TS. The estimated costs of capital contribution to HONI for Strachan TS are as shown below.

Table 4: Capital Contribution for Strachan TS

Job Description	Capital Contribution Estimate ($, millions)	Year
Strachan TS, A7-8 switchgear replacement engineering study	$0.07	2012
Strachan TS, A5-6 switchgear replacement engineering study	$0.07	2013
Strachan TS, A7-8 replace incoming circuit breakers capital contribution	$3.00	2013
Strachan TS, A5-6 replace incoming circuit breakers capital contribution	$3.00	2014
Total:	**$6.14**	

If funding for THESL's capital contribution is not available, THESL expects that HONI will not carry out engineering study to determine project feasibility and the required capital contribution for HONI to replace HONI's incoming circuit breakers at Strachan TS. This could result in delay or possible cancellation of THESL A7-8 and A5-6 switchgear replacements.

If the HONI capital contributions were denied, the likely ultimate system impact will be increased risks of outages as THESL continues to rely on the non-arc resistant A7-8 and A5-6 switchgear at Strachan TS. This increased risk would impact approximately 15,600 customers currently relying in whole or in part on the A7-8 and A5-6 switchgear at the Strachan TS for electricity distribution service.

3.3. Windsor TS Switchgear Replacement and HONI Capital Contributions

The main drivers for Windsor TS A5-6 switchgear replacement are safety (existing switchgear is non-arc-resistant), aging, obsolescence (brick structure enclosure), high maintenance (for the air blast system), increased capacity for future load growth, and mitigation of the risk of significant customer outages serving the financial district. The load on Windsor TS A5-6 switchgear in 2012 is 55 MVA. An estimate for a major outage duration is between eight hours to 168 hours (one week) to repair and put switchgear back in service. The need to replace Windsor TS switchgear is described in the evidence for TS Switchgear.

Since the incoming circuit breakers connected to the A7-8 and A5-6 switchgear at Strachan TS are owned by HONI, there is no option for work to be performed by companies other than HONI. The work to be performed by HONI at Windsor TS is non-contestable according to Transmission System Code and HONI is the only supplier.

To initiate the Windsor A5-6 switchgear replacement, THESL is required to fund a HONI engineering study to determine project feasibility, and to provide the estimated required capital contribution for HONI to replace the incoming circuit breakers connected to the existing A5-6 switchgear at Windsor TS. The estimated costs of capital contribution to HONI for Windsor TS are as shown below:

Table 5: Capital Contribution for Windsor TS

Job Description	Capital Contribution Estimate ($, millions)	Year
Windsor TS, A5-6 switchgear replacement engineering study	$0.10	2013
Windsor TS, A5-6 replace incoming circuit breakers capital contribution	$3.00	2014
Total:	**$3.10**	

If funding for THESL's capital contribution is not available, THESL expects that HONI will not carry out the engineering study to determine project feasibility and THESL's required capital contribution to replace HONI's incoming circuit breakers at Windsor TS. As a consequence, the immediate impact is expected to be a delay or possible cancellation of switchgear replacement. The ultimate likely system impact will be increased risks of outages as THESL continues to rely on the non-arc-resistant and aging A5-6 switchgear at Windsor TS. This increased risk would impact approximately 3,500 customers in the financial district currently relying in whole or in part on the A5-6 switchgear at the Windsor TS for electricity distribution service.

3.4. Duplex TS Switchgear Replacement and HONI Capital Contributions

The main driver for Duplex TS A5-6 switchgear replacement is to mitigate the risk of significant customer outages (42 MVA load with estimate outage duration of eight hours to 168 hours (one week) to repair and put switchgear back in service). The job is to replace the existing air switchgear with Gas Insulated Switchgear (GIS) switchgear to prevent a water flooding problem, since the existing switchgear is located in the basement with risk of water flooding. HONI has a deluge system on main floor that could create a risk of flooding in the basement where THESL switchgear is located.

The need to replace Duplex TS switchgear is described in the evidence for TS Switchgear.

To initiate the Duplex A5-6 switchgear replacement, THESL is required to fund a HONI engineering study to determine project feasibility and to provide the estimated capital contribution required for HONI to replace the incoming circuit breakers connected to the existing A5-6 switchgear at Duplex TS. The estimated costs of capital contribution to HONI for Duplex TS are as shown below.

Table 6: Capital Contribution for Duplex TS

Job Description	Capital Contribution Estimate ($, millions)	Year
Duplex TS, A5-6 switchgear replacement engineering study	$0.07	2012
Duplex TS, A5-6 replace incoming circuit breakers capital contribution	$3.00	2013
Total:	**$3.07**	

If funding for THESL's capital contribution is not available, THESL expects that HONI will not carry out the engineering study to determine project feasibility and the capital contribution required for HONI to replace its incoming circuit breakers at Duplex TS. As a consequence, the likely impact is delay or possible cancellation of THESL A5-6 switchgear replacement at Duplex TS. The ultimate likely impact will be increased risks of outage as THESL continues to rely on the existing A5-6 switchgear at Duplex TS where risks of water flooding in the basement exist due to the potential malfunction of the deluge system on the main floor.

Since the incoming circuit breakers connected to the A5-6 switchgear at Duplex TS are owned by HONI, there is no alternative option for work to be performed by companies other than HONI. The work to be performed by HONI at Duplex TS is non-contestable according to Transmission System Code and HONI is the only supplier.

4. Other HONI Capital Contributions

4.1. Malvern TS 2 New Circuit Breakers and HONI Capital Contribution

Existing feeders NT47M3 at Sheppard West TS are heavily loaded (18MVA) and have experienced a high number of outages, with the 12-month rolling average of 14 interruptions from February 2007 to December 2011. The feeder is direct-buried cable and was installed from 1974 to 1978 (34 to 38 years old), with the long feeder length creating a voltage drop issue.

The purpose of this job is to provide two additional circuit breakers at Malvern TS in 2012 to allow THESL install two additional 27.6kV feeders to supply new customer load and to provide additional capacity to relieve the existing heavily loaded feeder NT47M3 at the adjacent Sheppard West TS. The work is required now to reduce the outage impact of NT47M3 on system reliability (with an 18MVA load, a 12-month rolling average of 14 interruptions from February 2007 to December 2011, with an average outage duration of 5.5 hours, affecting 6,430 customers) and to provide approximately 32 MVA additional capacity to connect new customers. Without the new circuit breakers and feeders, connection of new customers will be at higher cost due the need to run long cables from Sheppard TS to provide service to customers closer to Malvern TS, because Malvern TS feeders are already heavily loaded. The average load on Malvern TS feeders is 17.4 MVA which is above the designed load level of 16 MVA for 27.6kV feeders.

Since the circuit breakers connected to Malvern TS bus are owned by HONI, there is no alternative option but to have the work performed by HONI. The work to be performed by HONI at Malvern TS is non-contestable according to Transmission System Code and HONI is the only supplier.

To complete this work, THESL was required to fund a HONI engineering study to provide the required capital contribution for HONI to install two new 27.6kV circuit breakers at Malvern TS. THESL has signed an agreement worth $20,000 for HONI to carry out engineering study to estimate the capital contribution required from THESL. HONI informed THESL that a capital contribution of $1.28 million is required for HONI to install two new 27.6 kV circuit breakers at Malvern TS.

The required capital contributions to HONI for Malvern TS are as shown below.

Table 7: Capital Contribution for Malvern TS

Job Description	Capital Contribution Estimate ($, millions)	Year
Malvern TS two new circuit breakers engineering study	$0.02	2012
Malvern TS two new circuit breakers required capital contribution	$1.28	2012
Total:	**$1.30**	

If funding is not available for capital contribution to HONI to install two new circuit breakers at Malvern TS, THESL is expected to need to run a longer feeder from Sheppard TS to provide service to new customers located closer to the Malvern TS, and this option will increase the cost for connection of new customers. The Sheppard West TS is approximately 5.4Km away from Malvern TS. An initial estimate of additional cost to supply a 10 MVA customer (who is located closer to Malvern TS) from Sheppard West TS instead of Malvern TS is between $2 to $3 million. Due to the long cable distance, voltage drop may also be an issue. This option was not proposed because it will cost more than the preferred option of installing two new circuit breakers at Malvern TS.

The most economical option to address long term load growth is by providing additional capacity at Malvern TS by installation of two new circuit breakers.

4.2. Leslie MS Switchgear Replacement and HONI Capital Contribution

The main driver for Leslie MS switchgear replacement is the deteriorated conditions of the switchgear and its housing.

The need for Leslie MS switchgear replacement is described in the evidence for MS Switchgear.

Leslie MS is an isolated 13.8KV distribution system surrounded by 27.6kV distribution system. If a major failure occurred on Leslie switchgear, over 6,000 customers could experience a lengthy outage (estimate of eight hours to one week) since there is no other 13.8kV municipal substation that can provide backup supply for the Leslie MS.

Without HONI engineering and design support, THESL cannot proceed with the switchgear replacement at Leslie MS. The likely impact of not being able to replace the switchgear at Leslie MS is an increasing risk of a lengthy outage as the switchgear continues to age and deteriorate.

Since THESL switchgear is located within the property owned by HONI at Leslie MS and HONI work is non-contestable, there is no alternative option but for HONI to perform the engineering and design work and for THESL to pay the resulting capital contribution.

THESL is required to fund a HONI engineering study to provide engineering and design support for THESL to replace the existing switchgear at Leslie MS. HONI informed THESL that an estimated cost of $25,000 is required to carry out engineering study.

The estimate of capital contributions to HONI for Leslie MS is as shown below:

Table 8: Capital Contribution for Leslie MS

Job Description	Capital Contribution Estimate ($, millions)	Year
Leslie MS switchgear replacement engineering study	$0.03	2012
Leslie MS switchgear replacement estimate capital contribution	$0.15	2012
Total:	**$0.18**	

THESL has signed an agreement for HONI to carry out an engineering study to provide the capital contribution required from THESL. THESL is waiting for the estimated cost from HONI on the required capital contribution to support THESL switchgear replacement. THESL estimates a capital contribution of $150,000 is required for HONI work.

4.3. Horner TS Second Bus Expansion HONI Engineering Study

The main driver for a HONI engineering study to determine the cost and feasibility of installation of a second bus at Horner TS is to provide additional capacity to relieve load at Manby TS and provide capacity for future load growth at Horner TS.

Load at the adjacent Manby TS is forecasted to remain at 95% capacity in 2012. To relieve the load level at Manby TS in short term, a project has been underway for HONI to install additional capacity by adding two new 27.6kV circuit breakers at Horner TS, and THESL is implementing a plan to transfer approximately 26 MVA load from Manby TS to Horner TS to relieve the heavily loaded condition at Manby TS.

For the medium-term, a second 192 MVA bus expansion at Horner TS is required to relieve load at the adjacent Manby TS. Due to the long lead time of approximately five to six years required to install a new 192 MVA bus at Horner TS, an engineering study is required now to identify any constraints on the transmission line and determine the cost for possible reinforcements to provide a feasible supply for the additional 192 MVA bus at Horner TS. Without the second bus, Horner TS load will reach 95% of station capacity (182MVA load with 192MVA capacity) in 2016 and will reach 100% of station capacity in 2021.

Initial consultation with HONI indicates that there is adequate space to install the second 192 MVA bus at Horner TS. HONI has also informed THESL previously that there would be no space readily available, without major transmission system rearrangements, for installation of an additional bus at Manby TS. Therefore, the most feasible option to relieve load at Manby TS is to install the second bus at Horner TS. The new capacity from the second bus at Horner TS will be used to connect new customers in the Manby-Horner area, to balance load among Manby TS and Horner TS, and to increase reliability to area customers.

Since the 27.6kV bus at Horner TS is owned by HONI, and this engineering study is a non-contestable work, there is no alternative source for the engineering study. THESL estimates a capital contribution of $150,000 is required for HONI to perform this engineering study as shown in Table 9 below.

Table 9: Horner TS Second Bus Expansion - Capital Contribution for HONI Engineering Study

Job Description	Capital Contribution Estimate ($, millions)	Year
Horner TS second bus expansion engineering study	$0.15	2012
Total:	**$0.15**	

If funding is not available, THESL expects that HONI will not carry out engineering study to determine project feasibility and the cost required to install a second bus at Horner TS. This will likely delay the relief of load for both Manby TS and Horner TS. Horner TS is currently loaded at 145 MVA which is 76% of available capacity (192 MVA). The expected impact of not being able to relieve load at Manby TS, is that over 32,200 customers at Manby TS could experience lengthy outages.

4.4. Runnymede TS Second Bus Expansion HONI Engineering Study

The main driver for this engineering study is the urgent need for additional capacity at Runnymede TS to connect new customers and to meet current and future load growth.

THESL has forecasted the load at Runnymede TS will reach 100% of station capacity in 2013 based on area growth, transfers and new customer connections. There are 4 MVA of remaining capacity available in 2012 (113 MVA load with 117 MVA capacity) and new customers' load cannot connect to this Runnymede TS until additional capacity is installed or loads transferred to adjacent stations.

Due to the long lead time of approximately five to six years required to install a new 117 MVA bus at Runnymede TS, an engineering study is required now for HONI to identify any constraints on the transmission line and to determine cost for possible reinforcements to provide feasible supply for the additional 117MVA bus at Runnymede TS.

One alternative considered to relieve load at Runnymede TS was to transfer loads from Runnymede TS to adjacent stations such as Manby TS and Fairbank TS. However, it was determined that this alternative option was not viable because adjacent stations are also heavily loaded. One adjacent station is Manby TS, whose load has reached 95% of capacity in 2012 and requires load relief from Horner TS; the other adjacent station is Fairbank TS which has reached beyond 100% capacity in 2011 due to heavy base load in addition to temporary load transfers from other stations during the summer. There is no available capacity at Fairbank TS to provide load support for Runnymede TS due to the need to receive load transfers from other adjacent stations to support feeder operations during the summer.

Since the 27.6kV bus at Runnymede TS is owned by HONI, and this study is a non-contestable HONI work, there is no alternative source for the engineering study. THESL estimates a capital contribution of $150,000 is required for HONI to perform the engineering study as shown in Table below.

Table 10: Runnymede TS Second Bus Expansion - Capital Contribution for HONI Engineering Study

Job Description	Capital Contribution Estimate ($, millions)	Year
Runnymede TS second bus expansion HONI engineering study	$0.15	2012
Total:	**$0.15**	

If funding is not available, THESL expects that HONI will not carry out engineering study to determine project feasibility and the cost to install a second bus at Runnymede TS. As load continues to grow at Runnymede TS, additional capacity must be installed to meet current and future load growth. The likely impact of not being able to install additional capacity at Runnymede TS is that THESL cannot connect new customers' load from Runnymede TS, and significant risks of outages arise to approximately 20,700 customers, if overloaded equipment fails at Runnymede TS. Until the second bus is installed, new customers' load will be supplied by adjacent stations which are located at farther distance, meaning longer distribution routes for cables and structures and more expense to connect new customers who are located nearer to Runnymede TS.

4.5. Bridgman TS Transformer Upgrade HONI Engineering Study

The main driver for the engineering study for Bridgman TS transformer upgrade is the need to increase transformer capacity for the A5-6H bus, and to provide 4-wire capacity for conversion of aging and deteriorated 4kV system at High Level MS.

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THESL A5-6H switchgear at High Level MS is rated at 72 MVA. This rating is higher than the existing transformer capacity which has limited usage to the existing transformer capacity of 36 MVA. Providing larger transformer capacity will allow THESL to use the greater capacity of A5-6 switchgear at High Level MS (i.e., 72MVA). THESL needs to determine the feasibility of transformer upgrades to provide additional capacity for a 4-wire configuration system which will be used for conversion of the aging 4 kV box construction system supplying load from High Level TS. The benefits of conversion of box construction are documented in the ICM evidence for Box Construction. The conversion of 4kV to higher voltage of 13.8kV cannot proceed until additional 4-wire system capacity is made available by upgrading HONI transformers.

The ICM evidence for Box Construction shows the average outage duration on a 4kV box construction feeder is almost double that of 13.8kV overhead feeders built to current construction standards as shown in table below:

Table 11: Reliability Performance for 4kV Box Construction vs. Standard 13.8kV O/H Feeders from 2000-2010

	4.16kV Overhead Box Construction	**13.8kV Overhead construction**
Total CI	1,423,683	1,500,102
Total CMO	109,627,274	62,459,681
Average Outage Duration	**77 minutes**	**42 minutes**

Since the transformers at Bridgman TS are owned by HONI, and the work is non-contestable, there is no alternative source for the engineering study. THESL estimates a capital contribution of $100,000 is required for HONI to perform this engineering study.

If funding is not available, THESL expects that HONI will not carry out the engineering study to determine project feasibility and the cost required to upgrade transformers located at Bridgman TS and connected to High Level MS A5-6 switchgear. As load continues to grow on A5-6 switchgear at High Level MS, which is currently loaded at 83% of capacity (30MVA load with

36MVA capacity), additional transformation capacity must be installed as soon as possible to allow the conversion of the aging and deteriorated 4kV system in the area to newer and higher voltage system and to meet current and future load growth. The expected impact of a lack of additional transformation capacity at Bridgman TS is that conversion of deteriorated 4kV system cannot proceed; as a result, approximately 7,750 customers in the area will face increased risks of outages.

2.4.6 Esplanade TS Second Bus Expansion and HONI Capital Contribution

The main driver for this engineering study for second bus expansion at Esplanade is the future need to install additional capacity to meet new load demand from West Don Lands and East Bayfront development plans.

THESL has forecasted the load at Esplanade TS will reach 95% of station capacity in 2021, without the taking into account loads from the West Don Lands and East Bayfront developments. Due to the long lead time for installation of the second bus at Esplanade TS, an engineering study is required now to determine the project feasibility and the associated cost for a feasible transmission supply for the second bus at Esplanade TS**.** The new capacity is required to meet anticipated load growth for West Don Lands 80 acres development of approximately 6,000 residential units[1] and the East Bay front 55 acres development of approximately 6,000 residential units[2]. New connection requests continue to be received at Toronto Hydro for waterfront revitalization.

Since the building structures and the property at Esplanade TS are owned by HONI, and the work is non-contestable, there is no alternative source for the engineering study. THESL estimates a capital contribution of $100,000 is required for HONI to perform this engineering study as shown in Table below.

[1] See http://www.waterfrontoronto.ca/explore_projects2/west_don_lands

[2] See http://www.waterfrontoronto.ca/explore_projects2/east_bayfront

Table 12: Esplanade TS Second Bus Expansion - Capital Contribution for HONI Engineering Study

Job Description	Capital Contribution Estimate ($, millions)	Year
Esplanade TS second bus expansion HONI engineering study	$0.10	2012
Total:	**$0.10**	

If funding is not available, THESL expects that HONI will not carry out an engineering study to determine project feasibility and the cost required to install a second bus at Esplanade TS. As load continues to grow at Esplanade TS, additional capacity must be installed to meet current and future load growth from Waterfront revitalization developments. The expected impact of not being able to install additional capacity at Esplanade TS is that THESL cannot connect new customers' load from the West Don Lands and East Bay Front developments, and increased risks of outages to approximately 6,620 customers, if overloaded equipment failure occurs at Esplanade TS.

III DETAILED DESCRIPTION OF THE JOBS

1. LISTING OF ALL JOBS

The list of jobs that required capital contribution to HONI is shown below.

Table 13: List of jobs required Capital Contribution to HONI

Estimate Number	Job Title	Estimated Cost ($, millions)	Year
22416	Bremner TS Capital Contribution 2012	$6.00	2012
22463	Bremner TS Capital Contribution 2013	$27.00	2013
25117	Bremner TS Capital Contribution 2014	$27.00	2014
20757	Leaside-Birch Transmission Reinforcement Capital Contribution	$17.60	2012
24733	Leaside-Birch Transmission Reinforcement Capital Contribution	$15.28	2013
24744	Wiltshire TS A3-4 Capital Contribution	$3.00	2013
24748	Wiltshire TS A5-6 Capital Contribution	$3.00	2014
24740	Wiltshire TS A1-2 transformer upgrade HONI Engineering study	$0.10	2013
24510	Wiltshire TS A3-4 switchgear replacement HONI Engineering Study	$0.07	2012
24743	Wiltshire A5-6 switchgear replacement engineering study	$0.07	2013
24745	Strachan TS A7-8 Capital Contribution	$3.00	2013
24749	Strachan TS A5-6 Capital Contribution	$3.00	2014
24511	Strachan TS A7-8 switchgear replacement HONI Engineering Study	$0.07	2012

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Estimate Number	Job Title	Estimated Cost ($, millions)	Year
24741	Strachan TS A5-6 switchgear replacement HONI Engineering Study	$0.07	2013
24751	Windsor TS A5-6 capital contribution	$3.00	2014
24742	Windsor TS A5-6 switchgear replacement engineering Study	$0.10	2013
24747	Duplex TS A5-6 Capital contribution	$3.00	2013
24512	Duplex TS A5-6 switchgear replacement HONI Engineering Study	$0.07	2012
22109	Malvern TS two new CBs HONI Capital Contribution Agreement	$1.28	2012
24507	Malvern TS two new CBs HONI Engineering Study	$0.02	2012
24509	Leslie MS switchgear replacement Capital Contribution estimate cost	$0.15	2012
24508	Leslie MS switchgear replacement HONI Engineering Study	$0.03	2012
24736	Horner TS second bus expansion HONI Engineering study	$0.15	2013
24737	Runnymede TS second bus expansion HONI Engineering study	$0.15	2013
24739	Bridgman/High Level transformers upgrade HONI Engineering study	$0.10	2013
24738	Esplanade TS second bus expansion HONI Engineering study	$0.10	2013
	Total:	**$113.40**	

The map for all capital contribution work is shown below.

ICM Project | **HONI Capital Contributions**

Figure 5: Map of jobs required capital contributions to HONI

The addresses of these jobs are shown below for reference to the map.

Table 14: Addresses of Capital Contribution Jobs

Map Reference Number	Station	Address
1	Bremner TS	Bremner Blvd and Rees St
2	Leaside-Birch	1080 Millwood Ave
3	Malvern TS	1702 Neilson RD
4	Duplex TS	400 Duplex St
5	Strachan TS	6 Strachan Ave
6	Wiltshire TS	13-19 Wiltshire Ave
7	Leslie MS	5733 Leslie St
8	Horner TS	455 Kipling Ave
9	Runnymede TS	99 Woolner Ave
10	Esplanade TS	106 Lower Sherbourne St
11	Bridgeman/High Level	MacPherson Ave and Huron St
12	Windsor TS	253 Wellington St W

2. BREMNER TS CAPITAL CONTRIBUTION

2.1. Job Objectives

The purpose of this job is to develop a new station, Bremner TS, to be located at Bremner Boulevard and Rees Street in downtown Toronto. THESL owns the site and will be the station developer. The job will include construction of a new underground cable tunnel, site preparation, construction of the station building, installation of electrical equipment and site landscaping work.

2.2. Job Scope of Work

The scope of work for Bremner TS capital contribution involves procurement and installation of:

- Install High voltage cabling from Front St breakout to Bremner TS

- Install four high voltage surge arrestors
- Install high voltage switchgear on HONI side
- Install Protection and control facilities
- Provide DC station services for HONI switchgear room
- Provide AC station services for HONI rooms
- Provide coordination services during the construction phase.

2.3. Job Map and Locations

Refer to Figure 5 in section 3.1 for map location.

2.4. Required Capital Costs

Currently, the cost provided for capital contribution to HONI for Bremner TS are estimates only. HONI is in the process of firming up this cost, based on their detailed design.

Table 15: Bremner TS Capital Contribution Requirement

Estimate Number	Job Title	Estimated Cost ($, millions)	Year
22416	Bremner TS Capital Contribution	$6.00	2012
22463	Bremner TS Capital Contribution	$27.00	2013
25117	Bremner TS Capital Contribution	$27.00	2014
	Total:	**$60.00**	

3. LEASIDE-BIRCH TRANSMISSION REINFORCEMENT

3.1. Job Objectives

The objectives of this job are the following:

1) Replace an end-of-life underground cable section of the 115 kV L14W circuit between Bayview Junction (“Jct.”) and Birch Jct.

2) Provide a new circuit between Leaside TS and Bridgman TS to address the overloading of the existing circuits and provide additional capacity to address long term load growth in the City of Toronto Midtown area.

3.2. Job Scope of Work

The scopes of work on this job are the following:

1) Between Leaside TS to Bayview Junction
   Building a 115 kV three circuit overhead line between Leaside TS and Bayview Junction (approximately 1.7 kilometres in length) as a replacement to the existing L14W/ L15W two circuit overhead line. Two circuits are to replace the existing circuits and the third circuit is to be used as a new circuit to address the need for increased capacity. The existing towers will not support the addition of the third circuit.
2) Between Bayview Junction to Birch Junction
   Installing two underground cable circuits between Bayview Junction and Birch Junction in a deep rock tunnel (approximately 2.2 kilometres in length) along the Canadian Pacific Railways (CPR) right-of-way (ROW), City of Toronto property, HONI property and City of Toronto road allowance. One cable will replace the end-of-life underground section of the existing L14W circuit. The second cable circuit will be used to address the need for increased capacity in the area.
3) Between Birch Junction to Bridgman Junction
   Reconductoring the overhead section of the existing L14W line (about 1.4 kilometres in length) between Birch Junction and Bridgman TS. This line section also carries an idle 115 kV circuit which will be reconductored and energized as part of the new circuit.
4) At Leaside TS, Bayview, Birch and Bridgman Junctions
   Install new equipment at Leaside TS, Bayview junction, Birch junction and Bridgman Junction.

3.3. Job Map and Locations

The map of the Leaside-Birch transmission corridor and location of work is shown below.

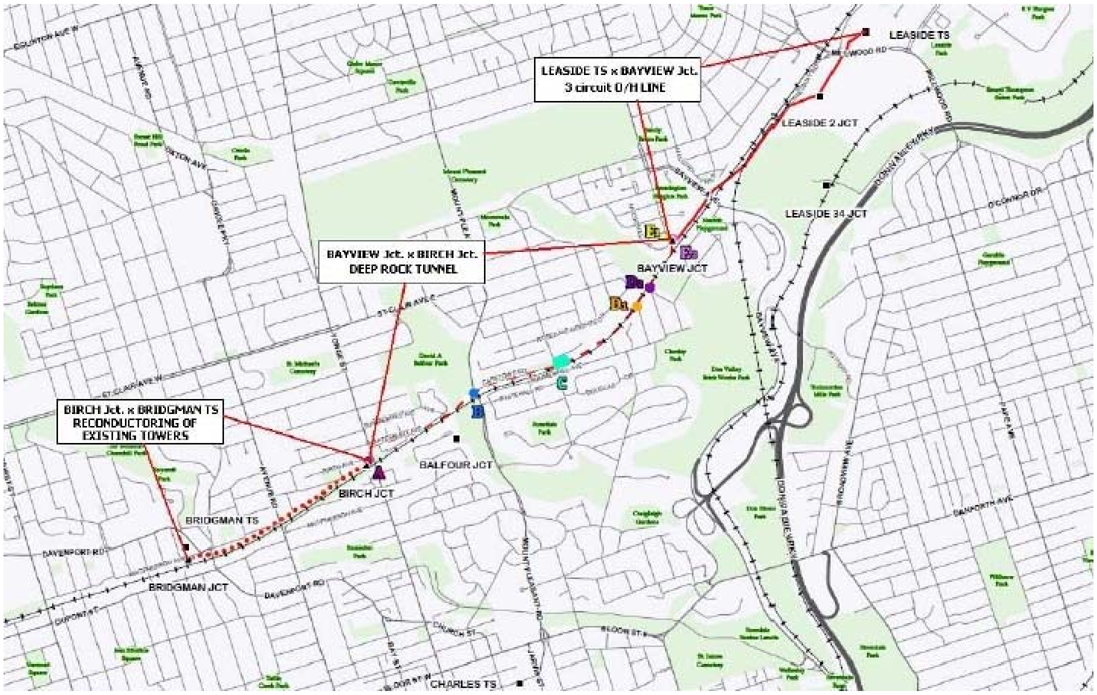


Figure 6: Map of Leaside-Birch transmission reinforcement job

3.4. Required Capital Contribution to HONI

Table 16: Leaside-Birch HONI Capital Contribution Requirement

Estimate Number	Job Title	Estimate Cost ($, millions)	Year
20757	Leaside-Birch Transmission Reinforcement	$17.60	2012
24733	Leaside-Birch Transmission Reinforcement	$15.28	2013
	Total:	**$32.88**	

4. TS SWITCHGEAR REPLACEMENTS AND ENGINEERING STUDIES

4.1. WILTSHIRE TS SWITCHGEAR REPLACEMENTS AND ENGINEERING STUDIES

4.1.1. Job Objectives

The purpose of this job is for Hydro One to perform engineering studies and to carry out replacement of incoming circuit breakers connected to the Wiltshire TS A3-4 and A5-6 switchgear, and to upgrade HONI transformers connected to A11-12 switchgear.

4.1.2. Job Scope of Work

Hydro One is expected to provide cost estimates, replace incoming circuit breakers, and replace transformers as described in the following:

- Modification of the current double bus, single breaker A3-A4 and A5-A6 switchgear configuration to a double bus, dual breaker arrangement on HONI side
- Replace existing HONI incoming cells with ten new, Hydro One owned cells (four cells for transformers, two cells for capacitor, four cells for links), to be located on the first floor of Building A
- Remove existing 2000 A LV transformer secondary cables and install new 3,000 A cables to supply the new switchgear
- Modification of the switchgear bus configuration from 3-wire to 4-wire
- Collaboration with THESL to install/modify and test all necessary Protection and Control equipment and commission the new protection schemes
- Purchase and installation of all necessary capacitor bank breakers and associated equipment required to meet switchgear configuration changes
- Purchase and installation of instrument transformers for revenue metering that meet all IESO requirements
- Replace HONI transformers connected to A11-A12 to increase supply capacity to 72 MVA to A11-A12 bus, and provide 4-wire configuration to A11-A12 bus.

4.1.3 Job Map and Locations

Refer to Figure 5 in Section 3.1 for map location.

4.1.3. Required Capital Contribution to HONI Costs

Table 17: Wiltshire TS Capital Contributions to HONI jobs

Estimate Number	Job Title	Estimated Cost ($, millions)	Year
24744	Wiltshire TS A3-4 Capital Contribution	$3.00	2013
24748	Wiltshire TS A5-6 Capital Contribution	$3.00	2014
24740	Wiltshire TS A1-2 transformer upgrade HONI Engineering study	$0.10	2013
24510	Wiltshire TS A3-4 switchgear replacement HONI Engineering Study	$0.07	2012
24743	Wiltshire A5-6 switchgear replacement engineering study	$0.07	2013
	Total:	**$6.24**	

4.2. STRACHAN TS SWITCHGEAR REPLACEMENTS AND ENGINEERING STUDIES

4.2.1. Job Objectives

The purpose of this job is for HONI to perform engineering study and to carry out replacements of incoming circuit breakers connected to Strachan TS A7-8 and A5-6 switchgears.

4.2.2. Job Scope of Work

Hydro One is expected to perform engineering studies and to carry out the replacements of incoming circuit breakers at Strachan TS as described below:

- Modification of the current double bus, single breaker A7-8 and A5-6 switchgear configuration to a double bus, dual breaker arrangement Gas Insulated Switchgear (GIS).

- Replacement of Hydro One's incoming circuit breakers with four new circuit breakers, two on each side of the replacement A11-A12 switchgear
- Remove existing 2000 A LV transformer secondary cables and install new 3000A cables to supply the new switchgear
- Modification of the switchgear bus configuration from 3-wire to 4-wire
- Collaboration with THESL to install/modify and test all necessary Protection and Control equipment and commission the new protection schemes
- Purchase and installation of instrument transformers for revenue metering that meet all IESO requirements

4.2.3. Job Map and Locations

Refer to Figure 5 in Section 3.1 for map location.

4.2.4. Required Capital Costs

Table 18: Strachan TS Capital Contributions to HONI jobs

Estimate Number	Job Title	Estimated Cost ($, millions)	Year
24745	Strachan TS A7-8 Capital Contribution	$3.00	2013
24749	Strachan TS A5-6 Capital Contribution	$3.00	2014
24511	Strachan TS A7-8 switchgear replacement HONI Engineering Study	$0.07	2012
24741	Strachan TS A5-6 switchgear replacement HONI Engineering Study	$0.07	2013
24745	Strachan TS A7-8 Capital Contribution	$3.00	2013
	Total:	**$6.14**	

4.3. WINDSOR TS SWITCHGEAR REPLACEMENT AND ENGINEERING STUDY

4.3.1. Job Objectives

The purpose of this job is for HONI to perform engineering study to determine job feasibility and to replace the incoming circuit breakers connected to Windsor TS A5-6 switchgear.

4.3.2. Job Scope of Work

Hydro One is expected to perform engineering and to replace incoming circuit breakers at Windsor TS as described below:

- Modification of the current double bus, double breaker at Windsor TS A5-6 switchgear configuration to a double bus, dual breaker arrangement, air insulated or Gas Insulated Switchgear (GIS).
- Replacement of Hydro One's incoming circuit breakers with four new circuit breakers, two on each side of the replacement Windsor TS A5-6 switchgear
- Remove existing LV transformer secondary cables and install new 3000A cables to supply the new switchgear
- Modification of the switchgear bus configuration from 3-wire to 4-wire
- Collaboration with THESL to install/modify and test all necessary Protection and Control equipment and commission the new protection schemes
- Purchase and installation of instrument transformers for revenue metering that meet all IESO requirements

4.3.3. Job Map and Locations

Refer to Figure 5 in Section 3.1 for map location.

4.3.4. Required Capital Costs

Table 19: Windsor TS Capital Contributions to HONI jobs

Estimate Number	Job Title	Estimated Cost ($, millions)	Year
24751	Windsor TS A5-6 capital contribution	$3.00	2014
24742	Windsor TS A5-6 switchgear replacement engineering Study	$0.10	2013
	Total:	**$3.10**	

4.4. DUPLEX TS SWITCHGEAR REPLACEMENT AND ENGINEERING STUDY

4.4.1. Job Objectives

The purpose of this job is for HONI to perform engineering study to determine job feasibility and to replace the incoming circuit breakers connected to Duplex TS A5-6 switchgear.

4.4.2. Job Scope of Work

Hydro One is expected to perform engineering and to replace incoming circuit breakers at Duplex TS as described below:

- Modification of the current double bus, single breaker Duplex TS A5-6 switchgear configuration to a double bus, dual breaker arrangement Gas Insulated Switchgear (GIS).
- Replacement of Hydro One's incoming circuit breakers with four new circuit breakers, two on each side of the replacement Duplex TS A5-6 switchgear
- Remove existing LV transformer secondary cables and install new 3000A cables to supply the new switchgear
- Modification of the switchgear bus configuration from 3-wire to 4-wire
- Collaboration with THESL to install/modify and test all necessary Protection and Control equipment and commission the new protection schemes

- Purchase and installation of instrument transformers for revenue metering that meet all IESO requirements

4.4.3. Job Map and Locations

Refer to Figure 5 in Section 3.1 for map location.

4.4.4. Required Capital Costs

Table 20: Duplex TS Capital Contributions to HONI jobs

Estimate Number	Job Title	Estimated Cost ($, millions)	Year
24747	Duplex TS A5-6 Capital contribution	$3.00	2013
24512	Duplex TS A5-6 switchgear replacement HONI Engineering Study	$0.07	2012
	Total:	**$3.07**	

5. OTHER CAPITAL CONTRIBUTIONS

5.1. MALVERN TS 2 NEW CIRCUIT BREAKERS AND ENGINEERING STUDY

5.1.1. Job Objectives

The purpose of this job is for HONI to provide and install 2 new 27.6kV circuit breakers at Malvern TS. HONI has completed the engineering study and informed THESL that a capital contribution of $1,275,047 is required to install the 2 new circuit breakers.

5.1.2. Job Scope of Work

The scope of work is for HONI to perform engineering study and install two feeder positions, M23 and M24, at Malvern TS for connection by the THESL. The scope of work includes items as described below:

1) Feeder Positions
    - Install two 27.6 kV, 1200 amp feeder breakers in the existing M23 and M24 positions at Malvern TS,
    - Verify the condition of existing support structures, buses, feeder disconnect switches, feeder tie switch, insulators and cabling associated with the M23 and M24 positions, and repair or replace if and as required
    - Install breaker foundations,
    - Provide and install cable riser support structures, and
    - Provide any coordination as may be required with the Customer.
2) Feeder Egress
    - Provide any required coordination for the THESL's installation of their duct banks and cables.
3) Protection and Control
    - Modify J and Q bus protections, T3 and T4 LV breaker failure protection and JQ bus tie breaker failure protection to accommodate new feeder position. New feeder protections will be installed to trip new feeder breakers (M23 as main, M24 as backup),
    - Set feeder protections as specified by the THESL.

4) Supervisory Control and Data Acquisition
    - Review and revise SCADA facilities as required to meet Network Operating and IESO CSCC requirements and SCADA standards.
5) Revenue Metering
    - M23 and M24 will be metered using existing bus metering.

5.1.3. Job Map and Locations

Refer to Figure 5 in Section 3.1 for map location.

5.1.4. Required Capital Costs

Table 21: Malvern TS Capital Contributions to HONI

Estimate Number	Job Title	Estimated Cost ($, millions)	Year
22109	Malvern TS two new CBs HONI Capital Contribution Agreement	$1.28	2012
24507	Malvern TS two new CBs HONI Engineering Study	$0.02	2012
	Total:	**$1.30**	

5.2. LESLIE MS SWITCHGEAR REPLACEMENT AND ENGINEERING STUDY

5.2.1. Job Objectives

The purpose of this job is for HONI to provide engineering design and support to assist THESL's effort in replacement of the existing 13.8kV switchgear at Leslie MS and for a capital contribution for HONI's station work.

5.2.2. Job Scope of Work

The scope of work for HONI is expected to include:

- Providing required easements, agreements or approvals for the property extension
- Extending the ground grid
- Grading
- Extending the station fence
- Providing required ground connections
- Reviewing bus protections and revising as required
- Providing landscaping as may be required by the City or Zoning requirement
- Providing coordination with Customer for outages, cables locates, etc.
- Conducting the Confirmation of Verification Evidence Report (COVER) process

5.2.3. Job Map and Locations

Refer to Figure 5 in Section 3.1 for map location.

5.2.4. Required Capital Costs

Table 22: Leslie MS Capital Contributions to HONI

Estimate Number	Job Title	Estimated Cost ($, millions)	Year
24509	Leslie MS switchgear replacement Capital Contribution estimate cost	$0.15	2012
24508	Leslie MS switchgear replacement HONI Engineering Study	$0.03	2012
	Total:	**$0.18**	

5.3. HORNER TS SECOND BUS EXPANSION HONI ENGINEERING STUDY

5.3.1. Job Objectives

The purpose of this job is for Hydro One to perform engineering study to determine the required capital contribution for HONI to install a second 27.6kV, 198 MVA bus at Horner TS.

5.3.2. Job Scope of Work

Hydro One is expected to perform engineering study to determine job feasibility to expand and install a second 198MVA bus, and the associated 115kV transmission line upgrade required to support long-term future load growth on this second bus.

5.3.3. Job Map and Locations

Refer to Figure 5 in Section 3.1 for map location.

5.3.4. Required Capital Contribution to HONI Costs

Table 23: Horner TS Capital Contributions to HONI

Estimate Number	Job Title	Estimated Cost ($, millions)	Year
24736	Horner TS 2nd bus expansion HONI Engineering study	$0.15	2013
	Total:	**$0.15**	

5.4. RUNNYMEDE TS SECOND BUS EXPANSION HONI ENGINEERING STUDY

5.4.1. Job Objectives

The purpose of this job is for Hydro One to perform engineering study to determine the required capital contribution for HONI to install a second 27.6kV, 117 MVA bus at Runnymede TS.

5.4.2. Job Scope of Work

Hydro One is expected to perform engineering study to determine job feasibility to expand and install a second 117MVA bus, and the associated 115kV transmission line upgrade required to support long-term future load growth on this second bus at Runnymede TS.

5.4.3. Job Map and Locations

Refer to Figure 5 in Section 3.1 for map location.

5.4.4. Required Capital Contribution to HONI Cost

Table 24: Runnymede TS Capital Contributions to HONI

Estimate Number	Job Title	Estimated Cost ($, millions)	Year
24737	Runnymede TS 2nd bus expansion HONI Engineering study	$0.15	2013
	Total:	**$0.15**	

5.5. BRIDGMAN TS TRANSFORMER UPGRADE HONI ENGINEERING STUDY

5.5.1. Job Objectives

The purpose of this job is for Hydro One to perform engineering study to determine job feasibility for HONI to upgrade transformers at Bridgman TS, to increase capacity for THESL A5-6 High Level MS. THESL A5-6 switchgear at High Level MS has a higher rating than the existing limited transformer capacity which is at 36 MVA. Providing larger transformers capacity will allow THESL to increase capacity of A5-6 switchgear at High Level MS to 66MVA to meet load growth on 4-wire configuration system.

5.5.2. Job Scope of Work

The scope of work is for Hydro One to perform engineering study to determine job feasibility for HONI to upgrade transformers at Bridgman TS, to increase capacity for THESL A5-6 switchgear at High Level MS.

5.5.3. Job Map and Locations

Refer to Figure 5 in Section 3.1 for map location.

5.5.4. Required Capital Costs

Table 25: Bridgman TS Capital Contribution to HONI

Estimate Number	Job Title	Estimated Cost ($, millions)	Year
24739	Bridgman/High Level transformer upgrade HONI Engineering study	$0.10	2013
	Total:	**$0.10**	

5.6. ESPLANADE TS SECOND BUS EXPANSION HONI ENGINEERING STUDY

5.6.1. Job Objectives

The purpose of this job is for Hydro One to perform engineering study to determine the required capital contribution for HONI to install a second 72 MVA bus at Esplanade TS.

5.6.2. Job Scope of Work

Hydro One is expected to perform engineering study to determine job feasibility to expand and install a second 72MVA bus to support to meet anticipated load growth for West Don Lands development of approximately 1,700 residential units and the East Bay front development of approximately 6,000 residential units.

5.6.3. Job Map and Locations

Refer to Figure 5 in Section 3.1 for map location.

5.6.4. Required Capital Costs

Table 26: Esplanade TS Capital Contributions to HONI

Estimate Number	Job Title	Estimated Cost ($, millions)	Year
24738	Esplanade TS second bus expansion HONI Engineering study	$0.10	2013
	Total:	**$0.10**	

ICM Project

Feeder Automation

Toronto Hydro-Electric System Limited (THESL)

ICM Project | Feeder Automation

I EXECUTIVE SUMMARY

1. Project Description

THESL's Feeder Automation ("FA") project installs automated switches, software and communications devices on selected trunk feeders. These devices improve reliability by reducing the impact of trunk-related outages. The FA system utilizes remote switching technology and specialized software loaded in each switch remote terminal unit (RTU) to reduce the duration of outages by automatically isolating the faulted area and restoring the power to the unaffected segments of the feeder within one minute. Dynamic loading conditions are communicated between the switches through a peer to peer mesh radio communication network (See Section II, 1).

Feeder Automation (FA) is an effective solution to mitigate the impact of outages on the main portions of the feeder (i.e., the trunk). When a fault occurs, FA works by dividing the feeder into segments, and then using networked and automated switches to perform an algorithmic review and switching to assess the outage and automatically restore power to any non-affected feeders and the customers they serve. With FA technology, this entire operation can be done in less than one minute. In comparison, the quickest alternative restoration method, remote operation of a SCADA switches by a system controller, takes approximately 30 minutes. Manual operation of switches by line crews typically takes between two and four hours to achieve the same restoration of power to non-affected customers. Thus FA can both limit the number of customers impacted by an outage on a trunk feeder and dramatically improve restoration times.

THESL is targeting areas with poor reliability to improve service to these neighbourhoods. The jobs will focus on the east, west and northern areas of the system over the next three years and the project cost, project net benefit, and benefit over cost ratio for the work proposed are listed in Table 1.

Table 1: Business Case Evaluation of Job Areas

Project Location	Project Cost Allocated ($ M)	Project Net Benefit ($ M)	Option Benefit/Cost Ratio
Etobicoke Grid	$3.04	$235.78	**78.50**
North York Grid	$2.53	$181.87	**72.67**
Scarborough Grid	$25.92	$3,003.07	**116.86**

The general scope of work for these jobs consists of two phases. The first phase involves choosing feeders that will benefit from automation. The second phase is effectively sectionalizing the feeder. Feeder selection was based on reliability, network configuration, and restoration capacity. Feeders were first selected on based on their reliability and focusing on the number of outages that occurred on the trunk. Since this project builds on the existing FA implementation, feeder selection also was based on designing a system that could connect into the existing FA implementation through interconnection with other FA feeders. Non-automated tie-points will be included where considered necessary to backfeed into established FA feeders. Each feeder selected must be able to backfeed into a section and resupply a faulted feeder.

The number of feeders that can be addressed in an area at any one time is limited to maintain operational flexibility in the case of an outage. Power system controllers require a sufficient number of feeders available to ensure adequate flexibility to restore an area in the event of an outage. One method used to maximize the amount of FA deployment is to work in multiple areas of the system, the east, west and north areas of the city, at the same time.

By focusing on trunk feeders and effectively deploying an FA scheme to specific areas, THESL has prepared a focused project that is expected to have a significant positive impact on SAIDI and SAIFI.

2. Why the Project is Needed Now

The project needs to be constructed on the selected feeders now for three reasons:

(a) to reduce the current reliability impact of feeder trunk outages,

(b) to reduce the risk of future outages due to the high probability of equipment failure, and

(c) to ensure effective FA saturation on the system.

Of the customer interruptions (CI) on the selected feeders, 67% are attributable to the trunk portions these feeders; for customer hours interrupted (CHI), 57% are attributable to the feeder trunk (See Figure 1). By deploying FA on these feeders a potential reliability savings of 50% for CI and 43% of CHI on the feeders can be achieved (See Section III).

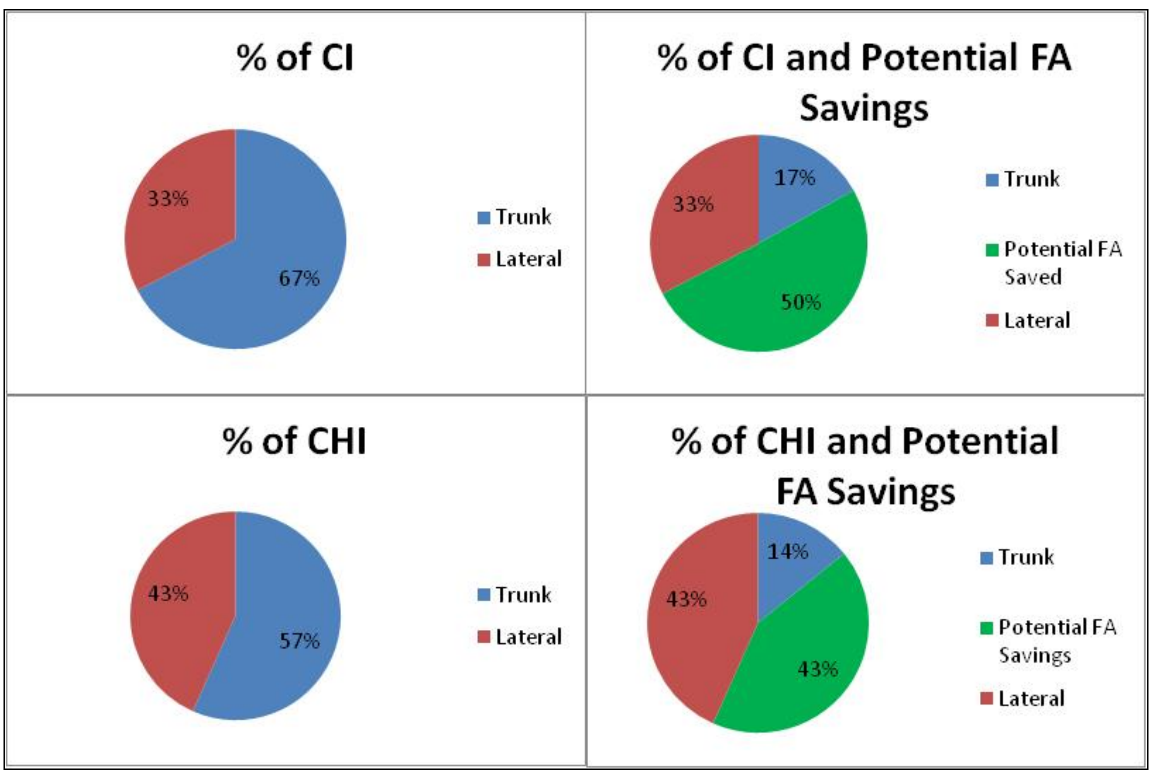


Figure 1: Reliabilty Impact and FA Savings on Selected Feeders

These savings will reduce the number of outages experienced customers, which will result in reliability improvements for those feeders in particular, and SAIDI and SAIFI improvements on the system as a whole.

Based on the business case evaluation presented in Appendix 1, these FA jobs have a high benefit to cost ratio and net benefits (See Table 1). This project also will mitigate the high risk cost associated with the selected feeders, which is attributable to a high probability of equipment failure due to the presence of end of life assets.

FA can mitigate the impact of these outages and efficiently manage trunk related outages if they were to increase in frequency. THESL plans to continue deploying FA solutions to poor reliability feeders and adjacent areas of the system to improve reliability for customers in these areas and for the system as a whole.

These jobs will incorporate proven technology that was not previously available and can provide significant benefits to THESL's system. Deferring work to the next cost of service filing would reduce the deployment and limit FA saturation in the system reducing reliability benefits to customers. At the very least, deferral would likely deprive customers of the potential reliability benefits from reducing the impact and duration of trunk related outages, and it could possibly expose them to deteriorating reliability as equipment failures on the system increase.

3. Why the Proposed Project Is the Preferred Alternative

The material above shows the benefits of installing FA, which significantly reduces the impact and the duration of outages by eliminating all the manual intervention initially needed from the controller and the field crew. As load growth continues, with new condominiums, the expansion of the TTC and future commercial development, the ability to perform load transfers via tie feeders will diminish. As a result, THESL will be required to undertake additional and more complex analyses of multiple feeders to sectionalize and re-supplying feeder segments. Through an FA implementation, this analysis can be performed automatically with self-healing switches and pre-determined sections that automate load transfers.

FA improves the benefit/cost ratios (B/C) compared to installing either manual switches or SCADA switches (See Section IV, 2). Compared to manual switches, there is a significant cost for installing FA, but the resulting benefits are substantially greater. Compared to SCADA, the incremental cost of installing FA is relatively low. For a slight investment over the cost of SCADA switches, a fully automated FA design can be implemented providing quicker restoration times and better reliability service to the customer. As FA saturates an area the benefits increase due to increased restoration flexibility resulting in improved reliability to the area and to the system as a whole.

In fact, FA provides one of the best B/C ratios of available reliability improvement options. Its ability to mitigate trunk related outages in under one minute provides a very high benefit in comparison to the cost of installation.

II PROJECT DESCRIPTION

1. FA Overview

THESL's Feeder Automation ("FA") project installs automated switches, software and communications devices on the worst performing trunk feeders that are not yet targeted for replacement. These devices will improve reliability by reducing the impact of trunk-related outages. The FA system utilizes remote switching technology (see Figure 1) and specialized software loaded in each switch remote terminal unit (RTU) (see Figures 2) to reduce the both the duration and impact of outages by automatically isolating the faulted area and restoring the power to the unaffected segments of the feeder within one minute. Dynamic loading conditions are communicated between the switches through a peer to peer mesh communication network. Figure 3 shows a repeater radio used for communication.

Figure 1: SCADA Switch with Omni-directional Antenna

Figure 2: Control Unit (RTU)

Figure 3: Repeater Radio

The FA project will produce significant system reliability benefits at relatively low cost. As assets continue to age and degrade within THESL's electrical distribution system, FA implementation provides an opportunity to reduce the impact of outages. Reducing outage impacts is particularly important on the worst performing feeders where outages are more likely to occur. The FA system can be deployed on many feeders for a relatively lower cost. As THESL manages the pace of capital replacement projects, FA can help to mitigate the impacts of outages on feeders where capital work must be deferred.

1.1. Outage Restoration in the Absence of Feeder Automation

Typically, when an outage occurs and FA is not in use, power system controllers attempt to pinpoint the location of the outage and utilize a series of remotely-controlled load break switches, in order to perform load transfers, sectionalizing and isolation activities. The basic sequence of restoring customers during a sustained trunk outage is to locate the fault, isolate the fault, restore the unaffected customers, and then repair the damaged area. These actions allow the outage to be contained and the majority of the feeder restored prior to undertaking necessary repairs. As part of this procedure, power system controllers must also individually analyze each feeder to verify the loading requirements and compare this to the feeders' supply capacity to ensure that any potential load transfers do not damage feeder assets from overloading. All told, these activities usually require about 30 minutes if all operable switches are remotely-controlled.

In addition to controlling the remote-operated switches, power system controllers must communicate to in-field crew workers to operate any manually-controlled switches along the feeder trunk as required. Traffic, poor visibility during inspection, or multiple outage events, as can occur on adverse weather days, will all work to delay crew action and add to the outage duration. Overall, manual switch operation can require between two and four hours, which significantly impacts the length of the outage.

The FA solution will reduce the impact of the fault by restoring all the customers in the unaffected section of the feeder automatically. These customers would otherwise have to wait for controllers to manage the feeder remotely or manually. Furthermore, FA enables field crews to focus quickly on outage repairs because all necessary switching is accomplished remotely.

1.2. Outage Restoration Using Feeder Automation

Under FA, the manual processes associated with fault location and isolation, feeder restoration, load transfers and analysis are all automated and executed almost immediately. During a trunk related fault, all the switches on the feeder will initially open to isolate the fault. The self healing logic in the software will then analyze the conditions prior to the fault in order to determine the failed segment and the available spare capacity on the alternate feeders before restoring power to the healthy segments. This is all done through a sequence of automated switch operations without overloading the alternate feeders.

FA uses peer-to-peer communication technology with pre-determined switching points. As a result of this technology, all the SCADA-enabled switches can communicate with one another to identify the location of the fault, quickly isolate the faulted switching region (the area between two SCADA-enabled switching points), and quickly restore power to the remaining unaffected customers.

Because the FA implementation is pre-programmed to determine the load of each feeder section and the available capacity of tie-feeders, time delays from the manual determination of these constraints are eliminated. This is done by strategically sectionalising a feeder and allocating tie-points with feeders that have adequate capacity to restore that section.

A feeder is typically divided into three to four sections, with each section having roughly the same number of customers and load requirements wherever possible. This can result in the restoration of approximately 67% to 75% of the customers on the feeder within a minute of a trunk fault.[1] This leaves the remaining 33% to 25% of the feeder to be cleared of the fault and restored. Even in a worst case scenario, where a FA can restore only half of the customers on a feeder within a minute, it provides a significant improvement in service reliability.

[1] FA is designed to locate and isolate the fault and restore the unaffected customers within one minute. Since in most instances, the bulk of the customers can be restored through isolation, the average outage time for most customers on the trunk feeder will be reduced from two-hours plus to less than a minute.

2. The Benefits of Feeder Automation

2.1. The ENMAX Case Study

ENMAX introduced feeder automation using the same FA system that THESL has used in its pilot study (discussed below) and has experienced promising results. Between the years 2004 to 2008, ENMAX has completed FA projects on 66 feeders. Between the initial implementation of the FA scheme in 2004 and February 2008, ENMAX has saved 107,450 CHI and 94,600 CI have been averted (ENMAX, EUCI Smart Grid Conference Presentation, March 27-28, 2008 – Appendix B). ENMAX has experienced a significant increase in reliability in each year that the project has been expanded as illustrated in Table 1 below.

ENMAX demonstrates the benefit of an FA scheme when multiple faults occur on the automated mesh. This occurred when ENMAX experienced three separate pole fires on March 16, 2006. What would have been a difficult scenario to manage for the power control operator was managed efficiently by having the FA isolate each section on which a pole fire occurred and restore power to the unaffected sections of each feeder. This saved 8,870 customers from experiencing a sustained power interruption and saved 419,050 CMO (6,984 CHI) from this event alone.

A common scenario where an FA scheme benefits the grid occurs in periods when the grid is exposed to adverse weather. This is when multiple faults are most likely to occur. An FA scheme can automatically manage multiple faults in much less time than it would take a power control operator. As seen, in Table 1, ENMAX's ability to mitigate outages increased as it expanded the FA program. In 2007, it mitigated 50 outages and saved 51,317 CHI; more than double the numbers of the previous year even though fewer customers were interrupted.

Table 1: ENMAX's Feeder Automation Reliability Improvements

Year	2004	2005	2006	2007	Total
Total FA Feeders (Cumulative)	18	28	44	66	66
Number of Outages Mitigated	11	12	19	50	92
CI	6,800	30,800	36,000	21,000	94,600
CHI	14,367	16,450	25,317	51,317	107,450

2.2. The THESL Pilot Project Study

THESL implemented a FA pilot project in 2010 using ten feeders between Bathurst T.S. and Fairbanks T.S. The pilot project has been operational since October of 2010 and has mitigated approximately 14,000 customers interrupted (CI) and approximately 2,700 customer hours interrupted (CHI) that would have otherwise occurred had feeder automation not been deployed on these feeders. The pilot project has demonstrated promising results for FA in terms of improved system reliability.

Between October 2010 and September 2011, a total of five outages occurred on the ten feeders where FA was installed. THESL calculated that FA produced a savings of 2,689 CHI (based on an assumption that it would have taken 19 minutes to remotely restore) and 13,955 CI From these five incidents as shown in Table 2.

The pilot project has proved that FA works on THESL's system and can provide an improvement in reliability. Distribution system data have demonstrated that our crews and controllers can use FA technology to benefit customers by reducing outage duration and the number of customers impacted by outages. The pilot also has provided some lessons learned for future deployments.

The pilot has shown that the ability to collect system data has allowed the controllers to analyze outages in greater detail and better determine their causes and precise locations. As the number of THESL's feeders included in the FA network increases, operations will further improve due to the availability of additional tie-points for automatic switching. This is expected to result in more customers benefiting from this technology and continuing improvements in reliability.

Table 2: Summary of Outages Where FA Operated (October 2010 to September 2011)

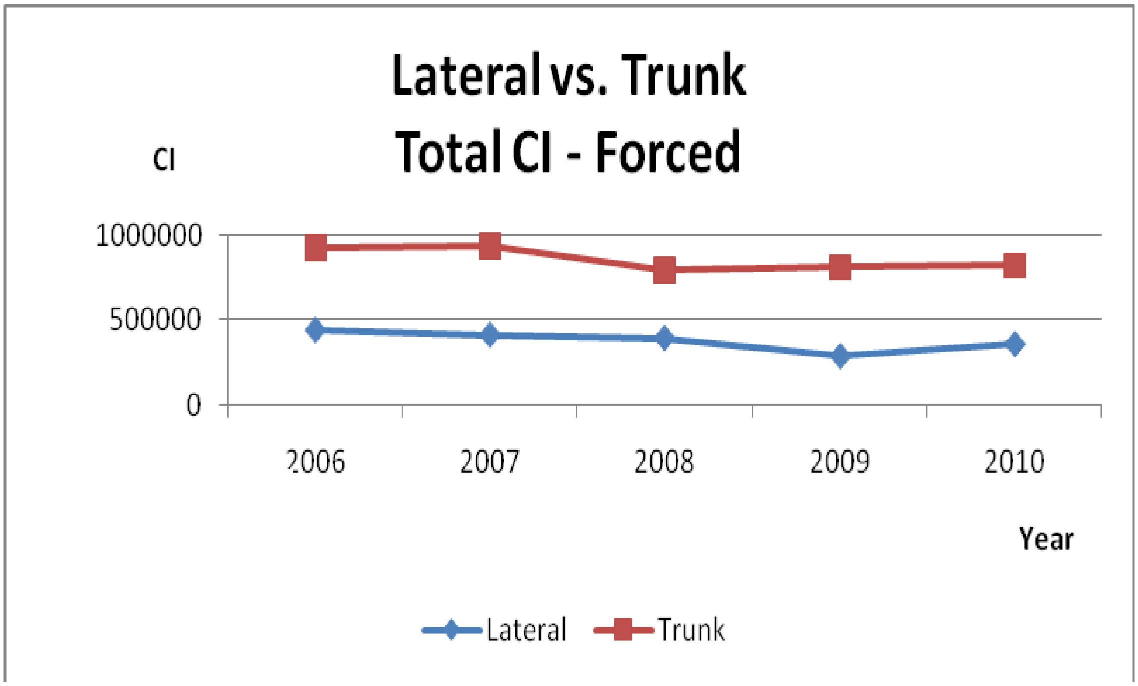
Event Date	Fault Type	Feeder	CHI		CI	
			Outage	**Saved**	**Outage**	**Saved**
March 9, 2011	Pole Fire	85M5	434	718	402	3,315
March 18, 2011	Tree Branch	85M5	280	156	1,442	1,873
July 3, 2011	Vehicle Interference	85M23	965	523	1,081	1,650
August 17, 2011	Defective Equipment	85M23	3	898	1	4,492
August 24, 2011	Failed Transformer	85M1	183	394	789	2,625
		Total	**1,865**	**2,689**	**3,715**	**13,955**

III NEED

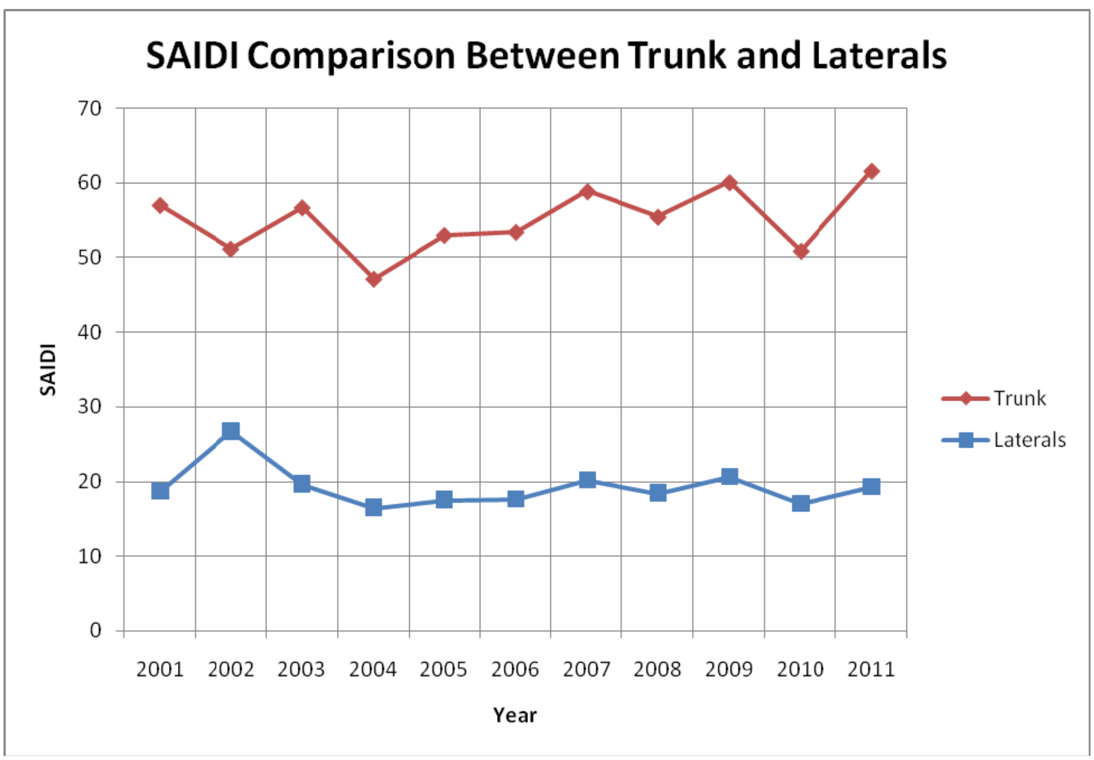
This project is necessary to help THESL maintain reliability by reducing the impact of feeder trunk related outages on SAIDI and SAIFI. As discussed above, FA helps limit the number of customers impacted by trunk outages and reduces the duration of these outages. In the face of aging infrastructure and financial and physical limitations on the pace of capital replacement, FA is a cost effective method of addressing reliability performance.

Examining the impacts of trunk related outages throughout the THESL system demonstrates the potential benefits of FA to improve reliability. Figures 4, 5 and 6 illustrate the reliability of the THESL distribution system over the last ten years using CI, SAIDI and SAIFI metrics. These figures show that trunk feeders have a much greater impact on overall reliability than lateral feeders. Figure 4 shows that in terms of the number of interruptions, trunk feeders cause more than twice as many as lateral feeders. This difference translates into more than 500,000 additional customer interruptions due to outages on trunk feeders. Figure 5 compares SAIDI over the last ten years for trunk and lateral feeders. In most years the SAIDI for trunk feeders is more than twice the SAIDI for lateral feeders, but in 2011, it is more than three time higher. Figure 6 shows that SAIFI is also several times higher for trunk feeders.

The reason for the greater reliability impacts of feeder trunks is that faults on lateral feeders affect relatively few customers compared to those on feeder trunks. Lateral feeder faults only affect the small number of customers that are protected by the fuse on that lateral. By comparison, faults on the feeder trunk cause the feeder's circuit breaker to open and disrupt power to all customers served by the feeder.



1 **Figure 4: Lateral vs. Trunk CI Contribution**



2 **Figure 5: SAIDI Comparison between Trunk and Laterals**

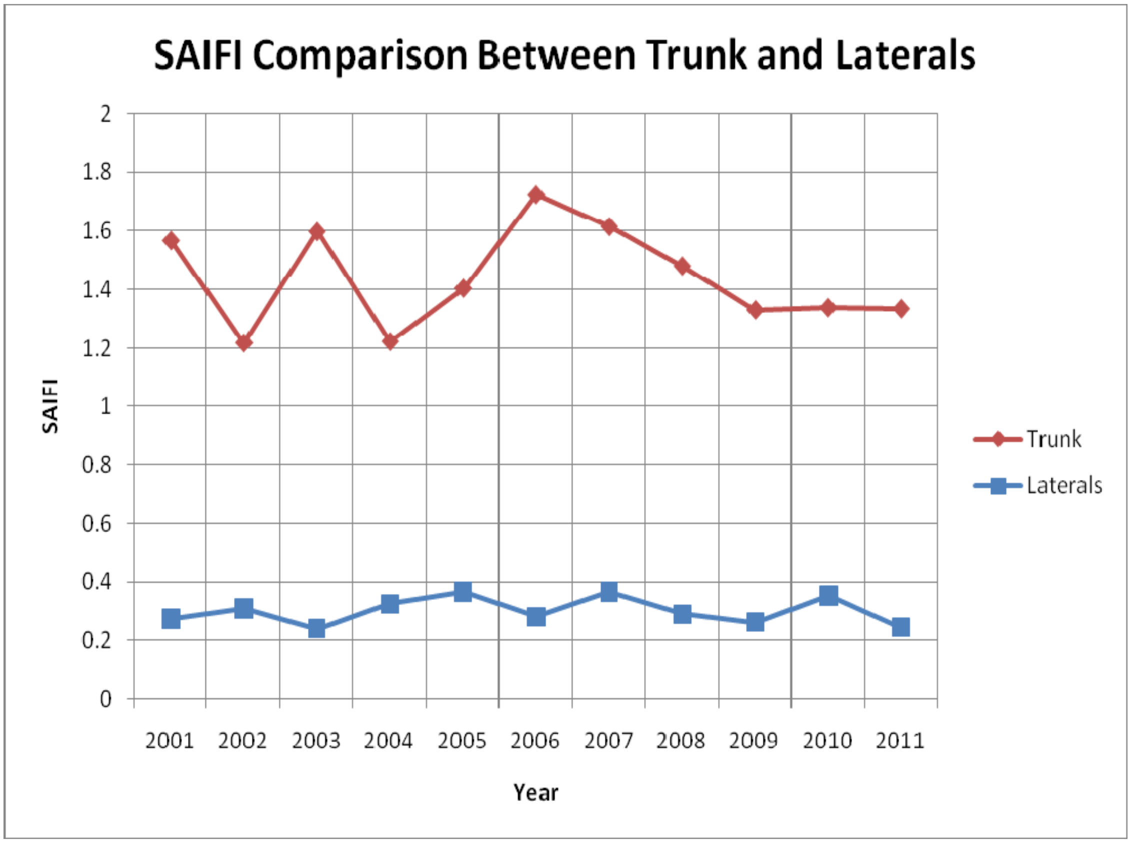
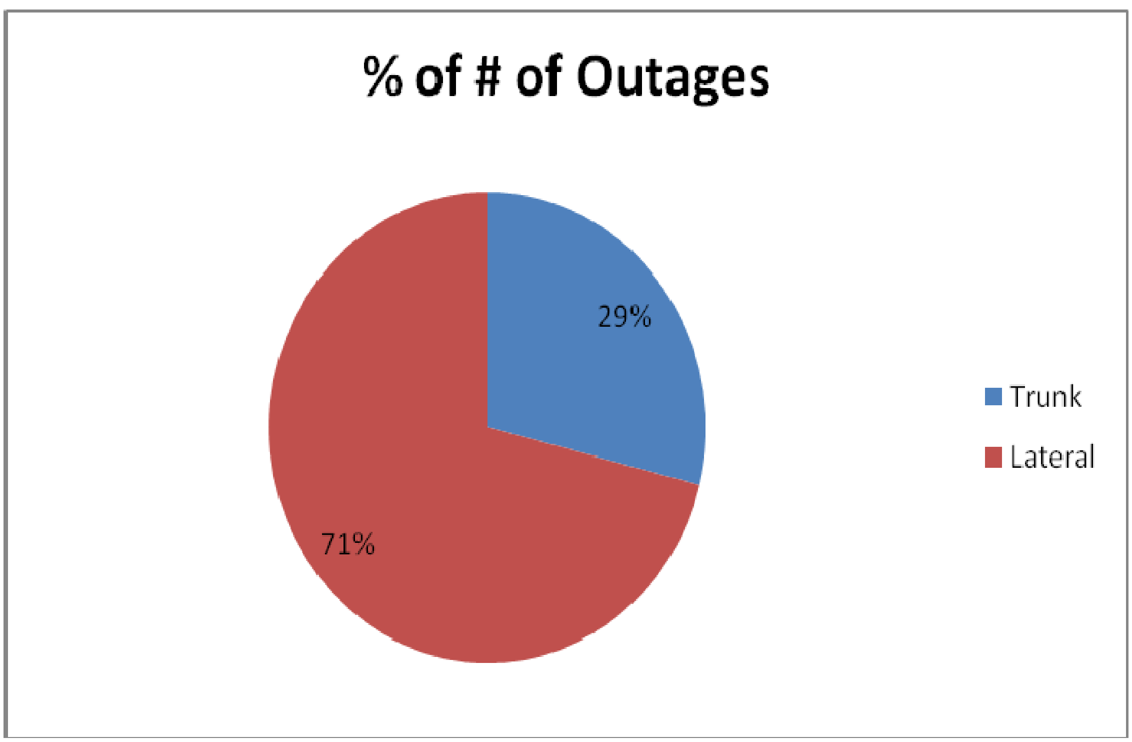


Figure 6: SAIFI Comparison between Trunk and Laterals

Historical reliability data for feeders planned for inclusion in FA over the next three years are shown in Table 3. Figures 7and 8 present graphical representations of lateral and trunk comparisons using the averages of the last five years. Figure 7 shows that, on average, more than two thirds of the outages over this period occur on laterals. As shown in Figure 8, however, trunk outages have a much larger impact on both CI and CHI (67% and 57%, respectively). In other words, the roughly two thirds of the faults occurring on laterals cause only one third of the customers interruptions (CI) and 43% of the customer hours interrupted (CHI). This aligns with the SAIDI and SAIFI graphs illustrated above in Figures 5 and 6.

1 **Table 3: Historical Reliability Data of Selected Feeders for the FA Scheme**

Year	Total Feeder Outages			Total Trunk Outages			Potential FA Savings	
	Number of Outages	CI	CHI	Number of Outages	CI	CHI	CI	CHI
2007	236	269,856	120,097.0	74	197,203	64,810.1	147,902	48,607.6
2008	184	143,450	97,691.5	49	89,024	58,631.8	66,768	43,973.8
2009	177	201,271	200,632.8	56	151,843	142,553.6	113,882	106,915.2
2010	160	163,063	92,892.0	43	87,459	33,673.4	65,594	25,255.0
2011	123	119,661	123,319.9	32	78,257	59,824.6	58,693	44,868.4
Total	**880**	**897,301**	**634,633.2**	**254**	**603,786**	**359,493.4**	**452,840**	**269,620.0**
Avg.	**176**	**179,460**	**126,926.6**	**50.8**	**120,757**	**71,898.7**	**90,568**	**53,924.0**



2 **Figure 7: Percentage of Trunk and Lateral Outages on Selected Feeders**

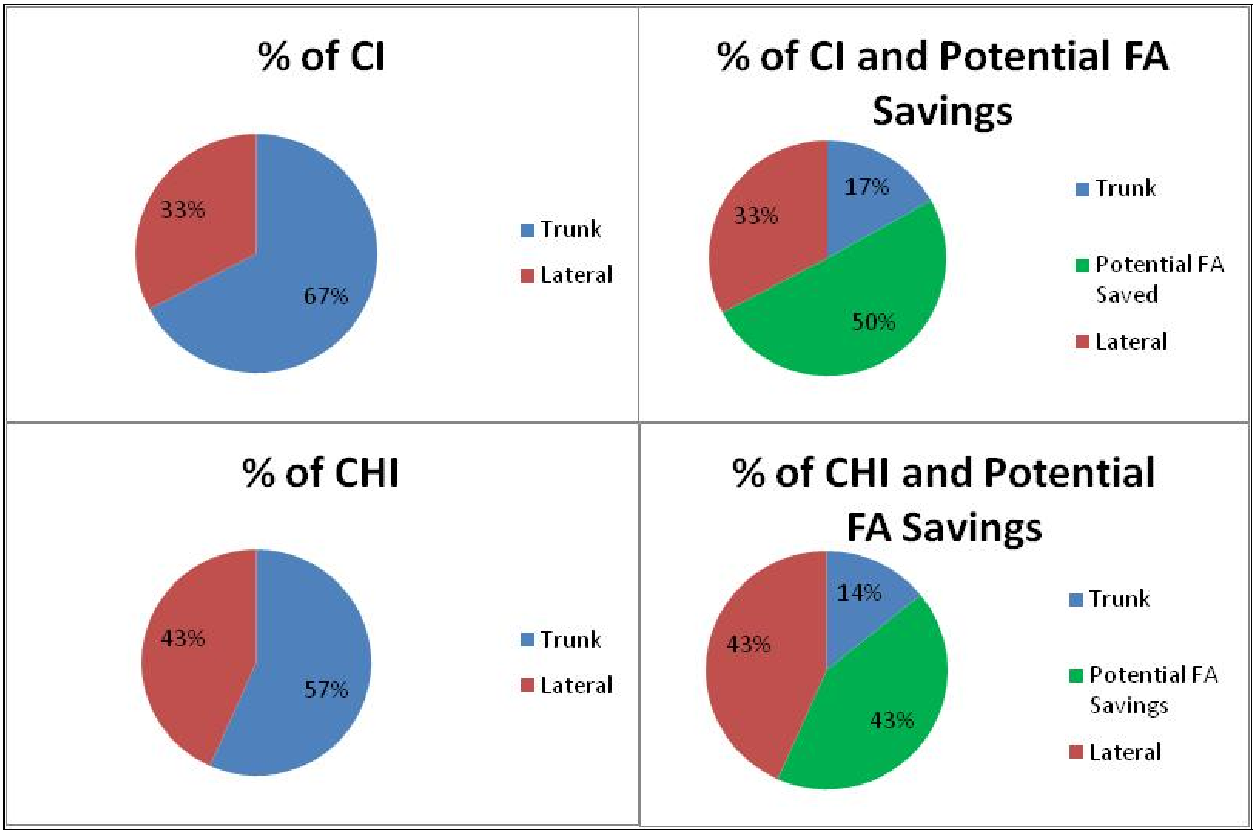


Figure 8: Reliabilty Impact and FA Savings on Selected Feeders

As shown above, outages on feeder trunks are the major source of both CI and CHI because trunk outages are lengthy and affect all the customers on a feeder. As long as there is no effective method to mitigate the impact of trunk related outages, it will be difficult to improve or even maintain current reliability levels as aging assets begin to fail at a higher frequency. The most cost effective solution to mitigate the impact of trunk outages is to deploy an FA scheme focusing on areas containing feeders with poor trunk reliability.

The true system benefits of FA can only be achieved by deploying it widely so that multiple feeders and switching points are covered. If the FA jobs proposed here are delayed until the next cost of service filing the number of feeders and areas that can be addressed will be reduced. The number of feeders that can be addressed in an area at any one time must be limited to maintain operational flexibility in the case of an outage. This is limitation is necessary to allow power system controllers to have a sufficient number of feeders available to restore an area in the event of an outage. One method used to maximize the amount of FA deployment is to work in multiple areas of the system, the east, west and north areas of the city, at the same time.

IV PREFERRED ALTERNATIVE

1. Alternatives Considered and Assessed

THESL's FA program is a cost-effective option to mitigate the system reliability consequences of outages in areas with poorly performing trunk feeders. THESL evaluated the FA program, the preferred alternative, against four other alternatives that also could be used to mitigate trunk related outages on these feeders:

- Do nothing. Respond to outages using existing switching capacity and processes.
- Reduce the impact of a fault on the trunk by adding more switching capability via manual switches;
- Reduce the impact of a fault on the trunk by adding more switching capability via SCADA enabled switches; and
- Reduce the probability of a fault on the trunk by rebuilding large portions of feeder trunks, up to and including the entire trunk portion.

2. Preferred Alternative – Install FA on Selected Feeder Trunks

The material above shows the benefits of installing FA, which tends to significantly reduce the impact and the duration of outages by eliminating all the manual intervention from the controller and the field crew. As load growth continues, with new condominiums, the expansion of the TTC and future commercial development, the ability to perform load transfers via tie feeders will diminish. As a result, THESL will be required to undertake additional and more complex analyses of multiple feeders to sectionalize and re-supply feeder segments. Through an FA implementation, this analysis can be performed automatically with self-healing switches and pre-determined sections that automate load transfers. The cost and benefits associated with the preferred alternative are set out in Appendix 1.

As shown by Figure 9 below, installing FA is expected to improve the benefit/cost ration (B/C) compared to manual switches (the green line) and shows an even greater improvement for FA compared to SCADA switches (the red line). The reason for the greater B/C ratio in the latter comparison is that the incremental cost of installing FA is relatively low once SCADA switches are already installed on the feeder. In contrast, if a feeder has only manual switches, FA requires the installation of SCADA switches as well as automation technology, which leads to substantially higher cost.

Figure 9 is based on the relative values for a single outage, but the value of FA increases if there are multiple outages on the feeder. The feeders to be addressed in the proposed jobs are likely to experience frequent outages because they have been selected to target the worst performing feeders. Tables D.2 through D.6 in Appendix 3, list the costs of implementation and the benefits for each proposed job.

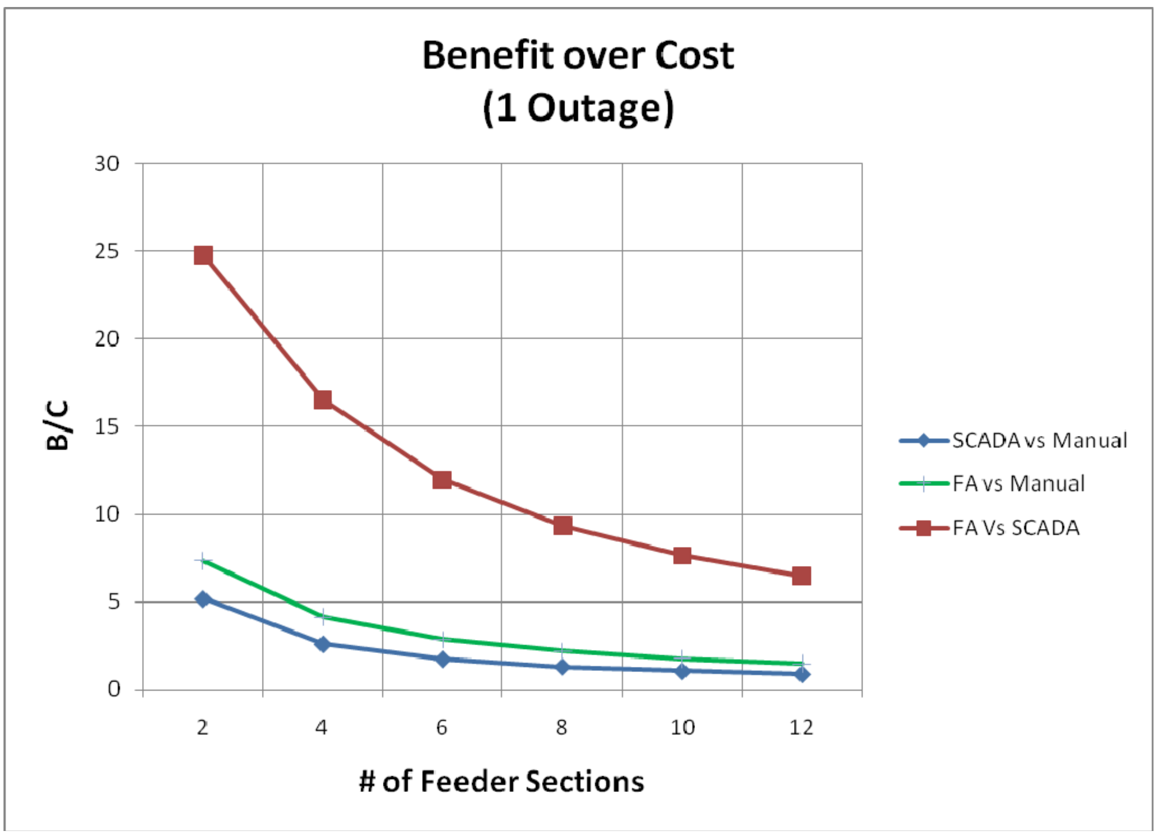


Figure 9: Comparison B/C Ratios for Various Alternatives

3. Alternative 1: No Investment.

Under this alternative, THESL will continue to respond to outages using existing manual switching capacity and current processes and protocols. By not investing in any improvement current reliability levels are likely to decline due to the high probability equipment failure that impacts feeder trunks. The Appendix 3 shows that reliability is forecasted to deteriorate due to projected failure rates on equipment that impacts feeder trunks.

4. Alternative 2: Add Manual Switches to Reduce the Impacts of Feeder Trunk Faults

Since most of the feeders in the system have a combination of manual and remote switches, the best method to determine the comparative B/C ratios of the available switching technologies s to develop a theoretical model that compares one technology to another and how each technology relates to the number of segments on a feeder. The results of this model are illustrated on Figure 9 and the methodology is explained in Appendix 1.

Installing additional manual switches is expected to help crews isolate the feeder into manageable segments. The crew will then be able to address the segment where the fault is located while restoring service the unaffected portions of the feeder. To repair a feeder with all manual switches would typically take a crew approximately three hours. This includes the time to deploy, locate the fault, isolate it and restore all the unaffected areas of the feeder.

Although adding more switches to create more segments improves the CHI of the feeder, it is a costly option to adopt throughout the system. The problem with manual switches is that there is no way to automatically determine where the fault has occurred without first visually inspecting the feeder and there is still the need to deploy crews to all the switch locations that need to be operated. As crews are manually restoring the feeder another crew would be needed to repair the fault. The cost and benefits associated with this alternative are set out in Appendix 1.

When comparing manual switches to SCADA-enabled switches in the model, it is evident that there is a benefit in reducing the impact of trunk related outages by remotely restoring the unaffected portion of the feeder. The blue line in Figure 9, illustrates the potential benefit to cost ratio from this comparison. The graph also illustrates that the benefit decreases as more switches are installed on the feeder due the higher initial cost of SCADA switches multiplied by the number switches installed. Three to four switches is generally the ideal number of sections on a feeder.

5. Alternative 3: Add SCADA Enabled Switches to Reduce the Impacts of Feeder Trunk Faults

This alternative adds SCADA-enabled switches with remote operation and sensing capabilities to the feeder trunk. When compared to the installation of manual switches, there is an improved B/C ratio as shown in Figure 9 by the blue line. A SCADA-enabled switch allows an operator to remotely determine where the outage has occurred, isolate the fault, and restore the unaffected portions of the feeder remotely**.** Since the switches have the ability to detect the faulted portion of the feeder, the operator can restore the unaffected portions of the feeder while isolating the faulted section. The operator can usually locate, isolate the fault, and restore the unaffected feeder within 30 minutes or less. By remotely operating the switches the restoration time is no longer determined by the time required for the crew to arrive and locate the fault. Furthermore, a crew no longer needs to drive to multiple locations to manually operate switches.

The efficiency of determining the fault location and operating the switches remotely provides a significant improvement in reliability, but outages are still extended by the time it takes for the controller to manage the feeder. The reliability gains work to improve the B/C ratio, but the additional cost of the remote SCADA switch installation works in the opposite direction. Thus, installing SCADA switches represents an improvement over manual switch installation, but is still inferior to installing FA. The cost and benefits associated with this alternative are set out in Appendix 1.

6. Alternative 4: Rebuild Large Portions of Feeder Trunks to Reduce the Occurrence of Faults

Rebuilding portions of the feeder by replacing end of life components likely decreases the probability of an outage. Also, rebuilding large portions of the trunk only reduce the probability of equipment-related outages. It does not account for non-component outages (non-asset risk) such as foreign interference and adverse weather (See Appendix 3).

In contrast, improved switching ability will likely mitigate the impacts of trunk related outages from any source. With feeder automation, the B/C ratio also would increase as more outages are experienced on the feeder regardless of their source. Furthermore, feeder automation will likely improve restoration flexibility even for feeders with a low probability of failure. Because the cost of implementing self healing switches is relatively low and the benefits of improved feeder restoration high, the FA project is beneficial to the system even if there is equipment on the feeder approaching end of life that will need to be replaced.

V JOB INFORMATION OVERVIEW

1. Implementation Plan

THESL intends to expand upon its existing 2010 FA pilot project to maximize the benefits of the proposed expenditures. By expanding FA to the interconnecting feeders located on the periphery of the existing network, the options for automatic restoration are enhanced. The first expansion project is expected to incorporate the remaining of the feeders at Fairbanks T.S. to the FA arrangement

The second expansion project, scheduled for 2012, will incorporate the remaining feeders at Bathurst T.S. into the existing FA grid. Furthermore, there will be further expansion into Fairchild T.S. in 2013. Where necessary and feasible, each expansion project also will incorporate existing non-automated tie-points into the expansion, which will make the existing FA feeders more efficient and the network more flexible. This approach is expected to increase the number of feeders in the mesh network and allow for more restoration options.

The project is expected to continue with further expansion in the east and west of Toronto by incorporating new areas to improve the reliability to the worst performing feeders in those areas. In Scarborough, THESL will create a new network targeting the worst performing feeders from Cavanagh T.S. and Agincourt T.S. in 2012, Ellesmere T.S. and Malvern T.S. in 2013, and Scarborough East in 2014. In Etobicoke, starting in 2013, THESL intends to create a new network involving feeders from Manby T.S. and Horner T.S. and targeting the worst performing feeders in that area. This will be the initial hub of expansion in west-end of Toronto and expansion will continue to incorporate other poorly performing feeders in the area. This is expected to allow this new system to target multiple parts of the city rather than focusing exclusively on the central North York location. This approach is expected to produce greater coverage and a more rapid diffusion of the benefits of FA.

2. Business Case Evaluation (BCE) Results

THESL undertook a business case evaluation of FA projects being proposed for Etobicoke, North York, and Scarborough to demonstrate the benefits of FA in each area. The results are shown in Table 4. As Table 4 demonstrates, the proposed work in each area provides significant benefits compared to its cost of implementation.

Table 4: Business Case Evaluation of FA Target Area Projects

Project Location	Project Cost Allocated ($ M)	Project Net Benefit ($ M)	Option Benefit/Cost Ratio
Etobicoke Grid	$3.04	$235.78	**78.50**
North York Grid	$2.53	$181.87	**72.67**
Scarborough Grid	$25.92	$3,003.07	**116.86**

The effectiveness of each Feeder Automation project can be further highlighted by determining the difference in cost of ownership between the existing overhead assets installed along the feeder trunk circuits, and the cost of ownership of those same assets with FA implemented as explained in Appendix 3. With an FA system in place, the average estimated outage duration per feeder trunk asset will be reduced considerably. This difference in ownership cost includes quantified risk costs, which take into account the assets' probability of failure, and the various direct and indirect costs associated with in-service asset failures, including the costs of customer interruptions, emergency repairs and replacement, as well as non-asset-related risks associated with the existing overhead plant, including outages caused by animals, human activity and weather-related events.

As shown in Table 4 above, carrying out immediate work on the Etobicoke grid will result a net present value of approximately $236 million, which represents the difference between these cost of ownership values and the total project cost of $3.04 M. There is a benefit-to-cost ratio of 78.50 that is produced when this difference in cost of ownership is divided by the capital cost of the project.

Carrying out immediate work on the North York grid will result a net present value of approximately $182 million, which represents the difference between the cost of ownership values and the total project cost of $2.54M. There is a benefit-to-cost ratio of 72.67 that is produced when this difference in cost of ownership is divided by the capital cost of the project.

Carrying out immediate work on the Scarborough grid will result a net present value of approximately $3 billion, which represents the difference between the cost of ownership values and the total project cost of $25.92. There is a benefit-to-cost ratio of 116.86 that is produced when this difference in cost of ownership is divided by the capital cost of the project.

The business case evaluation results for the proposed FA work in each area show that the proposed FA installations will provide high value. This result is largely attributable to large number of outages and associated high risk cost due to the presence of failing equipment on these feeders. Based on the business case evaluation, these projects should be undertaken immediately. Customers will receive substantial benefits from the reliability improvement that this project will produce. Further details for each of these business cases and corresponding calculations are provided in, Appendix 3.

VI SPECIFIC JOBS PROPOSED

1. LISTING OF ALL JOBS

1.1. Listing of all Jobs

Table 5: Cost of all Proposed FA Jobs over the Next Three Years

Job Title	Job Year	Cost Estimate ($ M)
Feeder Automation 2012 – Cavanaugh TS and Agincourt TS	2012	$7.82
Feeder Automation 2013 - Horner T. S. and Manby T. S.	2013	$3.04
Feeder Automation 2013 - Fairchild T. S.	2013	$2.54
Feeder Automation 2013 – Cavanagh TS, Agincourt TS, Ellesmere TS, and Malvern TS	2013	$10.72
Feeder Automation 2014 – Scarborough East T.S.	2014	$7.38
	Total:	**$31.50**

1.2. General Scope of Work

The general scope of work for these jobs consists of two phases. The first phase involves choosing feeders that will benefit from automation. The second phase is effectively sectionalizing the feeder. Feeder selection was based on reliability, network configuration, and restoration capacity. Feeders were first selected on based on their reliability and focusing on the number of outages that occurred on the trunk. Since this project builds on the existing FA implementation, feeder selection also was based on designing a system that could connect into the existing FA implementation. This will require utilizing non-automated tie-points considered to be necessary to backfeed into established FA feeders. The design considered feeders experiencing poor reliability in the area and interconnected with one another. Each feeder selected must be able to backfeed into a section and resupply a faulted feeder.

The design principle used for sectionalizing a feeder was to create segments with equal numbers of customers connected and similar amounts of load. Exceptions were made in cases where the feeder backfeeding into a segment had limited capacity. In these instances, efforts were undertaken to ensure that the load of that segment was reduced to accommodate the capacity limitations. In most cases, the existing infrastructure will be reused to reduce costs. Existing SCADA switches will be reused and a retrofit module installed in the RTU. This provides substantial savings when compared to installing a new SCADA switch with a new RTU.

2. Feeder Automation 2012 – Cavanagh T.S. and Agincourt T.S.

2.1. Job Objectives

The objective of this job is to introduce a new FA mesh network to address the worst performing feeders in Scarborough incorporating 13 feeders from Cavanagh T.S. and Agincourt T.S. These stations were chosen due to their poor reliability, their location and ability to expand to other stations, and the number of overhead switches available. Once this job is completed, THESL intends to use it as a starting point for expansion to other feeders in Scarborough.

The selected feeders demonstrate poor reliability and high impact trunk outages affecting the customer (CHI). In the last five years, these feeders have had had 206,560 customers interruptions and 103,807.0 of CHI. If feeder automation had been installed five years ago, with the assumption that 75% of the feeder would be restored during a trunk outage, a savings of 154,920 CI and 77,855.3 CHI would have been realized. These feeders are excellent candidates for FA and an opportunity for THESL to improve the reliability for the customers in this area.

Additional factors also motivated the selection of these feeders. Cavanagh T.S. and Agincourt T.S. are centred in the middle of Scarborough and provide excellent expansion opportunities to allow FA to be further integrated into the system. Greater integration is expected to facilitate lower cost or quicker implementation expansion that will increase the amount and speed of benefit accrual.

Table 6: Outage Data for 2012 FA Feeders (Cavanagh T.S. and Agincourt T.S.)

Year	Total Feeder Outages			Trunk Outages			Forecasted Savings if FA is Implemented	
	Number of Outages	CI	CHI	Number of Outage	CI	CHI	CI	CHI
2007	58	103,791	44,673.3	24	79,722	27,905.0	59,792	20,928.7
2008	39	42,579	23,373.1	10	23,332	8,690.4	17,499	6,517.8
2009	47	63,280	52,854.3	17	55,851	33,906.2	41,888	25,429.6
2010	35	31,429	22,087.9	3	9,219	4,724.5	6,914	3,543.3
2011	25	57,780	59,766.9	10	38,436	28,581.1	28,827	21,435.8
Total	**204**	**298,859**	**202,755.4**	**64**	**206,560**	**103,807.0**	**154,920**	**77,855.3**

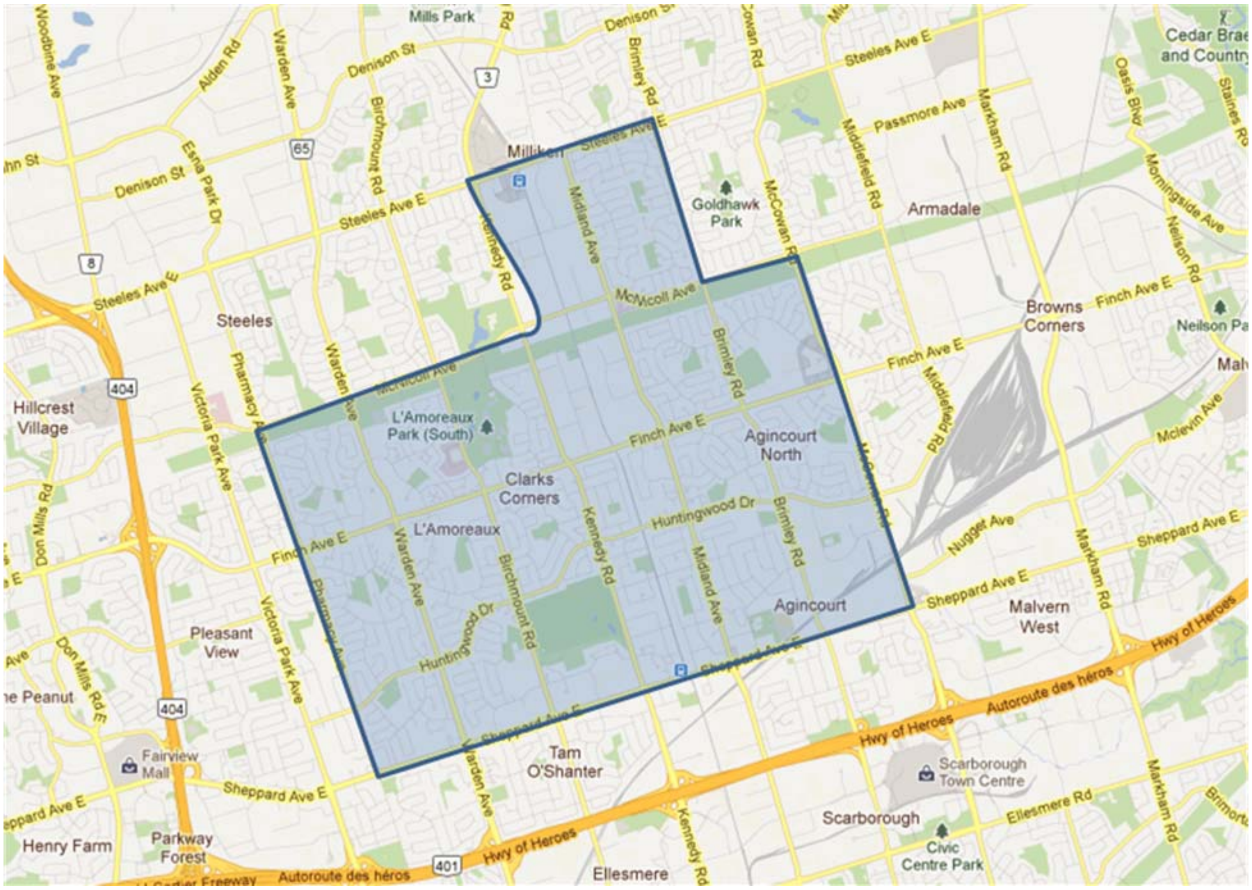
2.2. Scope of Work

This job anticipates implementing FA on 13 feeders from these two stations. At the completion of this job, it is estimated there were will be 57 self healing switching nodes on this network. It will require retrofitting 27 existing SCADA switches, installing seven new switches, and upgrading 23 manual switches to self-healing switches. This is summarized in Table 7, and Figure 10 provides a schematic of the plan with feeder and switch locations.

Table 7: 2012 FA Cavanagh T.S. and Agincourt T.S. Unit Count

Total of Switch Installations	
Type of Install	**Cavanagh T.S. and Agincourt T.S.**
Retrofit Existing SCADA	27
R1 to R2 Switch Upgrade	0
Install a New Switch	7
Replace Manual Switch	23
Total	**57**

1 **2.3. Job Map and Locations**



2 **Figure 10: 2012 Feeder Automation Cavanagh TS and Agincourt TS Map**

1 **Table 8: 2012 Feeder Automation Cavanaugh TS and Agincourt TS Job Breakdown**

2012 Feeder Automation - Cavanaugh TS and Agincourt TS					
Feeder	**Scope Package**	**Switch ID**	**Type**	**Location**	**Notes**
502M22	E12591	OSL80610	Replace	P3129-31A Milliken Blvd (105 Milliken Blvd.)	Sectionalizer
		OSL78126	Replace	P3080 Finch Avenue E	Tie-point
		OSL79631	Replace	P3440 Finch Avenue E	Sectionalizer
		OSC49119	Upgrade	P2187 Warden Avenue	Sectionalizer
		OSC46563	Upgrade	P3546 Sheppard Avenue E	Sectionalizer
502M23	E12592	OS89696	Replace	P3101 Kennedy Rd.	Sectionalizer
		OSL79068	Replace	P3548 Finch Avenue E	Tie-point
		OSL78099	Replace	P3050 Finch Avenue E.	Tie-point
		OS89628	Replace	P3045 Kennedy Rd.	Sectionalizer
		OSL79012	Replace	P3600 Finch Avenue E.	Sectionalizer
		OSC62447	Upgrade	P3390 Kennedy Rd	Tie-point
502M24	E12593	OSL76763	Replace	P3252 Sheppard Avenue E	Sectionalizer
		OSL86256	Replace	P3129-32A Milliken Blvd (105 Milliken Blvd)	Sectionalizer
		OSL75261	Replace	P2370 Pharmacy Avenue E	Sectionalizer
502M26	E12594	OS89656	Replace	P3043 Kennedy Road	Sectionalizer
		OSL82190	Replace	P4000 Finch Avenue E.	Tie-point
		OSC64590	Upgrade	P3760A Finch Ave E	Tie-point
		OSC20317	Upgrade	P34-133 Kennedy Road	Sectionalizer
		OSC70721	Upgrade	P4156 Sheppard Avenue E	Tie-point
		OSC-1	Replace	P34-127 Sheppard Avenue E.	Sectionalizer
502M29	E12597	OSL8627	Replace	P98 Miliken Blvd (105 Miliken Blvd.)	Sectionalizer
		OS88562	Replace	P3640 Finch Avenue E.	Tie-point
		OSC44144	Upgrade	P2550 Birchmont Road	Sectionalizer
		OSC-1	Replace	P3700 Finch Avenue E.	Sectionalizer
63M1	E12598	63M1-CA-L	Replace	P3129-32B Milliken Blvd (105 Milliken Blvd)	Sectionalizer
		OS6318	Replace	P3030 Victoria Park Avenue	Tie-point
502M32	E12600	OSL83708	Replace	P59-379 Brimley Road (2201Brimley Road).	Sectionalizer
		OSL85502	Replace	P58-20 Sheppard Avenue E	Sectionalizer
		OSC73460	Upgrade	P2015 Brimley Road	Sectionalizer
		OSC-1	Replace	P58-3 Sheppard Avenue E	Sectionalizer
63M11	E12601	OS9169	Replace	P3570-J Miliken Blvd.	Sectionalizer
		OS94394	Replace	P3010 McCowan Rd.	Sectionalizer
		OSL71694	Replace	P800 Middlefield Road.	Tie-point
63M4	E12603	OSL83584	Replace	P4695 Steeles Avenue E	Tie-point
		OSC-1	Replace	P44-430 (house #3860) Midland Avenue	Sectionalizer
		OSC-2	Replace	P45-24 Passmore Avenue	Sectionalizer
63M5	E12604	OSL86571	Replace	P92 Miliken Blvd.	Sectionalizer
		OSL82140	Replace	P4050 Finch Avenue E.	Tie-point
		OSL83520	Replace	P56 Heather Road	Tie-point
		OSC91100	Upgrade	P4040 Finch Ave E	Sectionalizer
		OSC64254	Upgrade	P32 Glen Watford Drive	Sectionalizer
		OSC-1	Replace	P2740 Midland Avenue	Sectionalizer
63M6	E12605	OSC23778	Upgrade	P3455 Midland Ave	Tie-point
		OSC10728	Upgrade	P3070 Brimley Road	Sectionalizer
		OSC89976	Upgrade	P2207 Brimley Road	Tie-point
		OSC64201	Upgrade	P2640 McCowan Road	Sectionalizer
		OSC59905	Upgrade	P1918 McCowan Road	Tie-point
		OSC38623	Upgrade	P4980 Finch Ave E	Sectionalizer
63M12	E12606	OSL81537	Replace	P3570-L Milliken Blvd	Tie-point
		OS96341	Replace	P2601 Brimley Road	Sectionalizer
		OS91684	Replace	P3570-K Milliken Blvd.	Sectionalizer
		OSC-1	Replace	P2603 Brimley Road	Sectionalizer
63M8	E12607	OSL72138	Replace	P5070 Finch Avenue E.	Sectionalizer
		OSC75950	Upgrade	P4060 Finch Ave E	Tie-point
		OSC61279	Upgrade	P4618 Finch Avenue E	Sectionalizer
		OSC26706	Upgrade	P68-13 Finch Avenue E	Sectionalizer
		OSC92794	Upgrade	P5177 Finch Avenue E	Sectionalizer

1 **2.4. Required Capital Costs**

3 **Table 9: Total Cost for the 2012 Feeder Automation Cavanagh T.S. and Agincourt T.S. Job**

Feeder Automation 2012 – Cavanagh TS and Agincourt TS			
Project Estimate Number	**Project Title**	**Project Year**	**Cost Estimate ($, millions)**
22443	E12591 - PPEast 2012 Feeder Automation Project on SCNA502M22	2012	$0.63
22444	E12592 - PPEast 2012 Feeder Automation Project on SCNA502M23	2012	$0.79
22445	E12593 - PPEast 2012 Feeder Automation Project on SCNA502M24	2012	$0.46
22446	E12594 - PPEast 2012 Feeder Automation Project on SCNA502M26	2012	$0.71
22449	E12597 - PPEast 2012 Feeder Automation Project on SCNA502M29	2012	$0.50
22450	E12598 - PPEast 2012 Feeder Automation Project on SCNT63M1	2012	$0.21
22452	E12600 - PPEast 2012 Feeder Automation Project on SCNT502M32	2012	$0.53
22453	E12601 - PPEast 2012 Feeder Automation Project on SCNT63M11	2012	$0.37
22455	E12603 - PPEast 2012 Feeder Automation Project on SCNT63M4	2012	$0.46
22456	E12604 - PPEast 2012 Feeder Automation Project on SCNT63M5	2012	$0.82
22457	E12605 - PPEast 2012 Feeder Automation Project on SCNT63M6	2012	$0.62

Feeder Automation 2012 – Cavanagh TS and Agincourt TS			
Project Estimate Number	**Project Title**	**Project Year**	**Cost Estimate ($, millions)**
22458	E12606 - PPEast 2012 Feeder Automation Project on SCNT63M12	2012	$0.58
22459	E12607 - PPEast 2012 Feeder Automation Project on SCNT63M8	2012	$0.56
22447	E12595 - PPEast 2012 FA Project - Radio Coordination Study & Repeater Radio Installation	2012	$0.35
22448	E12596 - PPEast 2012 Feeder Automation Project - Site Acceptance Tests	2012	$0.22
		Total:	**$7.82**

2.5. Job Business Case Evaluation (BCE) Results

The 2012 FA job will improve reliability of the 13 new feeders from Cavanagh T.S. and Agincourt T.S. and provide flexible switching capabilities that currently do not exist. The reliability of these feeders, as shown in Table 6, is poor with numerous high impact trunk outages. Carrying out immediate work on these feeders will result in present value benefits of approximately $1.47B. The proposed project will cost $7.82M to implement. The resulting benefit-to-cost ratio is 188.94. FA will allow THESL to mitigate the risk of these feeders.

Table 10: BCE of Cavanagh T.S. and Agincourt T.S. Job

Project Location	Project Cost Allocated ($)	Project Net Benefit	Option Benefit/Cost Ratio
Cavanagh TS and Agincourt TS	$7,820,666	$1,469,810,870	188.94

3. 2013 Feeder Automation – Horner T. S. and Manby T. S.

3.1. Job Objectives

The objective of this job is to introduce a new FA mesh network in Etobicoke. There are current or planned networks in North York and Scarborough and they are anticipated to continue expanding. This job is expected to create a new network in the west-end to continue modernizing THESL's 27.6kV system located in the horseshoe region surrounding central Toronto.

Manby T.S. and Horner T.S. have been selected to be the hub of future expansion for FA jobs. These stations were chosen based on feeders with poor trunk reliability. More northerly stations in Etobicoke were not selected due other ongoing external jobs (e.g., TTC subway and LRT expansion) in the area that may alter feeder configuration. Furthermore, this area of Etobicoke has an obsolete radio and control system that is no longer supported by the manufacturer (MOSCAD) and is considered at risk infrastructure because new spare parts are no longer available

3.2. Job Scope of Work

This job involves a group of nine interconnected feeders on the east side of these two stations. Care was given to ensure that they the feeders were well integrated and limit the number of non-automated switches on the periphery of the mesh. This is expected to enable the new network to be effective on its own until further expansion occurred. The design for sectionalizing the feeder is based on creating equal segments of customers connected and load consumed on each segment. Exceptions were made in cases where the feeder backfeeding into a segment had limited capacity. In these instances, efforts were undertaken to ensure that the load of that segment was reduced to accommodate the capacity limitations.

In most cases, the existing infrastructure is expected to be reused to reduce costs. Existing SCADA switches will be reused and a retrofit module installed in the RTU. This provides substantial savings when compared to installing a new SCADA switch with a new RTU.

At completion, this job is expected to have 46 self-healing switching nodes on this network. This figure will be achieved by retrofitting eight existing SCADA switches, upgrading 13 non-standard R1 switches to R2 switches, installing ten new switches, and upgrading 15 manual switches to self healing switches. This work is summarized in Table 11 and Figure 12 provides a schematic of the plan with feeder and switch locations. Furthermore, this job is expected to upgrade 14 switches from the obsolete MOSCAD network and incorporate them into the new Speednet network.

Table 11: 2013 FA Unit Count

Total of Switch Installations	
Type of Install	**Manby TS and Horner TS**
Retrofit Existing SCADA	8
R1 to R2 Switch Upgrade	13
Install a New Switch	10
Replace Manual Switch	15
Total	**46**

1 **3.3. Job Map and Locations**

2 **Figure 12: 2013 Feeder Automation Job for Manby T.S. and Horner T.S.**

3

1 **Table12: 2013 FA Manby T.S. and Horner T.S. Switch Locations**

Feeder Automation 2013 - Etobicoke - Manby T. S. and Horner T. S.					
Feeder	**Scope Package**	**Switch ID**	**Type**	**Location**	**Notes**
30M1	W13371	OSC69948	Upgrade	P464 Kipling Ave	Riser Switch
		New Switch 30M1_1	Replace	P415 Royal York Rd	Sectionalizer
		OSC17906	Upgrade	P159 Evans Ave	Sectionalizer
		OSC16303	Replace	P551 Royal York Rd	30M1/38M13
		OSC58022	Replace	P205 Evans Ave	Sectionalizer
		OSC73106	Upgrade	P884 Islington Ave	TP 30M1/38M8
		OSC75130	Upgrade	P445 Royal York Ave	Sectionalizer
		OSL61906	Replace	P327 Royal York Ave	TP 30M1/30M8
30M2	W13375	New Switch 30M2_1	Replace	P210 Horner Ave	Riser Switch
		OSC4821	Replace	P311-1 Cavell Ave	Sectionalizer
		OSL34893	Upgrade	P2269 Lake Shore Blvd	TP 30M2/30M8
30M4	W13377	OS95321	Replace	P215 Horner Ave	Riser Switch
		OSC2489	Replace	P40 New Toronto Ave	Sectionalizer
		OSC62786	Replace	P204 Islington Ave	TP 30M4/30M9
		OSL10621	Replace	P2636 Lake Shore Ave	TP 30M4/30M9
		OSL43741	Replace	P134 Mimico Ave	Sectionalizer
		OSL97364	Replace	P229 Royal York Rd	TP 30M4/30M2
30M8	W13378	New Switch 30M8_1	Replace	P220 Horner Ave	Riser Switch
		New Switch 30M8_2	Replace	P222 Judson St	Sectionalizer
		OSC10447	Replace	P31 Legion Rd	Sectionalizer
		OSC41616	Replace	P157 Park Lawn Rd	TP 30M8/38M13
		OSL1646	Replace	P177 Evans Ave	TP 30M8/30M1
30M9	W13379	New Switch 30M9_2	Replace	P2988 Lake Shore Blvd W	Sectionalizer
		New Switch 30M9_3	Replace	P2884 Lake Shore Blvd W	Sectionalizer
		New Switch 30M9_4	Replace	P11 Royal York Rd	Sectionalizer
		New Switch 30M9_1	Replace	P452 Kipling Ave	Riser Switch
		OSC67457	Replace	P100 Birmingham Ave	Sectionalizer
		OSC8146	Upgrade	P197 Royal York Rd	TP 30M9/30M4/30M6
		OSC93977	Upgrade	P3146 Lake Shore Blvd W.	TP 30M9/30M10/30M5
		OSL89332	Replace	P456 Kipling Ave	TP 30M9/30M1
38M12	W13380	New Switch 38M12_1	Replace	P1005 The Queensway	Sectionalizer
		OS38668	Replace	P87 Kipling Ave	Riser
		OSC10670	Replace	P787 The Queensway	TP 38M12/30M1
		OSC35254	Upgrade	P651 Kipling Ave	Sectionalizer
		OSL37500	Replace	P589 Kipling Ave	TP 38M12/30M3
38M4	W13384	OS98419	Replace	P67 North Queen St	Riser Switch
		OSC12081	Replace	P659 Kipling Ave	Sectionalizer
		OSC21749	Replace	P619 Kipling Ave	TP 38M4/30M1
		OSL55267	Replace	P723 Kipling Ave	TP 38M4/38M12
38M5	W13383	OS32405	Replace	P840 Kipling Ave	Riser Switch
		OSC58580	Upgrade	P888 Islington Ave	TP 38M5/30M1
		OS42073	Replace	P197 Norseman St	Sectionalizer
38M8	W13381	OS23912	Replace	P820 Kipling Ave	Riser Switch
		OSC31218	Replace	P1024 Islington Ave	Sectionalizer
		OSC65479	Replace	P65 Jutland Rd	TP 38M8/38M12
		New Switch 38M8_1	Replace	P245 Norseman St	TP 38M8/38M5

3.4. Required Capital Costs

Table13: 2013 FA Required Capital Costs

Feeder Automation 2013 - Horner T. S and Manby T. S.			
Project Estimate Number	**Project Title**	**Project Year**	**Cost Estimate ($M)**
24191	W13384 - 2013 FA - Etobicoke - Manby TS (38M4)	2013	$0.29
24187	W13383 - 2013 FA - Etobicoke - Manby TS (38M5)	2013	$0.16
24193	W13381 - 2013 FA - Etobicoke - 38M8	2013	$0.30
24154	W13380 - 2013 FA - Etobicoke - 38M12	2013	$0.26
24185	W13379 - 2013 FA - Etobicoke - Horner TS (30M9)	2013	$0.49
24183	W13377 - 2013 FA - Etobicoke - Horner TS (30M4)	2013	$0.45
24178	W13375 - 2013 FA - Etobicoke - Horner TS (30M2)	2013	$0.23
24188	W13378 - 2013 FA - Etobicoke - Horner TS (30M8)	2013	$0.40
24177	W13371 - 2013 FA - Etobicoke - Horner TS (30M1)	2013	$0.46
		Total:	**$3.04**

3.5. Job Business Case Evaluation (BCE) Results

Analyzing the reliability of the selected feeders shows that the outages occurring on the trunk have the greatest impact on the customers connected to these feeders. This can be seen in Table 14. Even though the number of outages that have occurred on the trunk are less than half of the total amount of outages that occur on the feeder, they contribute over 90% of the customer hours interrupted (CHI) on these feeders. Managing the trunk outages with self-healing switches is expected to reduce the CHI value on these feeders and also the number of customers affected by each outage. This confirms that these feeders are good candidates for feeder automation. Carrying out immediate work on these feeders will result in an approximate net present value of approximately $235.78M as shown in Table 15. The proposed project will cost $3.04 M to implement resulting in a benefit-to-cost ratio of 78.50.

Table 14: 2013 FA Feeders Reliability History

Year	Total Feeder Outages			Trunk Outages			Potential FA Savings	
	Number of Outages	CI	CHI	Number of Outage	CI	CHI	CI	CHI
2007	26	3,202	2,392.4	8	2,389	1,289.7	1,792	967.3
2008	23	17,669	23,403.6	11	17,321	22,616.8	12,991	16,962.6
2009	27	22,910	54,133.5	10	17,878	52,369.3	13,409	39,276.9
2010	12	21,141	2,307.0	5	19,667	2,136.8	14,750	1,602.6
2011	17	22,674	19,171.1	6	17,145	18,455.8	12,859	13,841.8
Total	**105**	**87,596**	**101,407.6**	**40**	**74,400**	**96,868.3**	**55,800**	**72,651.2**

Table 15: BCE for Horner T.S. and Manby T.S. Job

Project Location	Project Cost Allocated ($)	Project Net Benefit	Option Benefit/Cost Ratio
Horner TS and Manby TS	$3,042,223	$235,775,857	78.50

4. 2013 Feeder Automation – Fairchild T.S.

4.1. Job Objectives

The objective of this job is to expand the existing feeder automation network eastward from the North York network, incorporating new feeders from Fairchild T.S. The North York network was initiated by a pilot project in 2010. Since the pilot project, THESL has designed two phases to incorporate the remainder of Fairbanks T.S. and Bathurst T.S. This job will continue to expand this network at Fairchild T.S. to improve customer reliability in this area. This is a mixed use area consisting of residential and non-residential customers. This area is also considered one of the four centres for development and growth in the city and is planned to include facilities such as condominiums and office buildings. An expansion of FA eastward will improve the reliability in one of Toronto's developing neighbourhoods.

4.2. Job Scope of Work

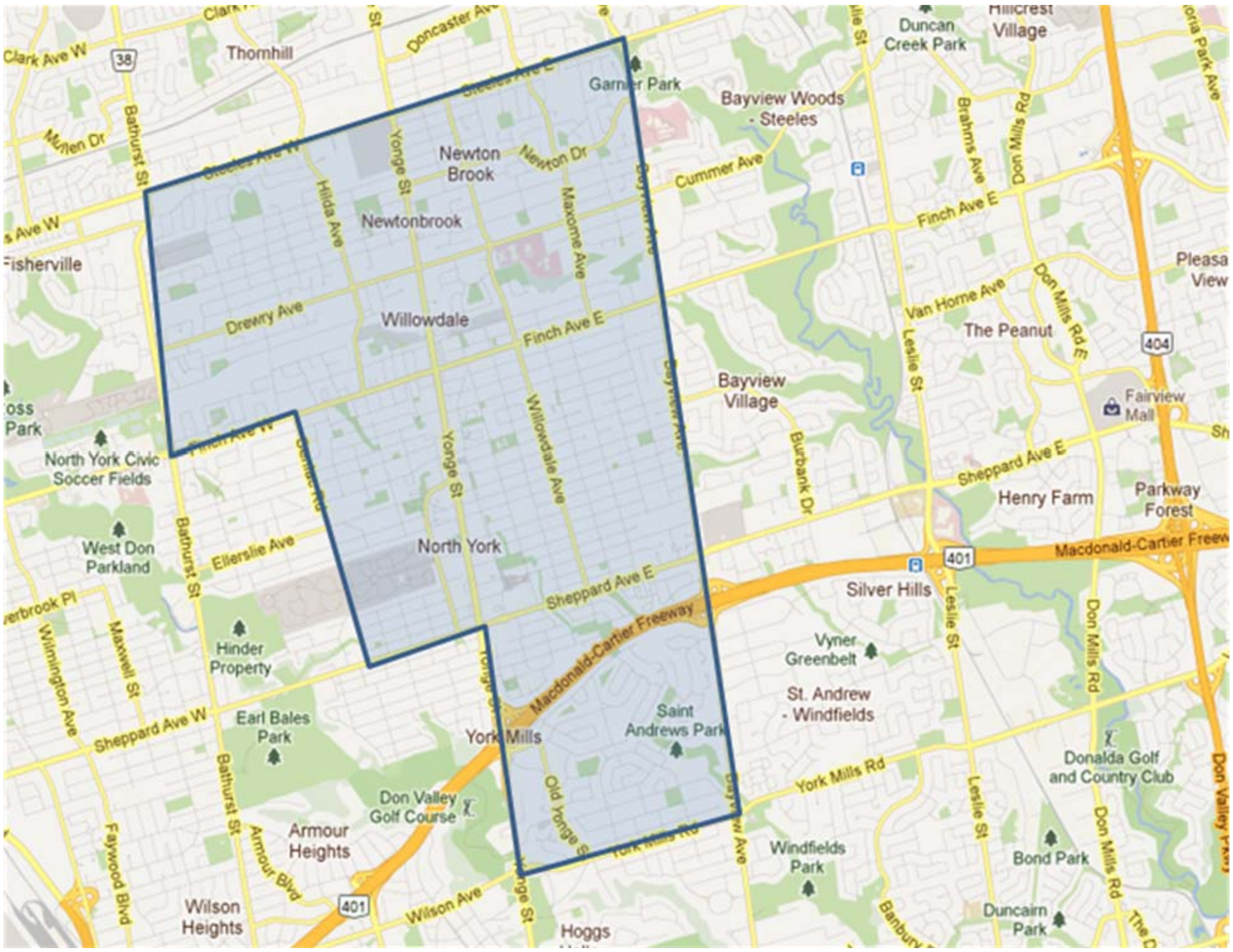
This scope of work for this job focuses on expanding the FA scheme onto eight feeders from Fairchild T.S. This is expected to incorporate these feeders onto the developed FA grid from Bathurst T.S. and will contribute to expanding the grid in North York. This will improve switching flexibility in the FA scheme. It is expected to establish more restoration options by introducing additional tie-points and automating the non-automated tie-points. This job will incorporate 44 self-healing switches into this network. This figure includes retrofitting 18 existing SCADA switches, installing seven new switches and upgrading 19 manual switches as shown in Table 16.

Table 16: 2013 FA Fairchild T.S. Unit Count

Total of Switch Installations	
Type of Install	**Fairchild TS**
Retrofit Existing SCADA	18
R1 to R2 Switch Upgrade	0
Install a New Switch	7
Replace Manual Switch	19
Total	**44**

1 **4.3. Job Map and Locations**

2



3 **Figure 13: 2013 FA Fairchild T.S. Map**

1 **Table 17: 2013 FA Fairchild T.S. Job Breakdown**

2013 FA Fairchild TS					
Feeder	Scope Package	Switch ID	Type	Location	Notes
80M2	W13367	OS95875/S1424	Replace	P97 Drewry Ave	Riser on the egress
		LC33	Replace	P85 Drewry Ave	Tie-point 80M4
		OSC3851/S47	Upgrade	P459 Patricia Ave	Sectionalizer
		OSC59862/S186	Upgrade	P5952 Bathurst St	Tie-point 80M8
		New SW1	New Swit	P95 Cactus Ave.	Sectionalizer
		New SW2	New Swit	P6200 Bathurst St	Sectionalizer
80M4	W13368	OS54675/OSL56852	Replace	P75 Drewry Ave	Riser on the egress
		OSC22676	Upgrade	P61 Cummer Ave	Sectionalizer
		OSC61755	Upgrade	P956 Willowdale Ave	Tie-point 80M6
		OS90738	Replace	P367 Cummer Ave	Sectionalizer
		OSC47012	Upgrade	P497 Cummer Ave	Tie-point 80M21
		New SW2	New Swit	P1131 Willowdale Ave	Tie-point 80M21
80M21	W13373	OSL97899	Replace	P309 Steeles Ave W	Tie-point 80M10
		OSC19741	Upgrade	P11 Steeles Ave W	Sectionalizer
		OS77279	Replace	P3587 Bayview Ave	Sectionalizer (Riser)
		OSC3939	Upgrade	P375 Steeles Ave W	Tie-point 51M3
		OSC67980	Upgrade	P3324 Bayview Ave	Tie-point 80M6
80M6	W13369	OS87184	Replace	P17-2 Hendon Ave.	Sectionalizer
		OSC64725	Upgrade	P851 Willowdale Ave	Sectionalizer
		OSC4679	Upgrade	P338 Willowdale Ave	Sectionalizer
		New SW1	New Swit	P218 Willowdale Ave	Sectionalizer
		OSC4778	Upgrade	P110 Willowdale Ave	Tie-point 80M29
80M8	W13370	New SW1	New Swit	P5760 Bathurst St	Sectionalizer
		OSC573	Upgrade	P4976 Bathurst St	Tie-point 80M1
		OSC48420	Upgrade	P539 Finch Ave W	Sectionalizer
		OS6680	Replace	P75 Grantbrook St.	Sectionalizer
80M1	W13366	OSC7353	Upgrade	P363 Senlac Rd	Sectionalizer
		OSL42108	Replace	P251 Finch Ave.	Sectionalizer
		OSL11444	Replace	P58 Senlac Rd	Sectionalizer
		New SW1	New Swit	P28 Greenview Ave.	Sectionalizer
		OS63486	Replace	P205 Churchill Ave.	Sectionalier
		OSL92822	Replace	P223 Sheppard Ave W	Tie-point 85M27
80M29	W13374	OS11106	Replace	P103 Willowdale Ave	Riser on the egress
		OS98881	Replace	P197 Avondale Ave	Sectionalizer (Riser)
		OS57616	Replace	P229 Upper Highland Cres	Sectionalizer
		OSL44267	Replace	P152 York Mills Rd	Sectionalizer
		OSC9200	Upgrade	P288 York Mills Rd	Tie-point 51M21
		OSC1727	Upgrade	P52 York Mills Rd	Tie-point 85M8
80M10	W13372	OS59180	Replace	P103 Drewry Ave	Riser on the egress
		LC30	Replace	P177 Goulding Ave	Tie-point 80M2
		New SW1	New Swit	P127 Hilda Ave	Sectionalizer
		OSC209	Upgrade	P203 Hilda Ave	Sectionalizer
		OSC70288	Upgrade	P160 Cactus Ave	Tie-point 80M2
		OSL39372/S424	Replace	P6168 Bathurst St	Tie-point 80M10

4.4. Required Capital Costs

Table 18: 2013 FA Fairchild T.S. Job Cost

Feeder Automation 2013 - Fairchild T. S.			
Project Estimate Number	**Project Title**	**Project Year**	**Cost Estimate ($M)**
24192	W13367 - 2013 FA - North York - Fairchild TS (80M2)	2013	$0.34
24195	W13368 - 2013 FA - North York - Fairchild TS (80M4)	2013	$0.34
24199	W13374 - 2013 FA - North York - Fairchild TS (80M29)	2013	$0.39
24200	W13366 - 2013 FA - North York - Fairchild TS (80M1)	2013	$0.42
24196	W13369 - 2013 FA - North York - Fairchild TS (80M6)	2013	$0.23
24197	W13370 - 2013 FA - North York - Fairchild TS (80M8)	2013	$0.19
24198	W13372 - 2013 FA - North York - Fairchild TS (80M10)	2013	$0.36
24194	W13373 - 2013 FA - North York - Fairchild TS (80M21)	2013	$0.27
		Total:	**$2.54**

4.5. Job Business Case Evaluation (BCE) Results

Deploying a feeder automation scheme on these feeders can significantly reduce the impact of the outages on the feeder trunk and the number of customers that would otherwise experience a sustained outage. These reliability improvements are expected to become even more significant based on the development that is occurring in this area. Significant customer growth is occurring in both residential and non-residential load.

Beyond reliability benefits, this job is also necessary to expand the effectiveness of previous FA installations nearby. Thus it not only is expected to improve reliability for the customers on the targeted feeders, but also will improve performance on the existing automated feeders that currently have non-automated tie-points. Carrying out immediate work on these feeders will result in an approximate net present value of approximately $181.9M. The proposed project will cost $2.54M to implement and it is expected to provide a benefit-to-cost ratio of 72.67 as shown in Table 19.

Table 19: BCE for Fairchild T.S. Job

Project Location	Project Cost Allocated($)	Project Net Benefit	Option Benefit/Cost Ratio
Fairchild TS	$2,537,530	$181,874,571	72.67

Table 20: 2013 FA Fairchild T.S. Feeder Reliability

Year	Total Feeder Outages			Trunk Outages			Potential FA Savings	
	Number of Outages	CI	CHI	Number of Outage	CI	CHI	CI	CHI
2007	60	47,817	25,539.3	21	37,395	16,059.4	28,046	12,044.5
2008	45	33,673	32,950.4	9	16,549	19,375.3	12,412	14,531.5
2009	32	23,929	19,526.2	11	20,767	8,809.0	15,575	6,606.8
2010	38	32,494	23,486.9	10	11,958	7,516.3	8,969	5,637.2
2011	15	6,235	13,639.4	4	3,661	3,404.2	2,746	2,553.1
Total	**190**	**144,148**	**115,142.2**	**55**	**90,330**	**55,164.1**	**67,748**	**41,373.1**

5. 2013 Feeder Automation – Agincourt T.S., Cavanagh T.S., Ellesmere T.S. and Malvern T.S.

5.1. Job Objectives

The objective of this job is to continue expanding the Scarborough FA network and proactively mitigate the risk of a future outage in this area of the city. This job is expected to expand the FA network from Agincourt T.S. and Cavanagh T.S. This feeder automation network is slated for construction in 2012, and is to be the take off point for future expansion in the east end of Toronto. This job is expected to upgrade 14 feeders and incorporate them into the FA arrangement that will be created by the 2012 work on feeders from Agincourt T.S. and Cavanagh T.S. In addition, this job will further expand FA to include feeders from Ellesmere T.S. and Malvern T.S.

5.2. Job Scope of Work

The scope of work for this job consists of the addition of 14 feeders from Cavanagh T.S., Agincourt T.S., Ellesmere T.S. and Malvern T.S. These feeders will expand the network proposed in 2012 for the east-end of Toronto and serve additional customers in that area. This job is designed to incorporate 81 self-healing switches into this network. This figure will include retrofitting 23 existing SCADA switches, installing seven new switches installed, and upgrading 51 manual switches as shown in Table 21. There is expected to be a significant improvement of feeder functionality and the ability to restore an outage automatically.

Table 21: 2013 FA Scarborough Unit Count

Total of Switch Installations	
Type of Install	**Scarborough**
Retrofit Existing SCADA	23
R1 to R2 Switch Upgrade	0
Install a New Switch	7
Replace Manual Switch	51
Total	**81**

5.3. Job Map and Locations

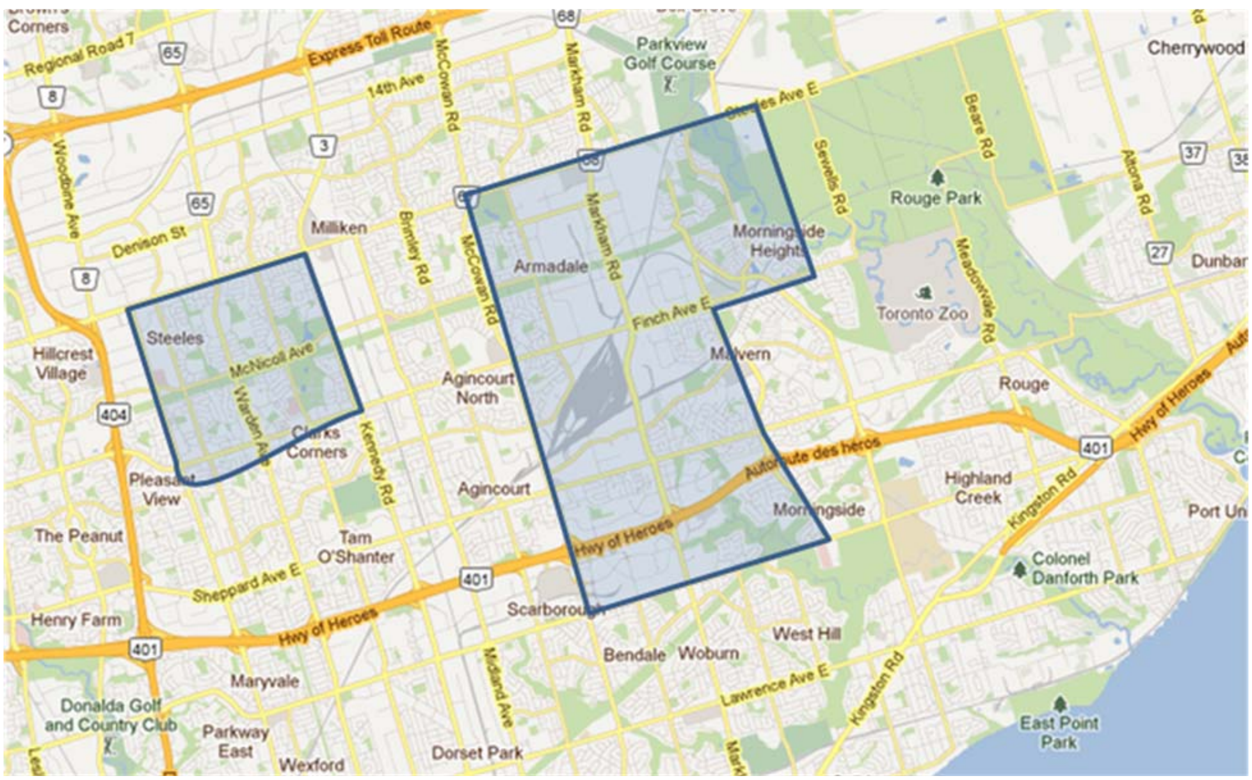


Figure 14: 2013 FA Scarborough Map

ICM Project | Feeder Automation

1 **Table 22: 2013 FA Scarborough Job Breakdown**

Feeder	Scope Package	Switch ID	Type	Location	Notes
502M21	E13349	36LIS-1	Replace	P36-204 Steeles Ave E.	Sectionalizer
		PS409	Replace	3039 Kennedy Rd	Tie-point 502M26
		PS6784	Replace	3039 Kennedy Rd	Tie-point 502M26
		OS90517	Replace	P4127 Steeles Ave E.	Sectionalizer
		OS93056	Replace	P3635 Steeles Ave E.	Sectionalizer
		OSL83237	Replace	P3281 Kennedy Rd	Sectionalizer
		PSC6026	Replace	22 Sunbird Crescent	Tie-point 502M23
502M28	E13315	PS60137	Replace	4100 Victoria Park Ave	Sectionalizer
		PS1426	Replace	20 Bamburgh Circle	Sectionalizer
		PSC18273	Replace	34 Bamburgh Circle	Tie-point 502M21
		PS58905	Replace	105 Milliken Blvd	Tie-point 63M12
		OSL77695	Replace	P3585-1 Victoria Park Ave	Sectionalizer
63M3	E13314	PS53773	Replace	3100 Birchmount Rd	Sectionalizer
		PS56875	Replace	317 Silver Springs Blvd	Sectionalizer
		OSC9516	Upgrade	P3620 Finch Ave E.	Tie-point 502M23
		PSC-1	New Switch	222 Silver Springs Blvd	Sectionalizer
R26M22	E13348	PS9948	Replace	Markham Rd and McNicoll Ave	Tie-point R26M32
		OSC45071	Upgrade	P5590 Finch Ave E.	Tie-point R26M31

Feeder	Scope Package	Switch ID	Type	Location	Notes
		OSC84468	Upgrade	P5235-B Finch Ave E.	Tie-point 63M8
		OSC-1	New Switch	P2662 Markham Rd	Sectionalizer
		OSC-1	New Switch	75-90 Finch Ave E.	Sectionalizer
R26M21	E13349	OSL75151	Replace	P1193 Tapscott Rd	Sectionalizer
		OSC19912	Upgrade	P3180 Markham Rd	Tie-point R26M32
		OSC18358	Upgrade	P5595 Steeles Ave E.	Tie-point 63M12
		PS43885	Replace	1060 Tapscott Rd	Tie-point R26M31
		PS43650	Replace	1160 Tapscott Rd	Sectionalizer
		OSC-1	New Switch	P3290 Markham Rd	Sectionalizer
		OSC-1	New Switch	P780 Passmore Ave	Sectionalizer
R26M36	E13350	OSL72348	Replace	P2294 Markham Rd	Sectionalizer
		OS2618	Replace	5903 Finch Ave E.	Sectionalizer
		OSL32642	Replace	P5917 Finch Ave E.	Sectionalizer
		OSC84659	Upgrade	P5500 Finch Ave E.	Tie-point 63M6
		OSC20772	Upgrade	P2098 Markham Rd	Tie-point H9M32
		OSC68123	Upgrade	P379 Old Finch Ave	Tie-point 47M18
		PS45638	Replace	Morningside Ave and Oasis Blvd	Sectionalizer
		PS46842	Replace	1630 Neilson Rd	Sectionalizer
R26M34	E13352	PS49809	Replace	2710 Morningside Ave	Sectionalizer

Feeder	Scope Package	Switch ID	Type	Location	Notes
		PS50761	Replace	5810 Finch Ave E.	Tie-point R26M31
		PS47833	Replace	1371 Neilson Rd	Sectionalizer
		PSC34341	Upgrade	31 Tapscott Rd	Sectionalizer
		PS4015	Replace	30 Melford Dr	Sectionalizer
		PS47577	Replace	380 Tapscott Rd	Sectionalizer
R26M31	E13353	OSL74812	Replace	P5636 Finch Ave E.	Sectionalizer
		OSC-1	New Switch	P90-72 Finch Ave E.	Sectionalizer
		PS45469	Replace	1051 Tapscott Rd	Tie-point R26M33
		PSC15603	Upgrade	1 Old Finch Ave	Tie-point 47M3
R26M32	E13356	OSL72524	Replace	P2822 Markham Rd	Sectionalizer
		OSL98	Replace	P1045-1 Tapscott Rd	Sectionalizer
		OSC33180	Upgrade	69-3 Steeles Ave E.	Tie-point 63M12
		OSC22631	Upgrade	P301 Tiffield Rd	Tie-point 63M11
		OSC3015	Upgrade	P6145 Steeles Ave E.	Sectionalizer
H9M31	E13355	OS67286	Replace	P1182 Bellamy Rd N.	Sectionalizer
		OS79432	Replace	P105 Bellamy Rd N.	Sectionalizer
		PS18435	Replace	550 Brimorton Dr	Tie-point H9M27
H9M32	E13356	OSC44082	Replace	P1558 Markham Rd	Sectionalizer
		OS62856	Replace	P900-C Markham Rd	Sectionalizer
		OS63736	Replace	P1180 Markham Rd	Sectionalizer
		OSC47289	Upgrade	5149 Sheppard Ave E.	Tie-point 47M1
		OSC84972	Upgrade	1760 Markham Rd	Tie-point H9M23
H9M26	E13357	OS62423	Replace	P225 Milner Ave	Sectionalizer
		OS63727	Replace	P1170 Markham Rd	Sectionalizer

Feeder	Scope Package	Switch ID	Type	Location	Notes
		OSL54852	Replace	P900-D Markham Rd	Sectionalizer
		OSL54879	Replace	P900 Progress Ave	Sectionalizer
		OSL58577	Replace	P734 Progress Ave	Tie-point H9M28
		OSC30210	Upgrade	P237 Milner Ave	Sectionalizer
		OSC93304	Upgrade	P5 Milner Ave	Tie-point 502M32
		OSC55277	Upgrade	P1564 Markham Rd	Tie-point H9M23
H9M23	E13358	OS69107	Replace	P6675 Sheppard Ave E.	Sectionalizer
		OS66355	Replace	P2 Military Trail	Sectionalizer
		OSL71325	Replace	P8 Shorting Rd	Sectionalizer
		OSC28664	Upgrade	P20 Nugget Ave	Tie-point 63M6
		OSC55748	Upgrade	P5121 Sheppard Ave E.	Sectionalizer
		OSC49484	Upgrade	P221-1 Neilson Rd	Tie-point 47M8
		OSC58853	Upgrade	P6715 Sheppard Ave E.	Tie-point 47M3
H9M25	E13331	OS64001	Replace	P2341 Ellesmere Rd	Sectionalizer
		OS64031	Replace	P2351 Ellesmere Rd	Tie-point H9M22
		OSL58811	Replace	P1072 Bellamy Rd N	Tie-point H9M26
		OSC-1	New Switch	P1845 Ellesmere Rd	Sectionalizer
		OSL52963	Replace	P1615 Ellesmere Rd	Tie-point H9M27
		PS93032	Replace	Bushby Dr and McCowan Rd	Tie-point H9M31
		OSC78778	Upgrade	P25 Channel Nine Crt	Tie-point 502M32

5.4. Required Capital Costs

Table 23: 2013 FA Scarborough Job CostFeeder Automation 2013 – Cavanagh TS, Agincourt TS, Ellesmere TS, and Malvern TS

Project Estimate Number	Project Title	Project Year	Cost Estimate ($M)
23154	E13314 PPEast 2013 Feeder Automation Project on SCNT63M3	2013	$0.72
23156	E13315 PPEast 2013 Feeder Automation Project on SCNA502M28	2013	$0.84
23191	E13318 PPEast 2013 Feeder Automation Project on SCNA502M21	2013	$1.00
23436	E13331 Feeder Automation of SCNAH9M25	2013	$0.82
23539	E13348 Feeder Automation of SCNAR26M22	2013	$0.63
23553	E13349 Feeder Automation of SCNAR26M21	2013	$0.93
23561	E13350 Feeder Automation of SCNAR26M36	2013	$1.04
23568	E13352 Feeder Automation of SCNAR26M34	2013	$0.97
23586	E13353 Feeder Automation of SCNAR26M31	2013	$0.48
23588	E13354 Feeder Automation of SCNAR26M32	2013	$0.42
23637	E13355 Feeder Automation of SCNAH9M31	2013	$0.42
23670	E13356 Feeder Automation of SCNAH9M32	2013	$0.48
23671	E13357 Feeder Automation of SCNAH9M26	2013	$0.77
23666	E13358 Feeder Automation of SCNAH9M23	2013	$0.59
23975	E13341 PPEast 2013 Feeder Automation Site Acceptance Test	2013	$0.22
23902	E12659 East 2013 and 2014 FA Repeater Radio Coordination Study	2013	$0.12
23905	E12678 East 2013 FA Repeater Radio Installation	2013	$0.28
		Total:	**$10.72**

5.5. Job Business Case Evaluation (BCE) Results

Historically, the feeders selected for this job have performed poorly and experienced numerous outages on the trunk. In recent years, most notably in 2011, reliability has improved (See Table 25). Since there has been very little capital work done on these feeders, however, the results for 2011 are considered an anomaly. These jobs are necessary based on past reliability performance and the need to integrate these feeders into the area's FA arrangement.

Feeder Automation is a proactive solution that will mitigate the impact of a trunk outage to these customers. Furthermore, this job is expected to expand the Scarborough network and create a tighter more robust design with the existing automated feeders and assist in incorporating future FA. The feeders in this area of Toronto require modernization because the majority of them have only a few remote switches; as a result, the majority of switching operations require manual intervention. Carrying out immediate work on these feeders is expected to produce a net present value of approximately $757.8M. The proposed project will cost $10.7M to implement and it will provide a benefit-to-cost ratio of 71.67 as shown in Table 24.

Table 24: BCE for Cavanagh T.S., Agincourt T.S., Ellesmere T.S., and Malvern T.S.

Project Location	Project Cost Allocated ($)	Project Net Benefit	Option Benefit/Cost Ratio
Cavanagh TS to Agincourt TS	$10,722,785	$757,801,166	71.67

Table 25: 2013 FA Scarborough Feeder Reliability

Year	Total Feeder Outages			Trunk Outages			Potential FA Savings	
	Numberof Outages	CI	CHI	Number of Outage	CI	CHI	CI	CHI
2007	60	47,817	25,539.3	21	37,395	16,059.4	28,046	12,044.5
2008	45	33,673	32,950.4	9	16,549	19,375.3	12,412	14,531.5
2009	32	23,929	19,526.2	11	20,767	8,809.0	15,575	6,606.8
2010	38	32,494	23,486.9	10	11,958	7,516.3	8,969	5,637.2
2011	15	6,235	13,639.4	4	3,661	3,404.2	2,746	2,553.1
Total	**190**	**144,148**	**115,142.2**	**55**	**90,330**	**55,164.1**	**67,748**	**41,373.1**

6. 2014 Feeder Automation – Scarborough East T.S.

6.1. Job Objectives

The objective of this job is to continue expanding the Scarborough feeder automation network and proactively mitigate the risk of a future outage in this area of the city. This job will expand the FA network to include Scarborough East T.S. This feeder automation network is slated for construction for 2014, and is to be the take off point for additional expansion in the east end of Toronto. This job will upgrade 14 feeders and incorporate them into the Scarborough FA network that is to be created in 2012.

6.2. Job Scope of Work

The scope of work for this job is to incorporate 14 feeders onto the FA scheme from Scarborough East T.S. This will continue expansion of the FA network from the proposed job in the east end of Toronto. This job will provide improved operational flexibility and efficiency by expanding on the FA scheme. This job is designed to incorporate 71 self-healing switches into this network. This figure will include retrofitting 14 existing SCADA switches, installing 14 new switches installed, and upgrading 43 manual switches as shown in Table 26. This job will create a significant improvement of feeder functionality and the ability to restore service after an outage.

Table 26: 2014 FA Scarborough East Unit Count

Total of Switch Installations	
Type of Install	**Scarborough East T.S.**
Retrofit Existing SCADA	14
R1 to R2 Switch Upgrade	0
RTU Upgrade	0
Install a New Switch	14
Replace Manual Switch	43
Total	**71**

6.3. Job Map and Locations

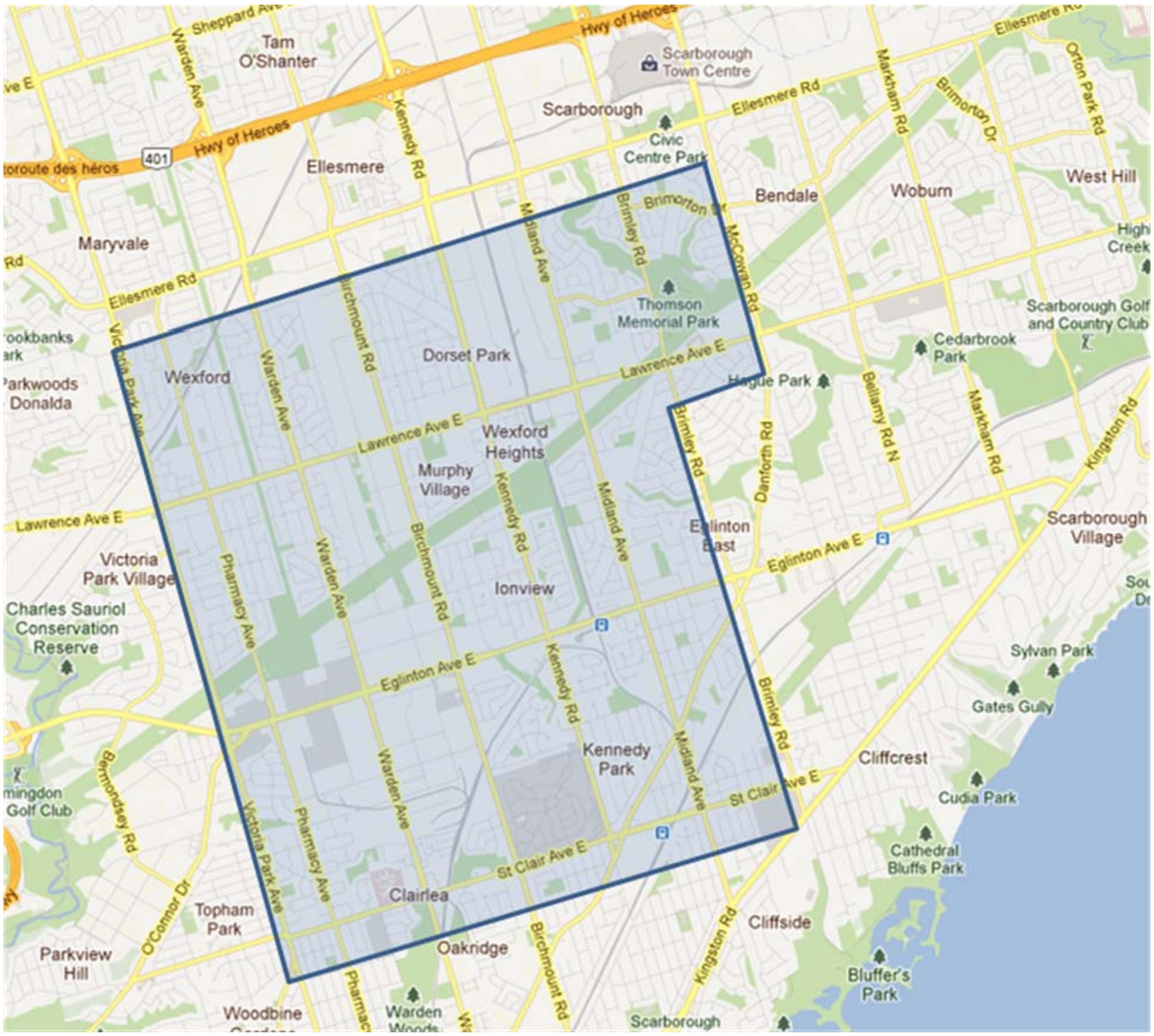


Figure 15: 2014 FA Scarborough T.S. East Map

1 **Table 27: 2013 FA Scarborough Job Breakdown**

Feeder Automation 2014 - Scarborough East T.S.					
Feeder	**Scope Package**	**Switch ID**	**Type**	**Location**	**Notes**
E5M2	E14387	OS28708	Replace	P939-4A Kennedy Rd	Sectionalizer
		OSL26434	Replace	P100 Thermos Rd	Tie point E5M1
		OSC11803	Upgrade	P49 Bertrand Ave	Tie point R43M25
		OSL2215	Replace	P10 Ashtonbee Rd	Sectionalizer
		OSL939	Replace	P14-F Ashtonbee Rd	Sectionalizer
		OSC-1	New Switch	P14-F Ashtonbee Rd	Sectionalizer
		OSC-1	New Switch	22-238 Ashtonbee Rd	Sectionalizer
E5M4	E14388	OS2871	Replace	P939-4D Kennedy Rd	Sectionalizer
		OSL46348	Replace	P1568 Pharmacy Ave	Tie point 502M24
		LC28474	Replace	P911-2 Hydro One Row	Tie point E5M8
		OSL26066	Replace	P14 Underwriters Rd	Tie point E5M9
		23LIS-7	Replace	23-447 Warden Ave	Sectionalizer
		OSL26219	Replace	P17-12 Hydro One Row	Sectionalizer
E5M6	E14389	OS28715	Replace	P939-4B Kennedy Rd	Sectionalizer
		OSL22275	Replace	P1535-6 Hydro One Row	Tie point E5M6
		OS44769	Replace	3-283 Victoria Park Ave	Tie point 53M5
		OSC10521	Upgrade	P630 Pharmacy Ave	Tie point R43M27
		OSC-1	New Switch	P863 Pharmacy Ave	Sectionalizer
		OSC-1	New Switch	P12-320 Pharmacy Ave	Sectionalizer

Feeder Automation 2014 - Scarborough East T.S.					
Feeder	**Scope Package**	**Switch ID**	**Type**	**Location**	**Notes**
E5M8	E14390	OSL21776	Replace	P911-1 Hydro One Row	Sectionalizer
		OSL21775	Replace	P1723-A Victoria Park Ave	Tie point 53M6
		OSC11234	Upgrade	P1987 Lawrence Ave E.	Tie point E5M9
		OSC32426	Upgrade	P1313 Pharmacy Ave	Tie point E5M4
		OSC-1	New Switch	P13-197 Wexford Blvd	Sectionalizer
E5M10	E14391	OS25242	Replace	P2251-A Lawrence Ave E.	Sectionalizer
		OS25198	Replace	P2265 Lawrence Ave E.	Tie point E5M29
		OSL47932	Replace	P9 Rolark Dr	Tie pointE5M9
		OSC-1	New Switch	24-354 Birchmount Rd	Sectionalizer
		OSC-1	New Switch	P1502 Birchmount Rd	Sectionalizer
E5M21	E14392	OSL31983	Replace	P3 LRT	Sectionalizer
		OSC15342	Upgrade	P1061 Ellesmere Serv Rd SE.	Tie point E5M29
		OS61429	Replace	P1423 Ellesmere Rd	Sectionalizer
		SUG-426 S1	Replace		Tie point H9M28
		OSC-1	New Switch	P1175 Ellesmere Rd	Sectionalizer
E5M22	E14393	OSL32181	Replace	P4 LRT	Sectionalizer
		OSL33477	Replace	P824 Midland Ave	Tie point E5M5
		OSL3600	Replace	P744 Brimley Rd	Sectionalizer
		OSC3515	Upgrade	56-35 Brimley Rd	Sectionalizer

Feeder Automation 2014 - Scarborough East T.S.					
Feeder	**Scope Package**	**Switch ID**	**Type**	**Location**	**Notes**
E5M23	E14394	OSL32429	Replace	P2 LRT	Sectionalizer
		OSC2007	Upgrade	P821 Brimley Rd	Tie point E5M22
		OSC9874	Upgrade	65-45 McCowan Rd	Tie point H9M28
		OSC-1	New Switch	3051-A Lawrence Ave E.	Sectionalizer
E5M24	E14395	OSL51826	Replace	P878-B Lawrence Ave E.	Sectionalizer
		OSL51903	Replace	P878-A Lawrence Ave E.	Tie point E5M23
		OSC47319	Upgrade	P374 Progress Ave	Tie point E5M26
		OSL52191	Replace	P1630 Brimley Rd	Sectionalizer
		OSC46418	Upgrade	P1988 Brimley Rd	Tie point 502M32
E5M25	E14396	OS34127	Replace	P805 Brimley Rd	Sectionalizer
		OSL3728	Replace	P255-C Brimley Rd	Tie point E5M22
		OSC36264	Upgrade	P111 Brimley Rd	Tie point R43M29
		OSC-1	New Switch	P55-152 Brimley Rd	Sectionalizer
E5M26	E14397	OSL3276	Replace	P21 Lawrence Serv Rd SW.	Sectionalizer
		OSL49694	Replace	P2160 Midland Ave	Sectionalizer
		PSC32511	Upgrade		Tie point 502M26
		OS58147	Replace	P34 Progress Ave	Sectionalizer
		OSC40834	Upgrade	P2190 Midland Ave	Tie point 63M5
		OSC-1	New Switch	P42-175 Progress Ave	Sectionalizer

Feeder Automation 2014 - Scarborough East T.S.

Feeder	Scope Package	Switch ID	Type	Location	Notes
E5M27	E14398	OSL32839	Replace	P11 Lawrence Serv Rd	Sectionalizer
		OSL48418	Replace	P506 Midwest Rd	Tie point E5M26
		OSL34944	Replace	P2759 Lawrence Ave E.	Tie point E5M23
		OSL51479	Replace	P1925 Midland Ave	Tie point E5M21
		OSC-1	New Switch	49-571 Midland Ave	Sectionalizer
		OSC-1	New Switch	P200 Midwest Rd	Sectionalizer
E5M29	E14399	OSL32855	Replace	P1041 Kennedy Rd	Sectionalizer
		OSL48363	Replace	P1164 Kennedy Rd	Tie point E5M30
		OS55079	Replace	P2 Munham Gate	Sectionalizer
		OSC-1	New Switch	32-33 Kennedy Rd	Sectionalizer
E5M30	E14400	OSL3313	Replace	P1035 Kennedy Rd	Sectionalizer
		OSC40880	Replace	P1933 Kennedy Rd	Tie point E5M29
		OSC38185	Upgrade	32-48 Ellesmere Rd	Tie point E5M10
		OSL47935	Replace	P1428 Kennedy Rd	Sectionalizer

6.4. Required Capital Costs

Table 28: 2013 FA Scarborough Job Cost Feeder Automation 2014 – Scarborough East T.S.

2013 FA Scarborough East T.S.			
Project Estimate Number	**Project Title**	**Project Year**	**Cost Estimate**
24675	E14387-P03 East Feeder Automation SCNAE5M2	2014	$0.73
24680	E14388-P03 East Feeder Automation SCNAE5M4	2014	$0.68
24681	E14389-P03 East Feeder Automation SCNAE5M6	2014	$0.62
24685	E14390-P03 East Feeder Automation SCNAE5M8	2014	$0.46
24689	E14391-P03 East Feeder Automation SCNAE5M10	2014	$0.55
24709	E14392-P03 East Feeder Automation SCNAE5M21	2014	$0.59
24690	E14393-P03 East Feeder Automation SCNAE5M22	2014	$0.40
24704	E14394-P03 East Feeder Automation SCNAE5M23	2014	$0.35
24691	E14395-P03 East Feeder Automation SCNAE5M24	2014	$0.47
24699	E14396-P03 East Feeder Automation SCNAE5M25	2014	$0.40
24730	E14397-P03 East Feeder Automation SCNAE5M26	2014	$0.61
24700	E14398-P03 East Feeder Automation SCNAE5M27	2014	$0.67
24732	E14399-P03 East Feeder Automation SCNAE5M29	2014	$0.45
24702	E14400-P03 East Feeder Automation SCNAE5M30	2014	$0.40
		Total:	**$7.38**

6.5. Job Business Case Evaluation (BCE) Results

Historically, these feeders have performed poorly and have had consistent outages on the trunk. There was some reliability improvement seen in 2011, however, this appears to be an anomaly and THESL anticipates that the feeder's future reliability will return to the levels experienced in prior years (See Table 3). Feeder Automation is a proactive solution that will mitigate the impact of a trunk outage to the customers on these feeders. Furthermore, expanding the

Scarborough network will create a tighter more robust design with the existing feeders and assist in incorporating future FA. The feeders in this area of Toronto require modernization because the majority of them have only a few remote switches and the majority of switching operations require manual intervention. Carrying out immediate work on these feeders will result in an approximate net present value of approximately $775.5M. The proposed project will cost $7.38M to implement and it will provide a benefit-to-cost ratio of 106.13 as shown in Table 29.

Table 29: BCE of Scarborough East T.S.

Project Location	Project Cost Allocated($)	Project Net Benefit	Option Benefit/Cost Ratio
Scarborough East T.S.	$7,376,248	$775,463,239	106.13

Table 30: 2014 FA Scarborough East T.S. Feeder Reliability

Year	Total Feeder Outages			Total Trunk Outages			Potential FA Savings	
	Number of Outages	CI	CHI	Number of Outages	CI	CHI	CI	CHI
2007	24	23,812	8,676.0	12	23,662	8,451.3	17,747	6,338.5
2008	14	14,177	6,794.5	7	11,009	6,058.2	8,257	4,543.7
2009	19	52,894	50,768.7	11	40,523	39,570.5	30,392	29,677.9
2010	26	29,572	13,527.2	13	22,667	10,029.0	17,000	7,521.8
2011	11	6,730	8,652.4	2	2,915	1,782.0	2,186	1,336.5
Total	**94**	**127,185**	**88,418.8**	**45**	**100,776**	**65,891.0**	**75,582**	**49,418.3**

V APPENDICES

Appendix 1: Feeder Automation Benefit over Cost Analysis

Appendix 2: EUCI – ENMAX Presentation – Distribution Automation for Smart Grid

Appendix 3: Feeder Automation (FA) Business Case Evaluation (BCE) Process and Results

Appendix 1

Feeder Automation Benefit over Cost Analysis

To understand the benefit over cost of the switching type installed on a feeder a comparison was conducted. The analysis was undertaken by comparing the installation of three switching technologies; manual switches, SCADA switches, and FA switches. This was modeled on a theoretical feeder with 3000 customers connected on it and comparison was made on the benefit of creating more sections on the feeder. An assumption was made that each section would divide the total customer value equally.

Three main metrics are considered in the event of a trunk related outage: 1) the number of customers affected initially; 2) the number of unaffected customers restored; and 3) the number of customers affected by the fault. The initial number of customers is the total number of customers that experience the outage immediately when a fault occurs. In the event of a trunk related outage it would be the entire feeder. The customers restored are the number of customers that are not directly affected by the fault and service can be restored. In the case of feeder automation all these customers would be restored within the first minute. The customers affected by the fault are customers on the section of feeder that is faulted and service cannot be restored until the fault is repaired. In the case of feeder automation the unaffected sections of the feeder is restored within a minute and only the customers on the faulted section of the feeder experience the outage beyond one minute.

Table 31 compiles number of customers initially affected by the outage, the unaffected customers restored, and the customers affected by the fault. These values have been compared to different feeder configuration sections to determine what the benefit is as more segments are configured into the feeder. Each segment will require one and a half switches; one switch to section the feeder and half a switch as the tie-point. The tie-point is designated half a switch since the switch will benefit the two feeders to which it is tied.

Table 31: Model Restoration Values per Section (Total Feeder Customers = 3000)

Number of Sections	Number of Switches	Number of Customers per Section	CI (Initial)			CI (Restore)			CI (Fault)		
			Manual	SCADA	FA	Manual	SCADA	FA	Manual	SCADA	FA
2	3	1,500	3,000	3,000	1,500	1,500	1,500	1,500	1,500	1,500	1,500
4	6	750	3,000	3,000	750	2,250	2,250	2,250	750	750	750
6	9	500	3,000	3,000	500	2,500	2,500	2,500	500	500	500
8	12	375	3,000	3,000	375	2,625	2,625	2,625	375	375	375
10	15	300	3,000	3,000	300	2,700	2,700	2,700	300	300	300
12	18	250	3,000	3,000	250	2,750	2,750	2,750	250	250	250

This model is assumes that the feeder has only one of the three switch types, either manual switches, SCADA switches or feeder automation enabled switches. Based on previously estimated restoration times, it would take a feeder with predominately manual switches two to four hours to restore the feeder. This model will average the time to three hours, for SCADA switches it will average the time to restore remotely to 30 minutes and for FA enabled switches no duration will be considered since the feeder will be restored in under a minute.

$$Time_{Manual\,Switch} = 3\ Hrs$$

$$Time_{SCADA\,Switch} = 0.5\ Hrs$$

$$Time_{FA\,Switch} = 0\ Hrs$$

$$Time_{Repair} = 1\ Hr$$

The theoretical outage cost is calculated based on the initial outage cost of the interruption for customers and the outage cost for the remaining duration when customers are without power. In a trunk related outage the remaining duration is based on the duration of the unaffected customers on the feeder that are restored and the duration for the customers on the affected segment of the faulted feeder. The manual and SCADA switch options are calculated the same with different outage durations. However, the FA enabled switch restores customers within a minute. This time is accounted for within the initial cost of the outage. The outage cost for the restored customers under FA is zero. The calculated outage cost is compared to the cost of implementation to get a benefit over cost ratio.

$$Outage\ Cost_{Manual\ Switch} = Outage\ Cost_{Initial\ Impact} + Outage\ Cost_{Restored\ Customers} + Outage\ Cost_{Faulted\ Customers}$$

$$= \left(CI_{1st\ Min} \times \frac{3KVA}{CI} \times \frac{\$80}{KVA}\right) + \left(CI_{Restored} \times \frac{3KVA}{CI} \times \frac{\$18}{KVA \times Hrs}\right) \times (Time_{Manual\ Switch}) + \left(CI_{Fault} \times \frac{3KVA}{CI} \times \frac{\$18}{KVA \times Hrs}\right) \times (Time_{Manual\ Switch} + Time_{Repair})$$

$$Outage\ Cost_{Manual\ Switch} = \left(CI_{1st\ Min} \times \frac{3KVA}{CI} \times \frac{\$80}{KVA}\right) + \left(CI_{Restored} \times \frac{3KVA}{CI} \times \frac{\$18}{KVA \times Hrs}\right) \times (Time_{Manual\ Switch}) + \left(CI_{Fault} \times \frac{3KVA}{CI} \times \frac{\$18}{KVA \times Hrs}\right) \times (Time_{Manual\ Switch} + Time_{Repair})$$

$$Outage\ Cost_{SCADA\ Switch} = Outage\ Cost_{Initial\ Impact} + Outage\ Cost_{Restored\ Customers} + Outage\ Cost_{Faulted\ Customers}$$

$$Outage\ Cost_{SCADA\ Switch} = \left(CI_{1st\ Min} \times \frac{3KVA}{CI} \times \frac{\$80}{KVA}\right) + \left(CI_{Restored} \times \frac{3KVA}{CI} \times \frac{\$18}{KVA \times Hrs}\right) \times (Time_{SCADA\ Switch}) + \left(CI_{Fault} \times \frac{3KVA}{CI} \times \frac{\$18}{KVA \times Hrs}\right) \times (Time_{SCADA\ Switch} + Time_{Repair})$$

$$Outage\ Cost_{FA\ Switch} = Outage\ Cost_{Initial\ Impact} \sout{+ Outage\ Cost_{Restored\ Customers}} + Outage\ Cost_{Faulted\ Customers}$$

$$Outage\ Cost_{FA\ Switch} = Outage\ Cost_{Initial\ Impact,Restored\ Customers} + Outage\ Cost_{Faulted\ Customers}$$

$$Outage\ Cost_{FA\ Switch} = \left(CI_{1st\ Min,Restored} \times \frac{3KVA}{CI} \times \frac{\$30}{KVA}\right) + \left(CI_{Fault} \times \frac{3KVA}{CI} \times \frac{\$18}{KVA}\right) \times (Time_{SCADA} + Time_{Repair})$$

Table 32: Cost of Switch and Interruption in the Model

Number of Sections	Number of Switches	Install Cost ($)			Cost of Interruption ($)		
		Manual	SCADA	FA	Manual	SCADA	FA
2	3	$56,058	$164,928	$178,537	-$1,237,500	-$675,000	-$337,500
4	6	$112,116	$329,856	$357,074	-$1,181,250	-$618,750	-$168,750
6	9	$168,174	$494,784	$535,612	-$1,162,500	-$600,000	-$112,500
8	12	$224,232	$659,712	$714,149	-$1,153,125	-$590,625	-$84,375
10	15	$280,290	$824,640	$892,686	-$1,147,500	-$585,000	-$67,500
12	18	$336,348	$989,568	$1,071,223	-$1,143,750	-$581,250	-$56,250

To determine the benefit of one option over another, a comparison is made between the differences in the benefit over costs (B/C ratios) of the two options. As seen in Table 33 a comparison between B/C ratios is made for SCADA switches compared to manual switches, FA enabled switches compared to manual switches, and FA enabled switches compared to SCADA switches. Furthermore, the B/C ratio based on the number of segments for each feeder is also calculated. The results of this chart are plotted in the graph contained in Figure 16.

As illustrated on the graph, installing either SCADA switches or FA enabled switches provides an improved B/C ratio compared to manual switches. The option that provides the best benefit is the FA option with greatest benefit over cost improvement realized by moving from SCADA switches to FA enabled switches. This is because the cost of the FA enabled switches is only slightly higher than the cost of SCADA switches, but FA switches provide a greater benefit in avoided outage costs to the customers. All options show the same trend as more segments are created more switches have to be deployed increasing the cost of implementation while the cost reduction for customers is slightly less with each segment. This B/C comparison is based on a one outage event on the trunk.

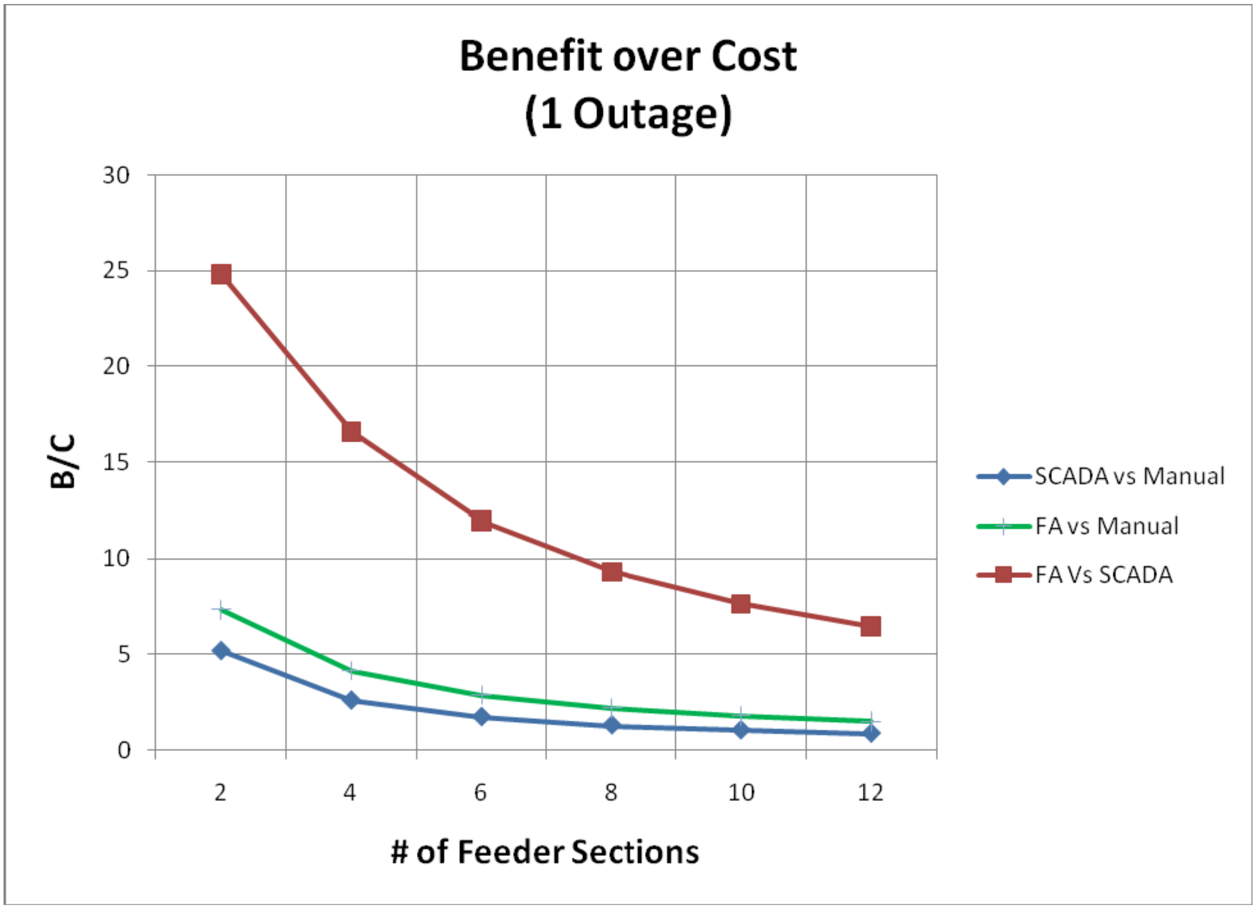
$$\frac{\Delta Benefit}{\Delta Cost} = \frac{Outage\ Cost_{SCADA\ Switch} - Outage\ Cost_{Manual\ Switch}}{Install\ Cost_{SCADA\ Switch} - Install\ Cost_{Manual\ Switch}}$$

$$\frac{\Delta Benefit}{\Delta Cost} = \frac{Outage\ Cost_{FA\ Switch} - Outage\ Cost_{Manual\ Switch}}{Install\ Cost_{FA\ Switch} - Install\ Cost_{Manual\ Switch}}$$

$$\frac{\Delta Benefit}{\Delta Cost} = \frac{Outage\ Cost_{FA\ Switch} - Outage\ Cost_{SCADA\ Switch}}{Install\ Cost_{FA\ Switch} - Install\ Cost_{SCADA\ Switch}}$$

Table 33: B/C Values of the Model

Number of Sections	Number of Switches	B/C (1 outage)		
		SCADA vs Manual	FA vs Manual	FA vs SCADA
2	3	5.17	7.35	24.80
4	6	2.58	4.13	16.53
6	9	1.72	2.86	11.94
8	12	1.29	2.18	9.30
10	15	1.03	1.76	7.61
12	18	0.86	1.48	6.43



1 **Figure 16: B/C Comparison Graph**

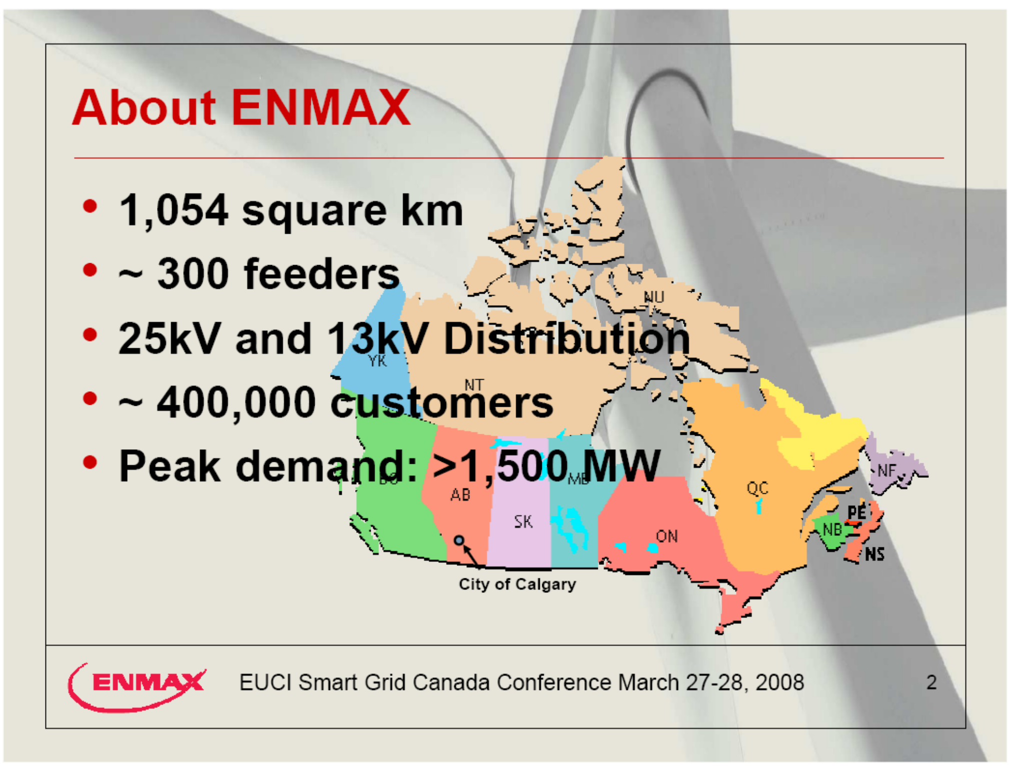
1 **Appendix 2**

2 **EUCI – ENMAX Presentation – Distribution Automation for Smart Grid**

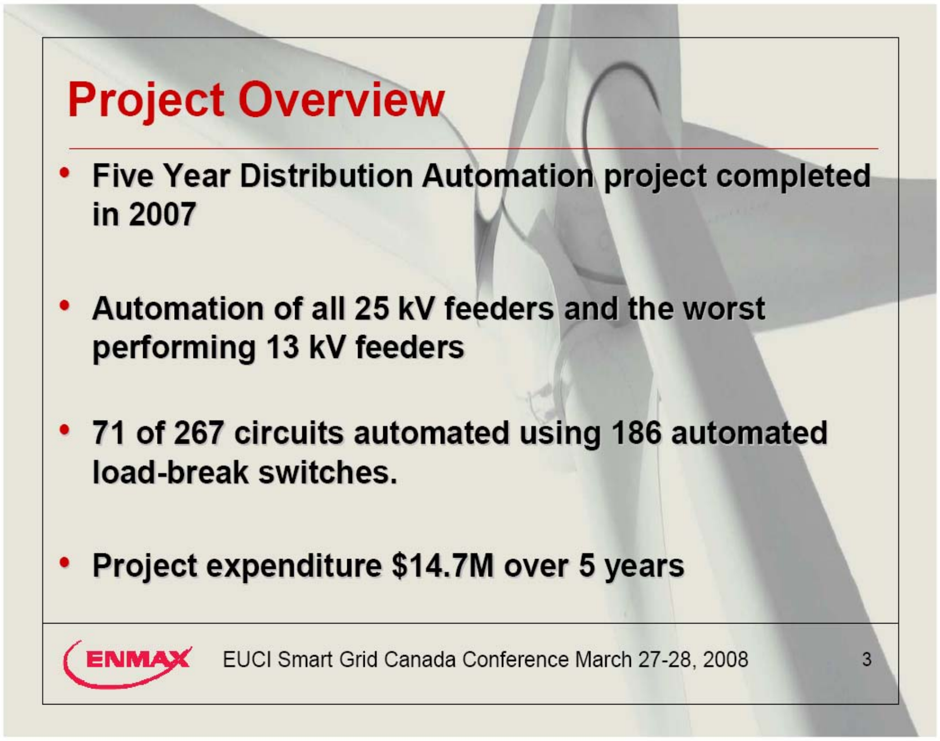
Presented to EUCI
March, 2008

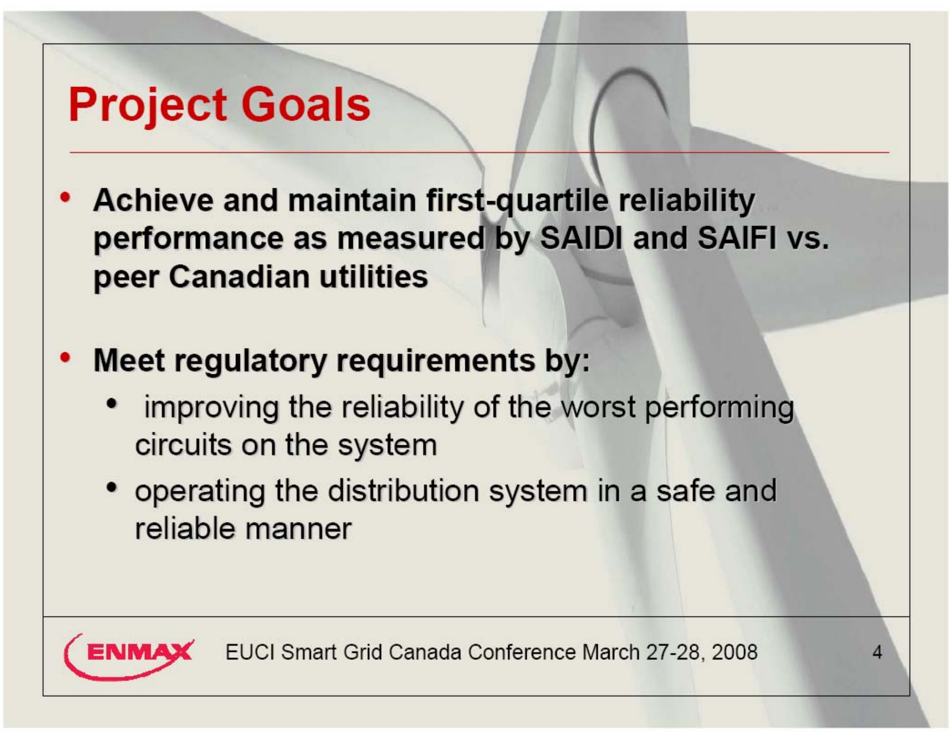
Dean Craig, P. Eng.
Project Specialist Engineer

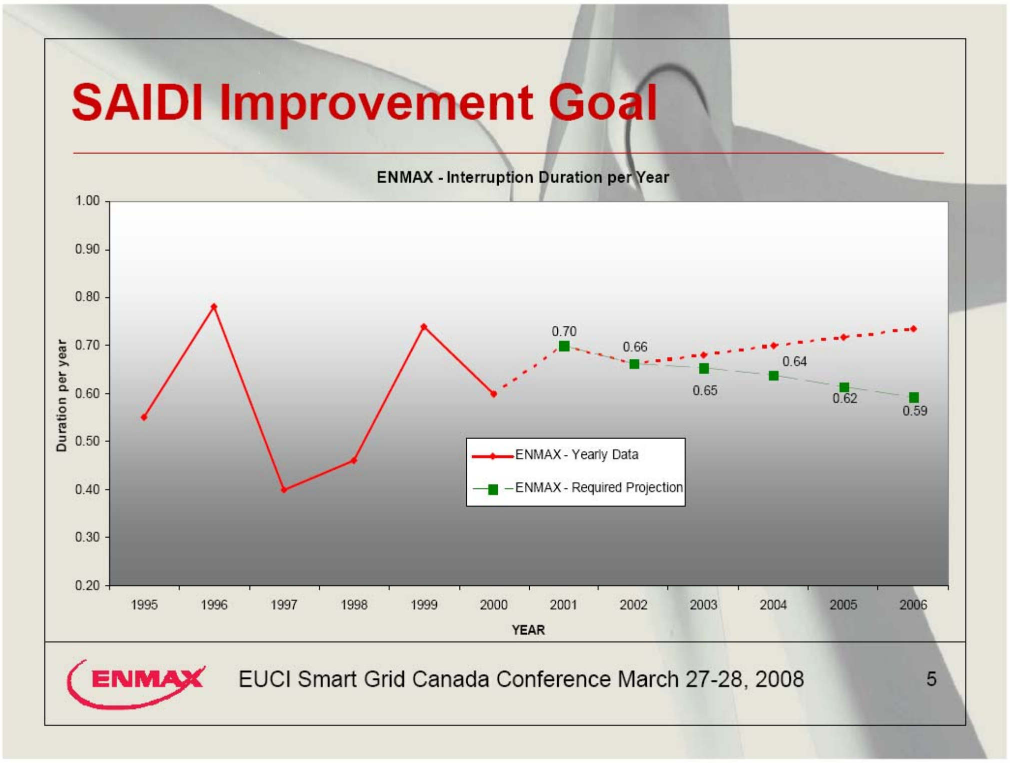
System Operations
ENMAX Power Corporation



ICM Project | Feeder Automation






SAIDI Improvement Goal
ENMAX - Interruption Duration per Year
Duration per year
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.70
0.66
0.65
0.64
0.62
0.59
ENMAX - Yearly Data
ENMAX - Required Projection
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
YEAR
ENMAX
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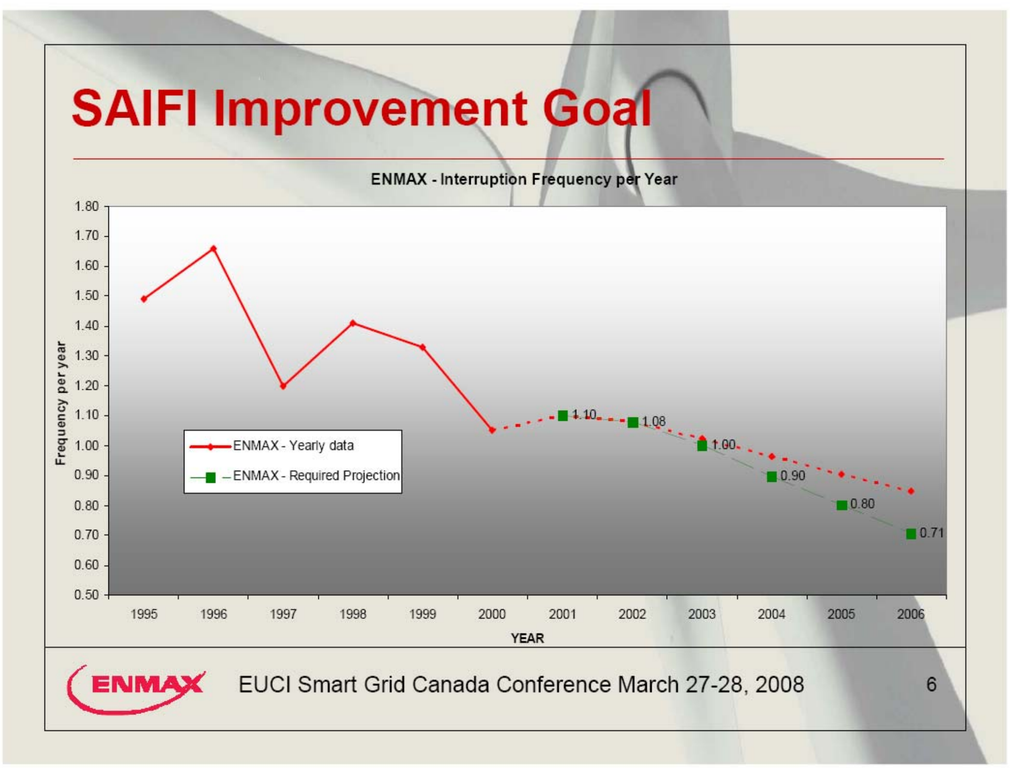
SAIFI Improvement Goal
ENMAX - Interruption Frequency per Year
Frequency per year
1.80
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
1.10
1.08
1.00
0.90
0.80
0.71
ENMAX - Yearly data
ENMAX - Required Projection
1995
1996
1997
1998
1999
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2002
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2004
2005
2006
YEAR
ENMAX
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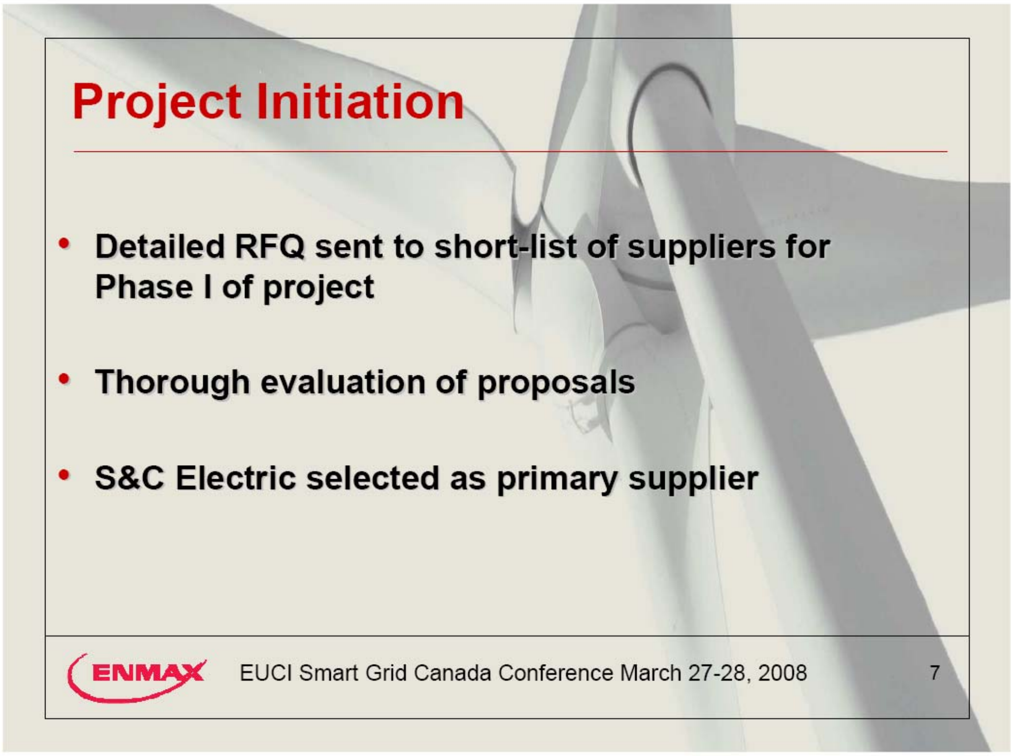
Project Initiation
• Detailed RFQ sent to short-list of suppliers for Phase I of project
• Thorough evaluation of proposals
• S&C Electric selected as primary supplier
ENMAX
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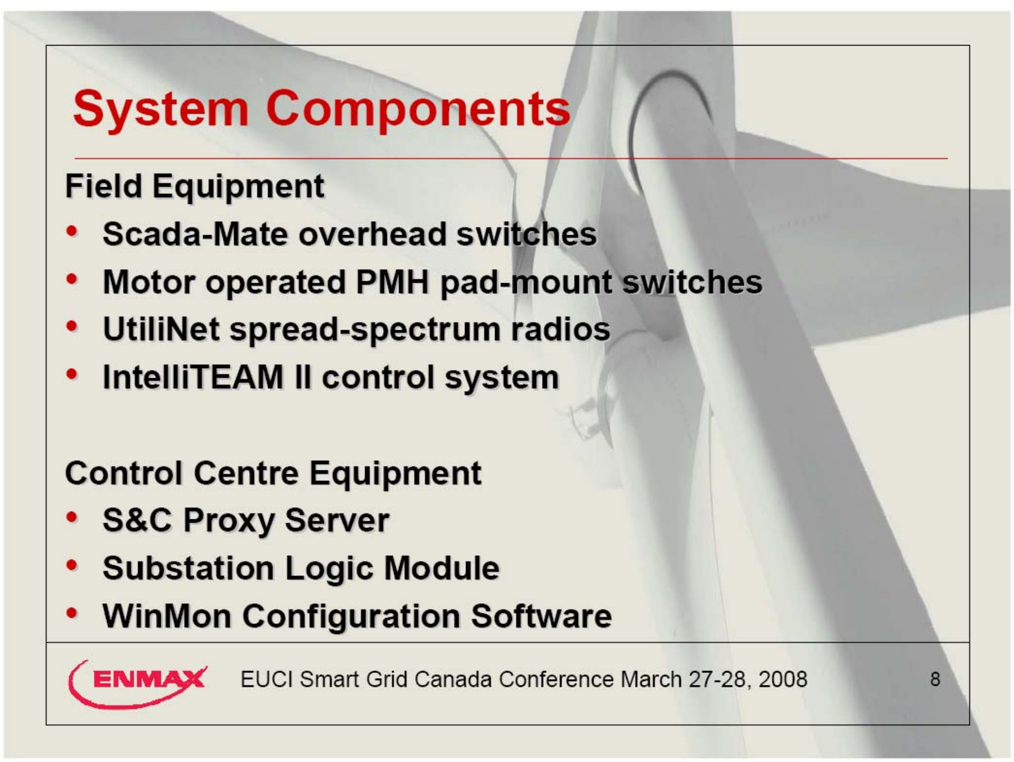
7


System Components
Field Equipment
• Scada-Mate overhead switches
• Motor operated PMH pad-mount switches
• UtiliNet spread-spectrum radios
• IntelliTEAM II control system
Control Centre Equipment
• S&C Proxy Server
• Substation Logic Module
• WinMon Configuration Software
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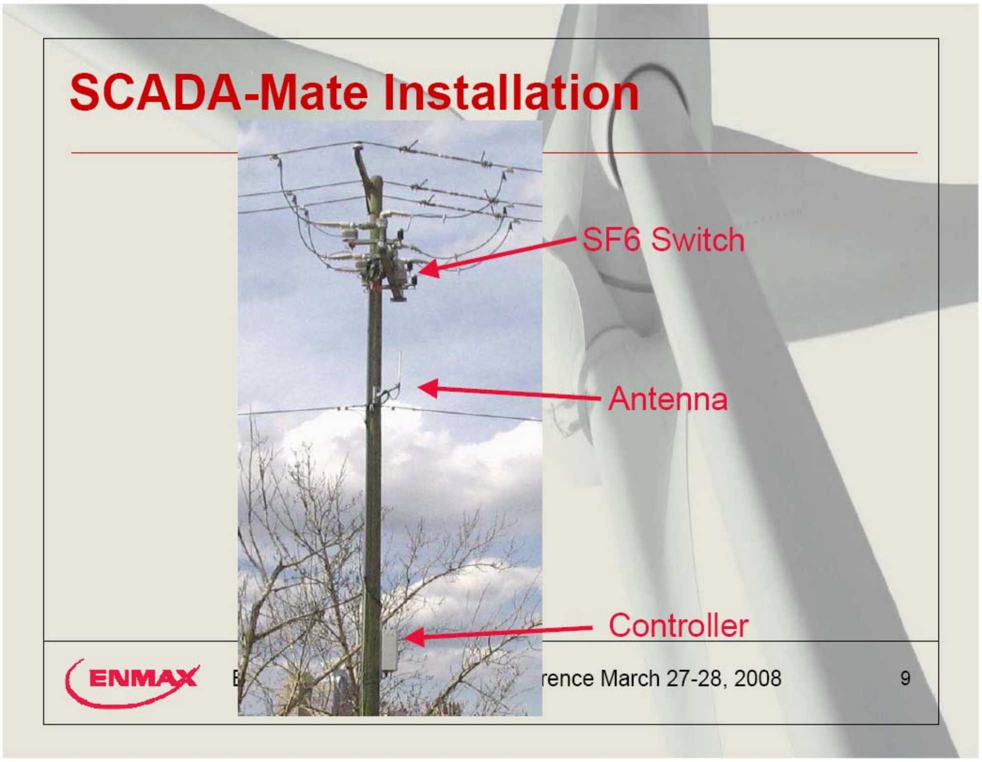
SCADA-Mate Installation
SF6 Switch
Antenna
Controller
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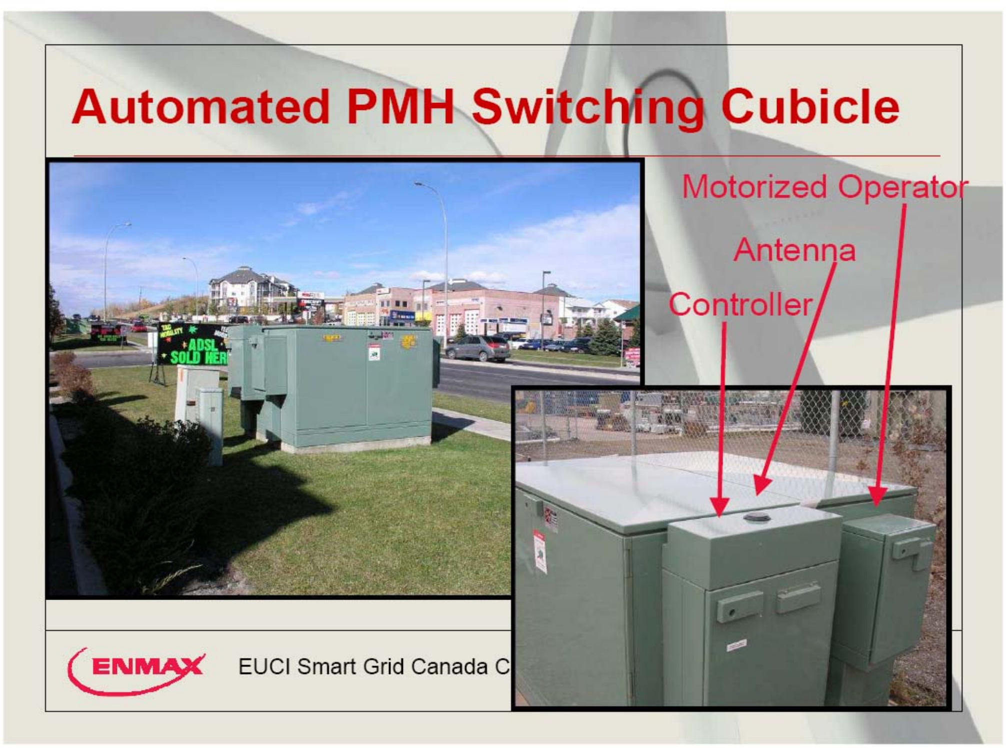
Automated PMH Switching Cubicle
Motorized Operator
Antenna
Controller
ENMAX
EUCI Smart Grid Canada C


Automated PMH Installation
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Controller Cabinet
ENMAX
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System Components

UtiliNet Spread-Spectrum Radio Network

- No radio licence required
- 900 MHz frequency band
- Mesh network Enables Peer to Peer communications
- "Smart" data packet routing (Self-healing Network)
- Highly scalable
- Investment in a "Full-Coverage" communications system is not required

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Repeater Radio

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Repeater Radio
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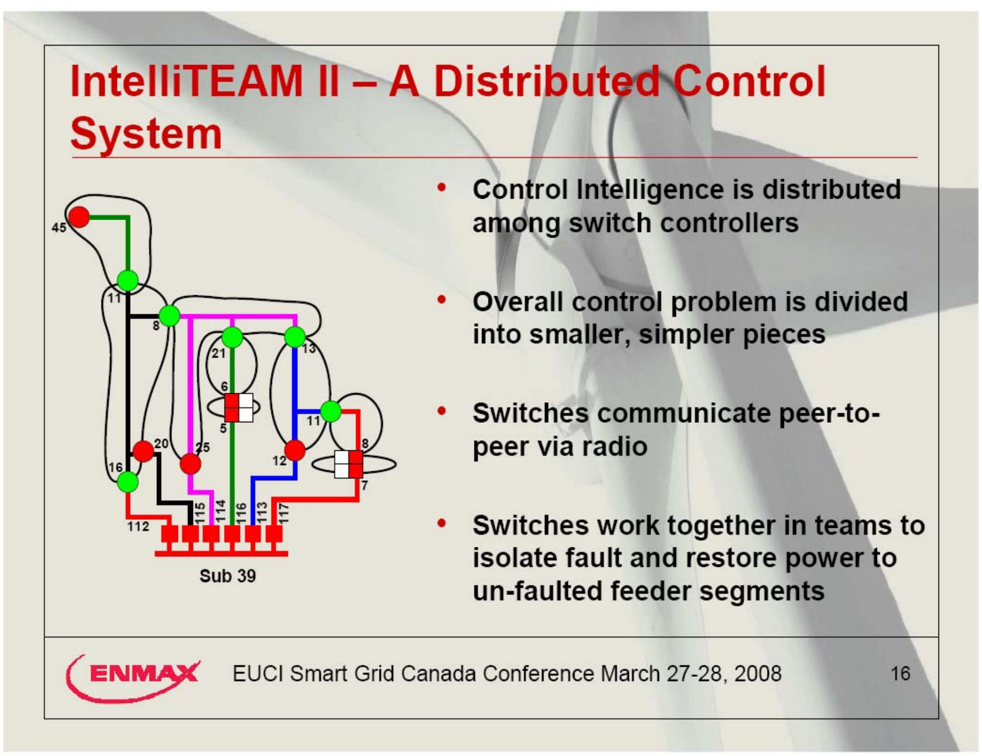
IntelliTEAM II – A Distributed Control System
45
11
8
21
6
5
13
11
8
7
20
25
12
16
112
115
114
116
113
117
Sub 39
• Control Intelligence is distributed among switch controllers
• Overall control problem is divided into smaller, simpler pieces
• Switches communicate peer-to-peer via radio
• Switches work together in teams to isolate fault and restore power to un-faulted feeder segments
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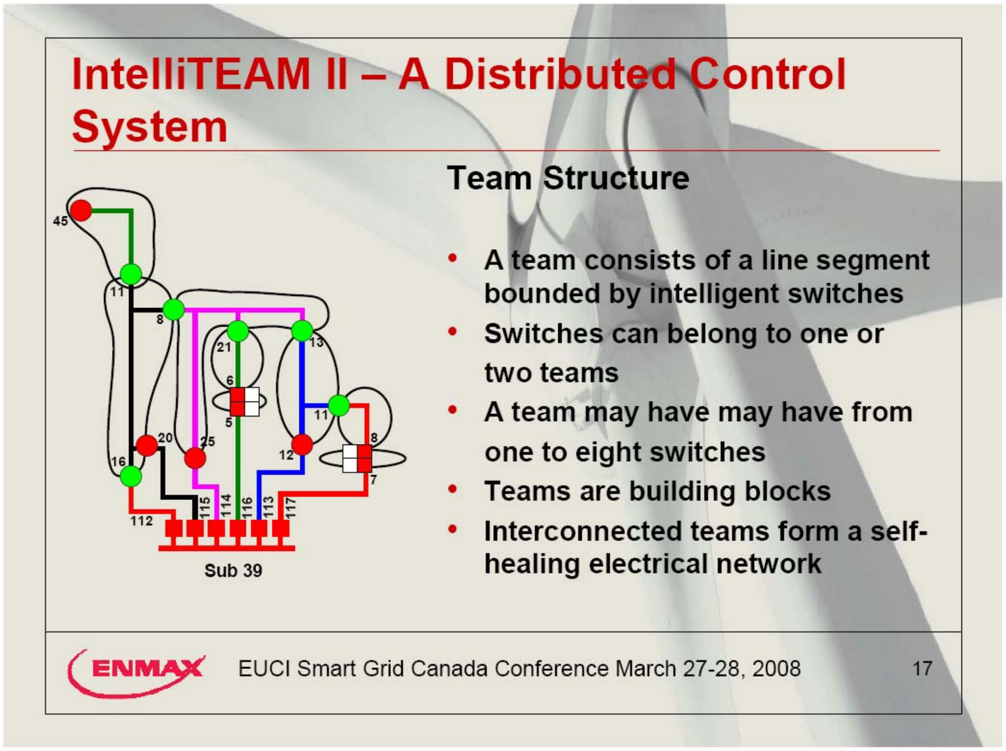
IntelliTEAM II – A Distributed Control System
Team Structure
A team consists of a line segment bounded by intelligent switches
Switches can belong to one or two teams
A team may have may have from one to eight switches
Teams are building blocks
Interconnected teams form a self-healing electrical network
Sub 39
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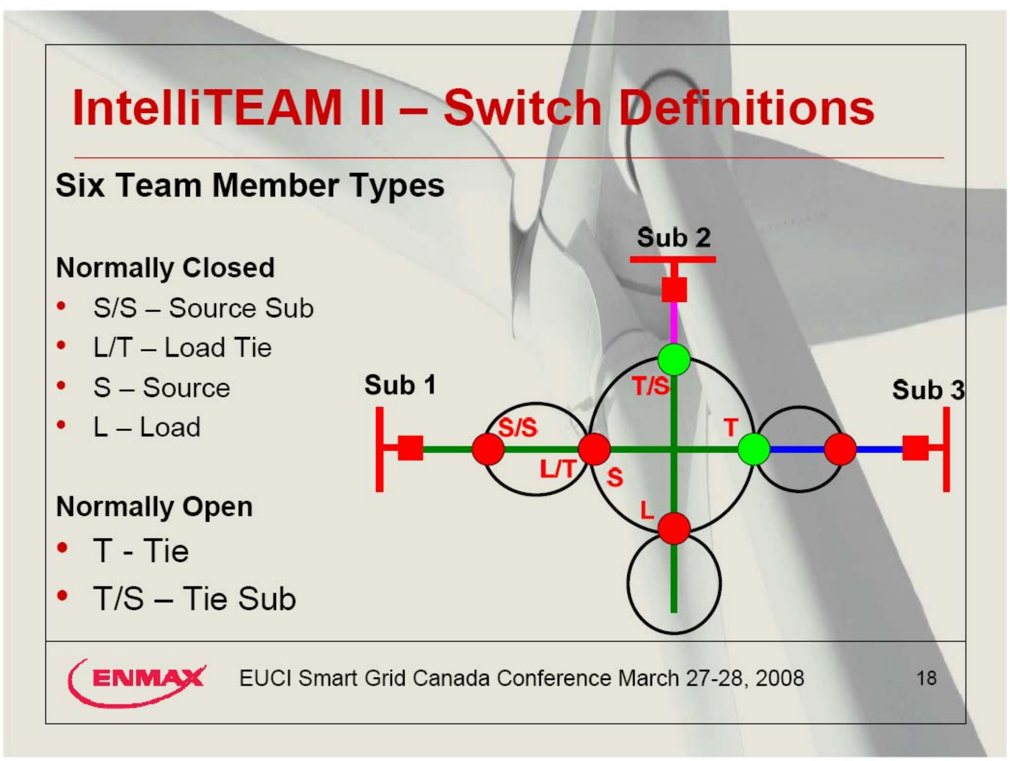
IntelliTEAM II – Switch Definitions
Six Team Member Types
Normally Closed
S/S – Source Sub
L/T – Load Tie
S – Source
L – Load
Normally Open
T - Tie
T/S – Tie Sub
Sub 1
Sub 2
Sub 3
S/S
L/T
S
T/S
T
L
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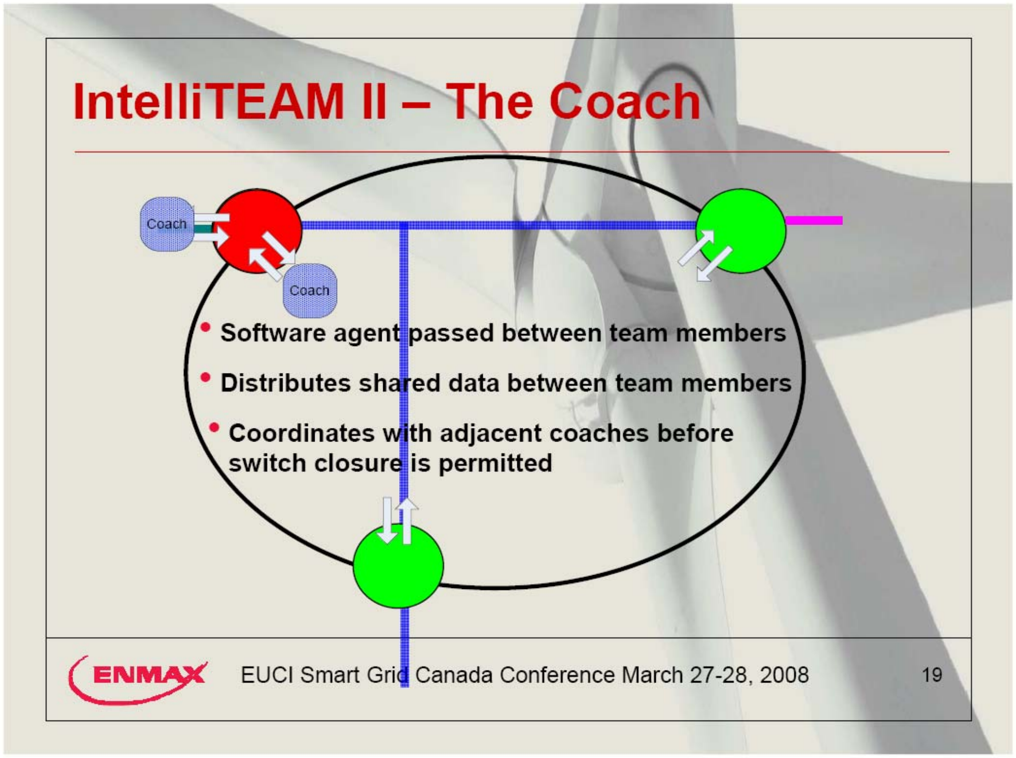
IntelliTEAM II – The Coach
Coach
Coach
Software agent passed between team members
Distributes shared data between team members
Coordinates with adjacent coaches before switch closure is permitted
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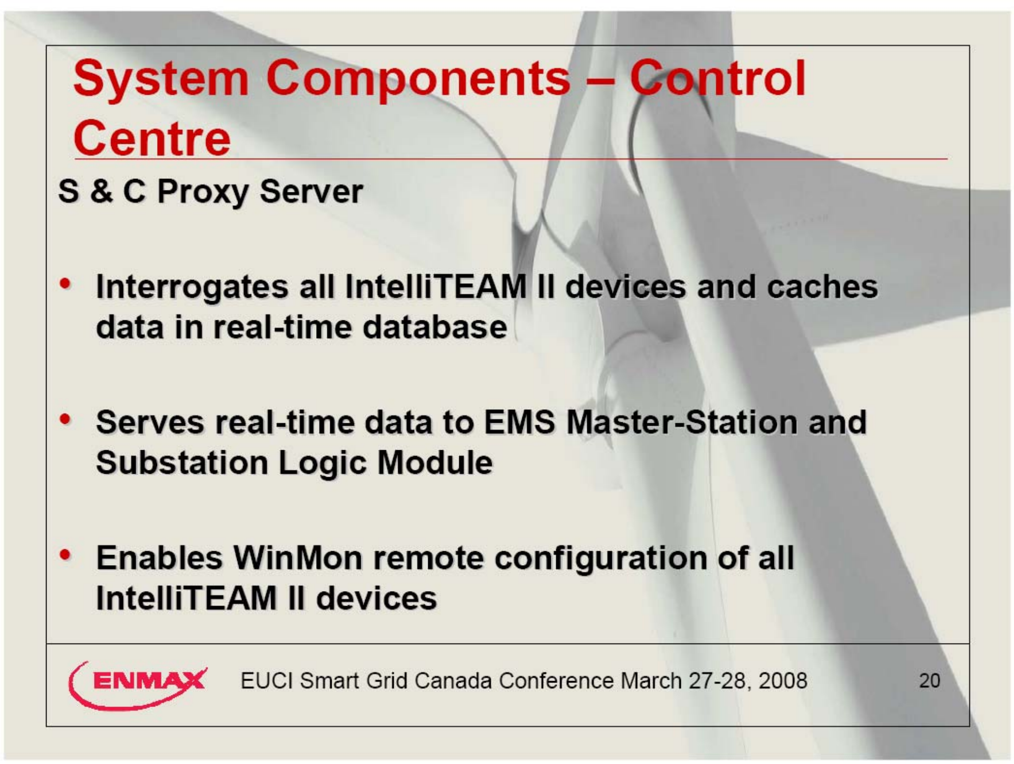
System Components – Control Centre
S & C Proxy Server
Interrogates all IntelliTEAM II devices and caches data in real-time database
Serves real-time data to EMS Master-Station and Substation Logic Module
Enables WinMon remote configuration of all IntelliTEAM II devices
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System Components – Control Centre

Substation Logic Module

- Required to automate feeder segment closest to substation
- Uses breaker status and first automated switch status to control the substation breaker
- Prohibits IntelliTEAM II restoration on feeder when substation recloser blocked or during under-voltage or under-frequency event
- Central location reduces equipment and installation costs

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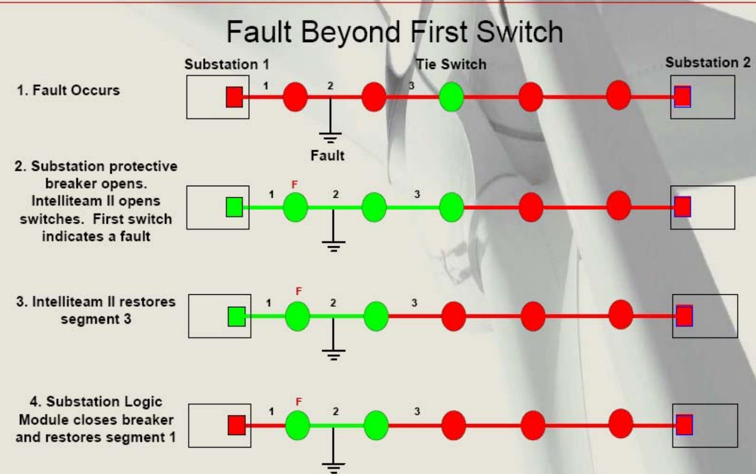
Substation Logic Module



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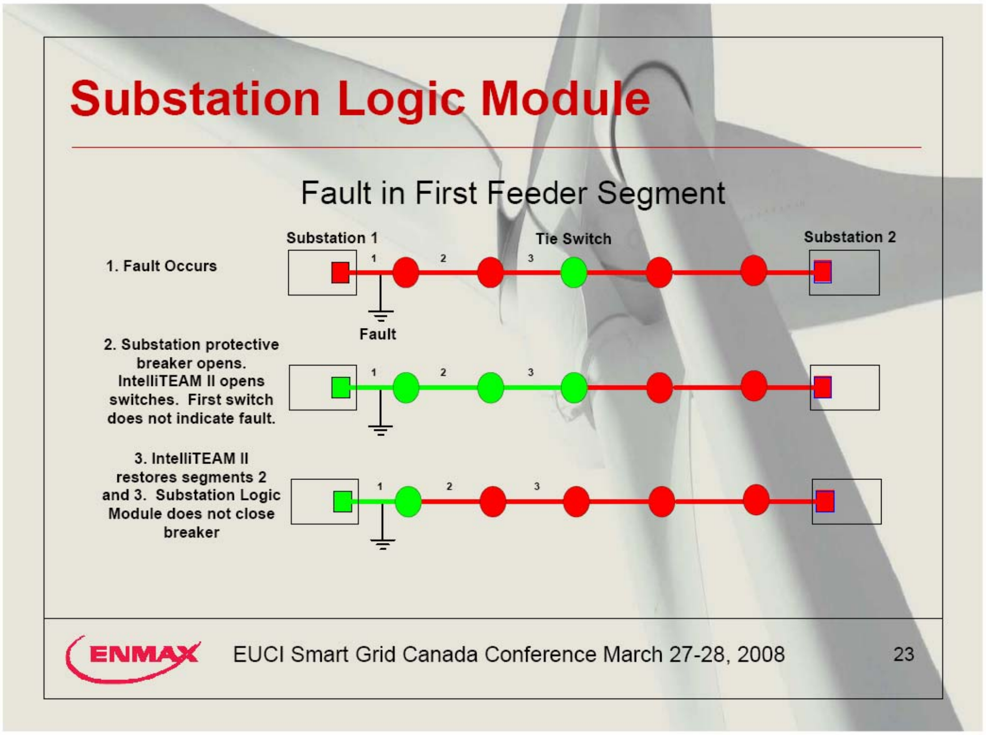
Substation Logic Module
Fault in First Feeder Segment
Substation 1
Tie Switch
Substation 2
1. Fault Occurs
Fault
2. Substation protective breaker opens. IntelliTEAM II opens switches. First switch does not indicate fault.
3. IntelliTEAM II restores segments 2 and 3. Substation Logic Module does not close breaker
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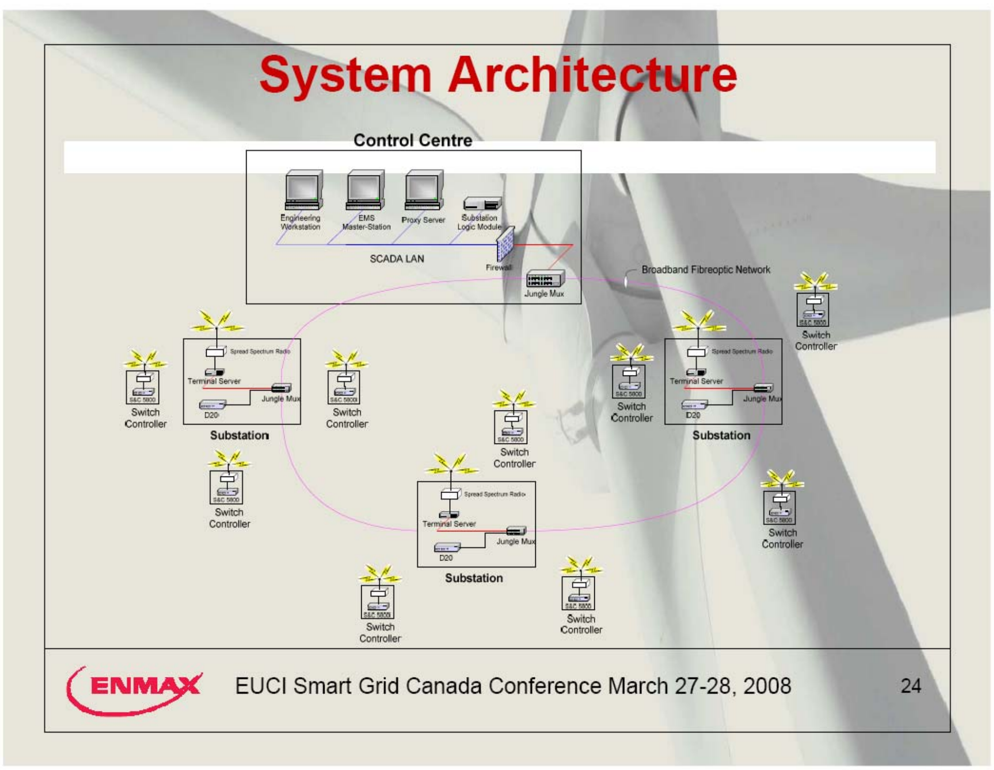
System Architecture
Control Centre
SCADA LAN
Firewall
Jungle Mux
Broadband Fibreoptic Network
Switch Controller
Terminal Server
D20
Substation
ENMAX
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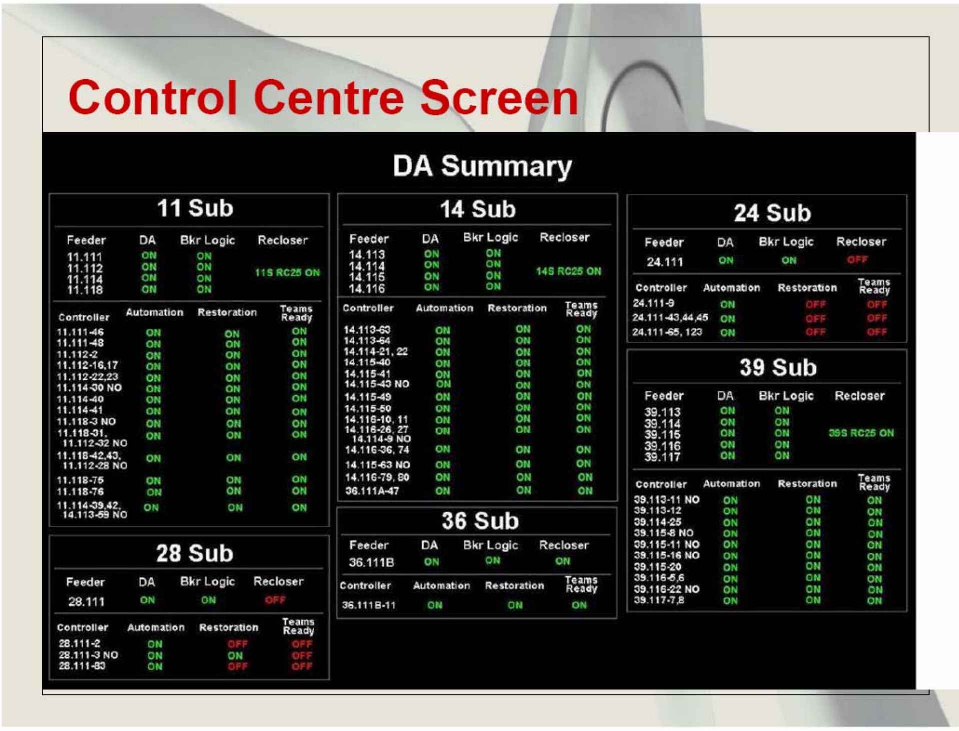
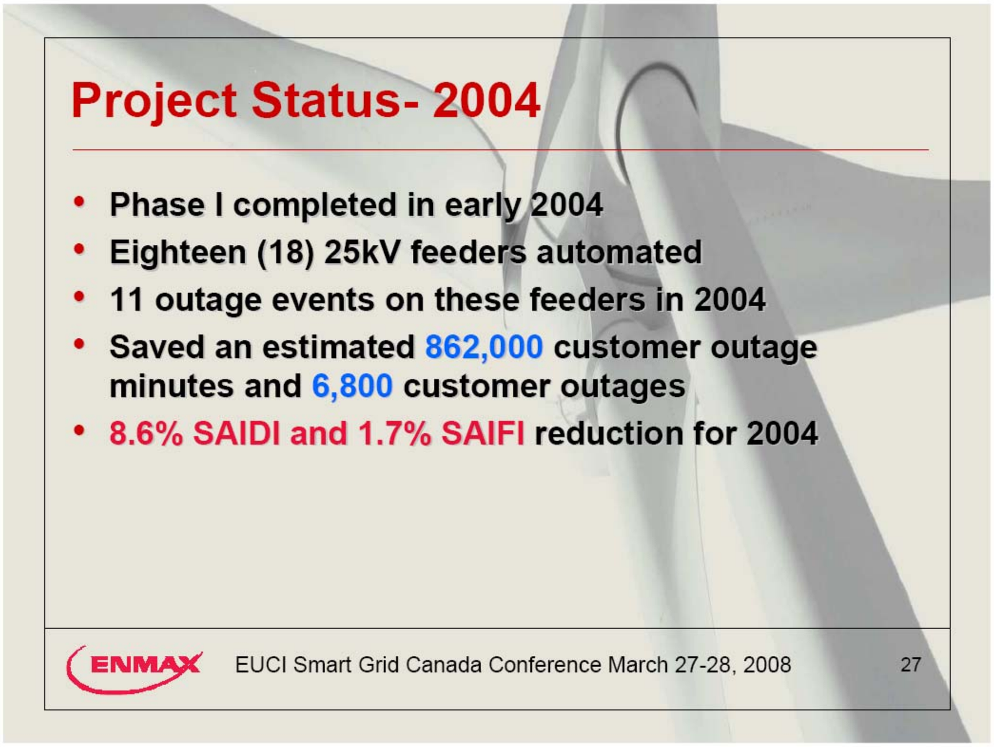

Control Centre Screen
DA Summary
11 Sub
Feeder DA Bkr Logic Recloser
11.111 ON ON
11.112 ON ON
11.114 ON ON
11.118 ON ON
11S RC25 ON
Controller Automation Restoration Teams Ready
11.111-46 ON ON ON
11.111-48 ON ON ON
11.112-2 ON ON ON
11.112-16,17 ON ON ON
11.112-22,23 ON ON ON
11.114-30 NO ON ON ON
11.114-40 ON ON ON
11.114-41 ON ON ON
11.118-3 NO ON ON ON
11.118-31, 11.112-32 NO ON ON ON
11.118-42,43, 11.112-28 NO ON ON ON
11.118-75 ON ON ON
11.118-76 ON ON ON
11.114-39,42, 14.113-59 NO ON ON ON
28 Sub
Feeder DA Bkr Logic Recloser
28.111 ON ON OFF
Controller Automation Restoration Teams Ready
28.111-2 ON OFF OFF
28.111-3 NO ON ON OFF
28.111-83 ON OFF OFF
14 Sub
Feeder DA Bkr Logic Recloser
14.113 ON ON
14.114 ON ON
14.115 ON ON
14.116 ON ON
14S RC25 ON
Controller Automation Restoration Teams Ready
14.113-63 ON ON ON
14.113-64 ON ON ON
14.114-21, 22 ON ON ON
14.115-40 ON ON ON
14.115-41 ON ON ON
14.115-43 NO ON ON ON
14.115-49 ON ON ON
14.115-50 ON ON ON
14.116-10, 11 ON ON ON
14.116-26, 27 14.114-9 NO ON ON ON
14.116-36, 74 ON ON ON
14.115-63 NO ON ON ON
14.116-79, 80 ON ON ON
36.111A-47 ON ON ON
36 Sub
Feeder DA Bkr Logic Recloser
36.111B ON ON ON
Controller Automation Restoration Teams Ready
36.111B-11 ON ON ON
24 Sub
Feeder DA Bkr Logic Recloser
24.111 ON ON OFF
Controller Automation Restoration Teams Ready
24.111-9 ON OFF OFF
24.111-43,44,45 ON OFF OFF
24.111-65, 123 ON OFF OFF
39 Sub
Feeder DA Bkr Logic Recloser
39.113 ON ON
39.114 ON ON
39.115 ON ON
39.116 ON ON
39.117 ON ON
39S RC25 ON
Controller Automation Restoration Teams Ready
39.113-11 NO ON ON ON
39.113-12 ON ON ON
39.114-25 ON ON ON
39.115-8 NO ON ON ON
39.115-11 NO ON ON ON
39.115-16 NO ON ON ON
39.115-20 ON ON ON
39.116-5,6 ON ON ON
39.116-22 NO ON ON ON
39.117-7,8 ON ON ON


Control Centre Screen
11 Sub 25 kV Automated Feeders
Click on Button for Feeder View
11 Sub RC
11S DA Summary
more 11 Sub
ties to 14 Sub
ties to 14 Sub
11 S


Project Status- 2004
• Phase I completed in early 2004
• Eighteen (18) 25kV feeders automated
• 11 outage events on these feeders in 2004
• Saved an estimated 862,000 customer outage minutes and 6,800 customer outages
• 8.6% SAIDI and 1.7% SAIFI reduction for 2004
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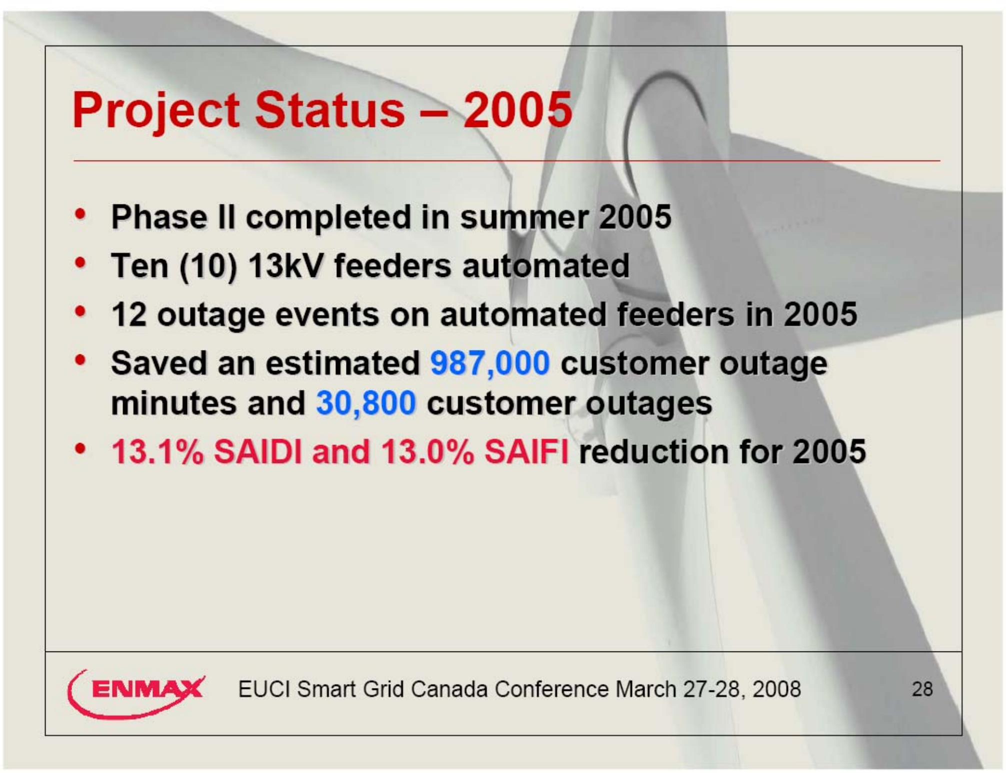
Project Status – 2005
• Phase II completed in summer 2005
• Ten (10) 13kV feeders automated
• 12 outage events on automated feeders in 2005
• Saved an estimated 987,000 customer outage minutes and 30,800 customer outages
• 13.1% SAIDI and 13.0% SAIFI reduction for 2005
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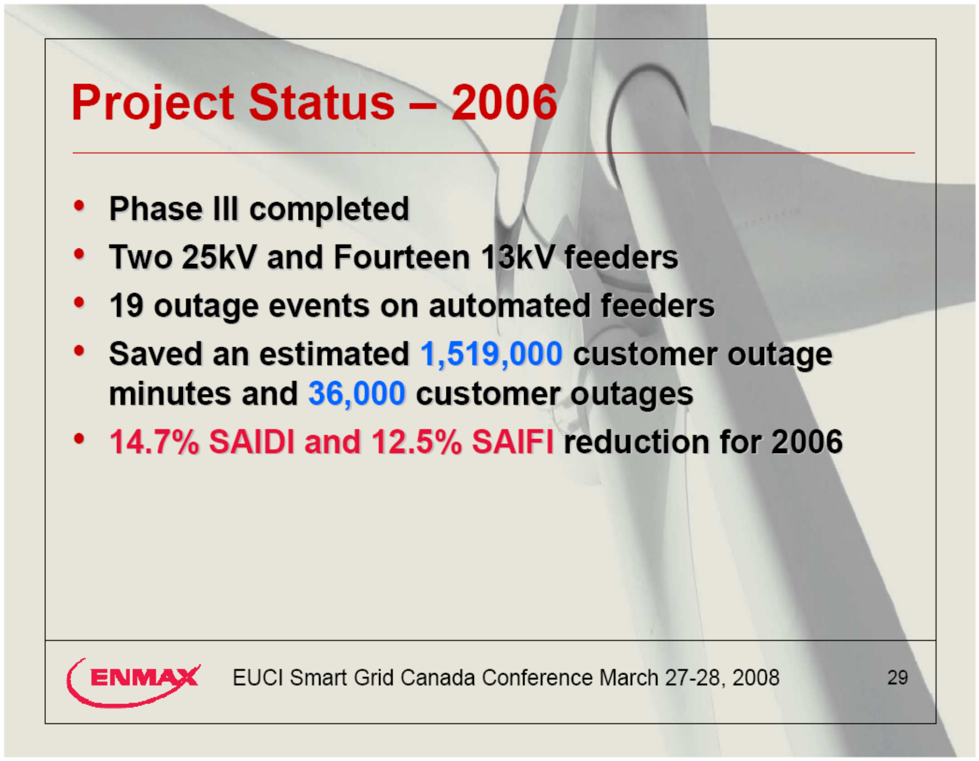
Project Status – 2006
Phase III completed
Two 25kV and Fourteen 13kV feeders
19 outage events on automated feeders
Saved an estimated 1,519,000 customer outage minutes and 36,000 customer outages
14.7% SAIDI and 12.5% SAIFI reduction for 2006
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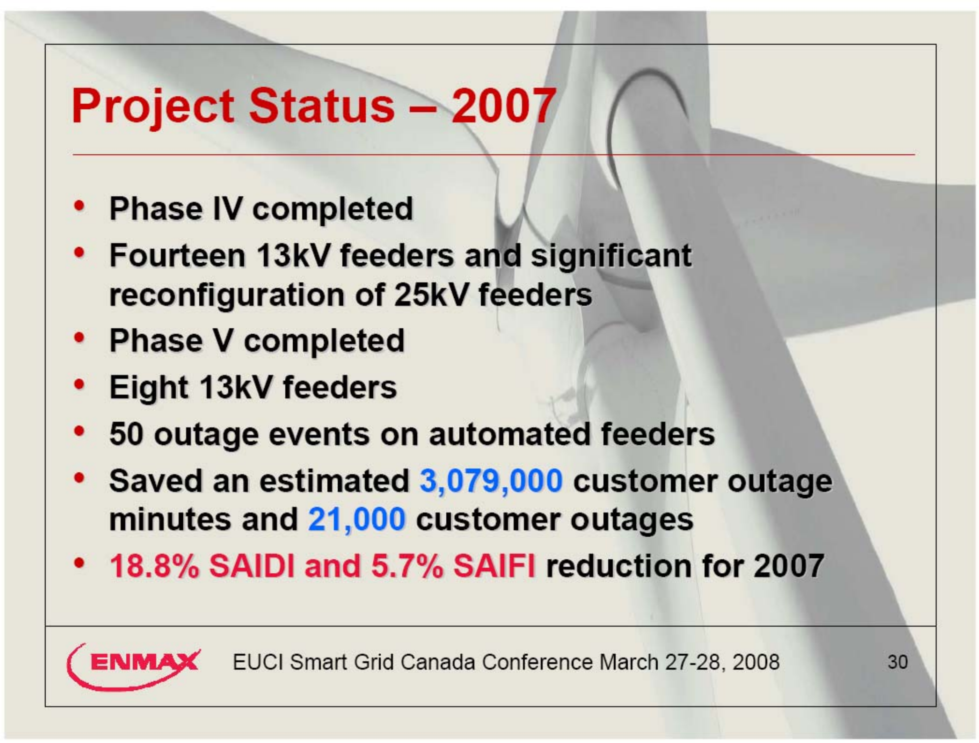
Project Status – 2007
Phase IV completed
Fourteen 13kV feeders and significant reconfiguration of 25kV feeders
Phase V completed
Eight 13kV feeders
50 outage events on automated feeders
Saved an estimated 3,079,000 customer outage minutes and 21,000 customer outages
18.8% SAIDI and 5.7% SAIFI reduction for 2007
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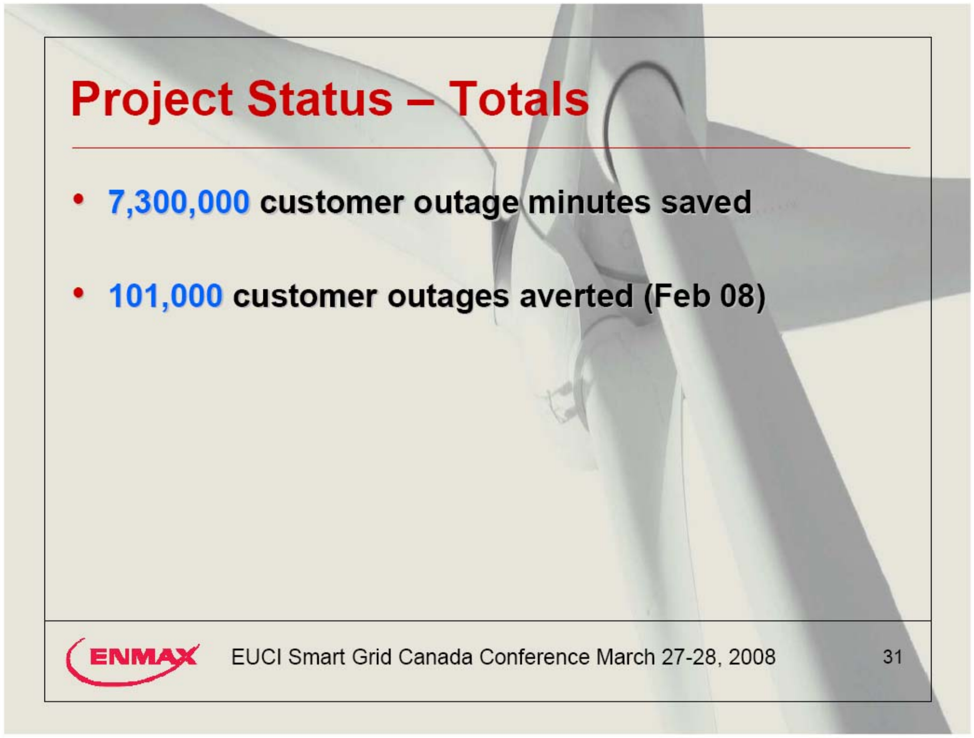
Project Status – Totals
• 7,300,000 customer outage minutes saved
• 101,000 customer outages averted (Feb 08)
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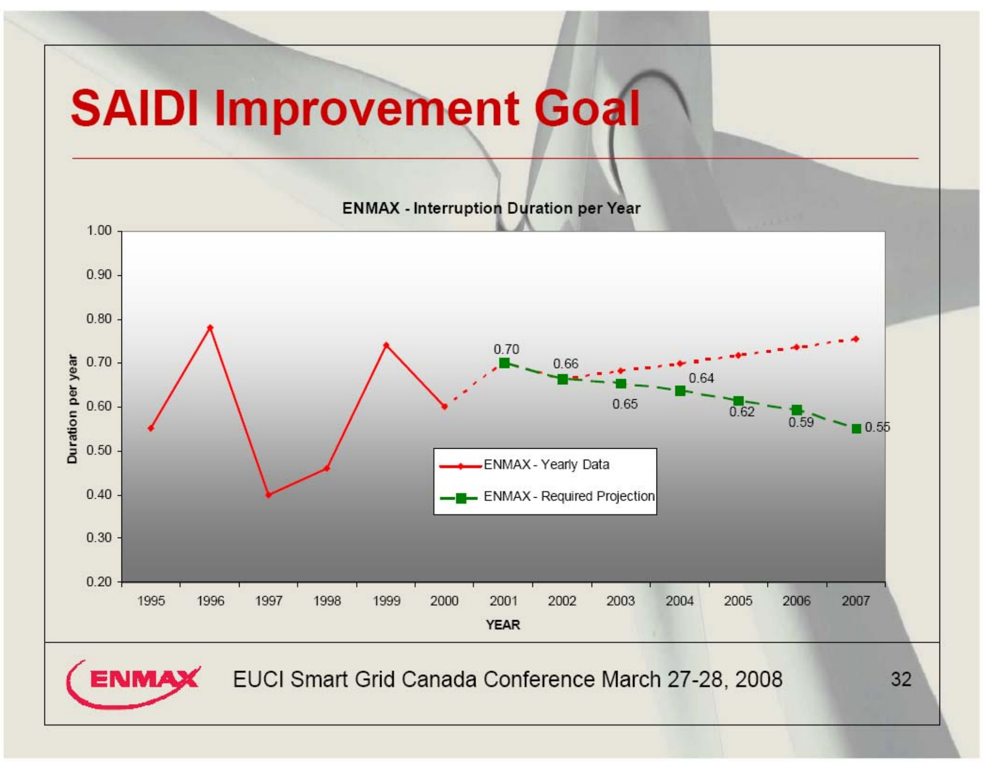
SAIDI Improvement Goal
ENMAX - Interruption Duration per Year
Duration per year
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
YEAR
0.70
0.66
0.65
0.64
0.62
0.59
0.55
ENMAX - Yearly Data
ENMAX - Required Projection
ENMAX
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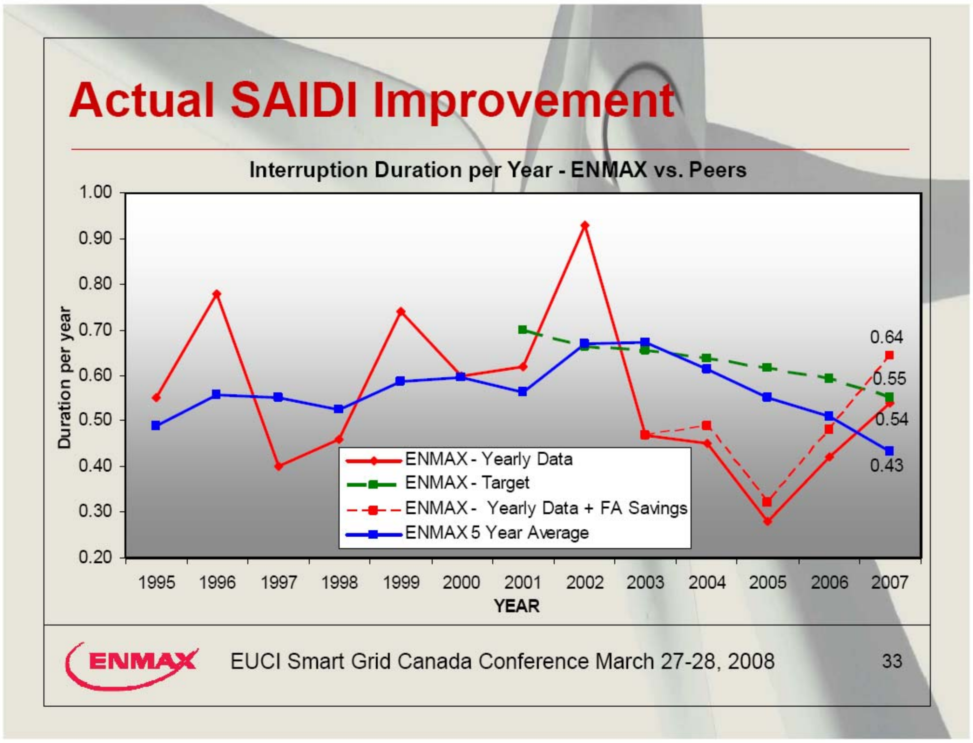
Actual SAIDI Improvement
Interruption Duration per Year - ENMAX vs. Peers
Duration per year
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.64
0.55
0.54
0.43
ENMAX - Yearly Data
ENMAX - Target
ENMAX - Yearly Data + FA Savings
ENMAX 5 Year Average
1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007
YEAR
ENMAX
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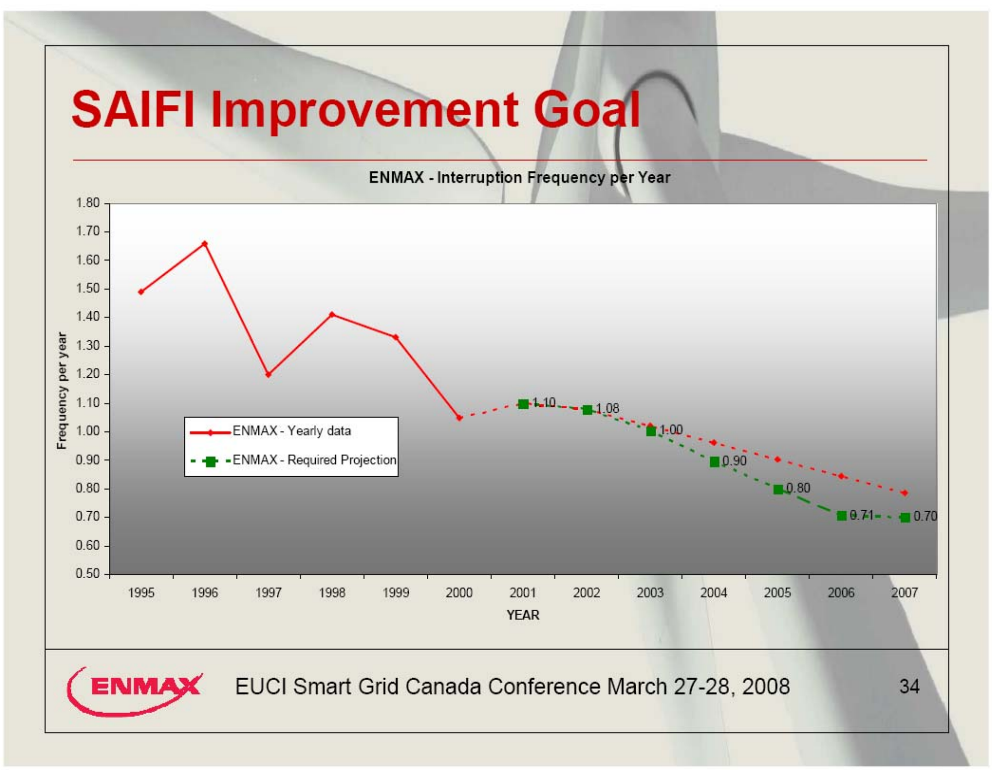
SAIFI Improvement Goal
ENMAX - Interruption Frequency per Year
Frequency per year
1.80
1.70
1.60
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
1.10
1.08
1.00
0.90
0.80
0.71
0.70
ENMAX - Yearly data
ENMAX - Required Projection
1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007
YEAR
ENMAX
EUCI Smart Grid Canada Conference March 27-28, 2008
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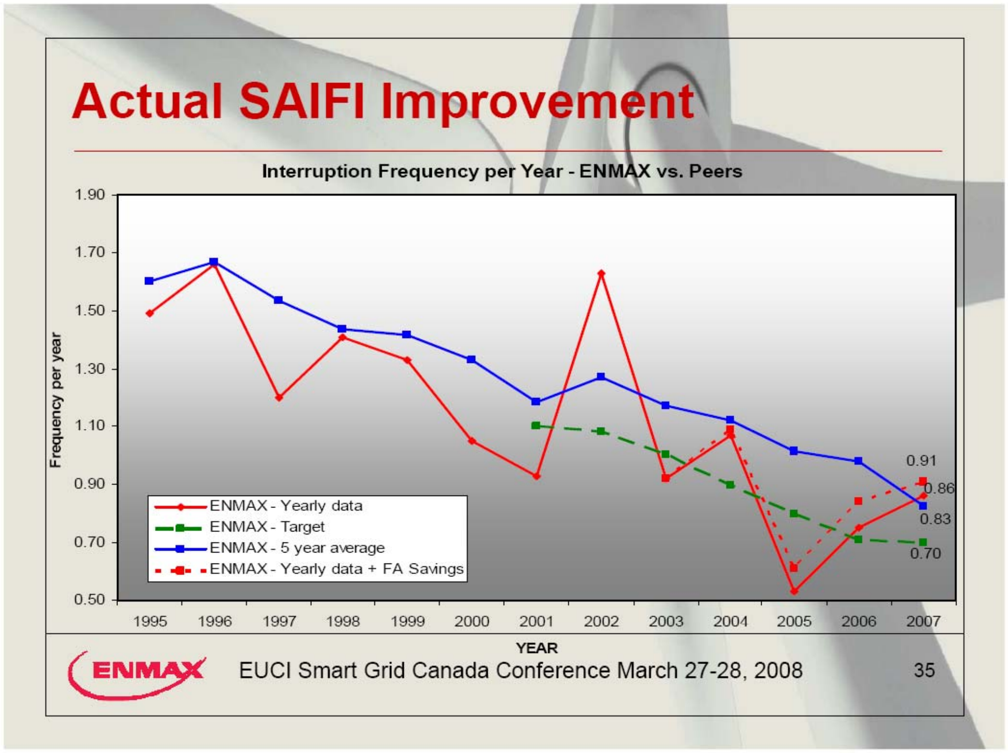
Actual SAIFI Improvement
Interruption Frequency per Year - ENMAX vs. Peers
Frequency per year
1.90
1.70
1.50
1.30
1.10
0.90
0.70
0.50
ENMAX - Yearly data
ENMAX - Target
ENMAX - 5 year average
ENMAX - Yearly data + FA Savings
0.91
0.86
0.83
0.70
1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007
YEAR
ENMAX
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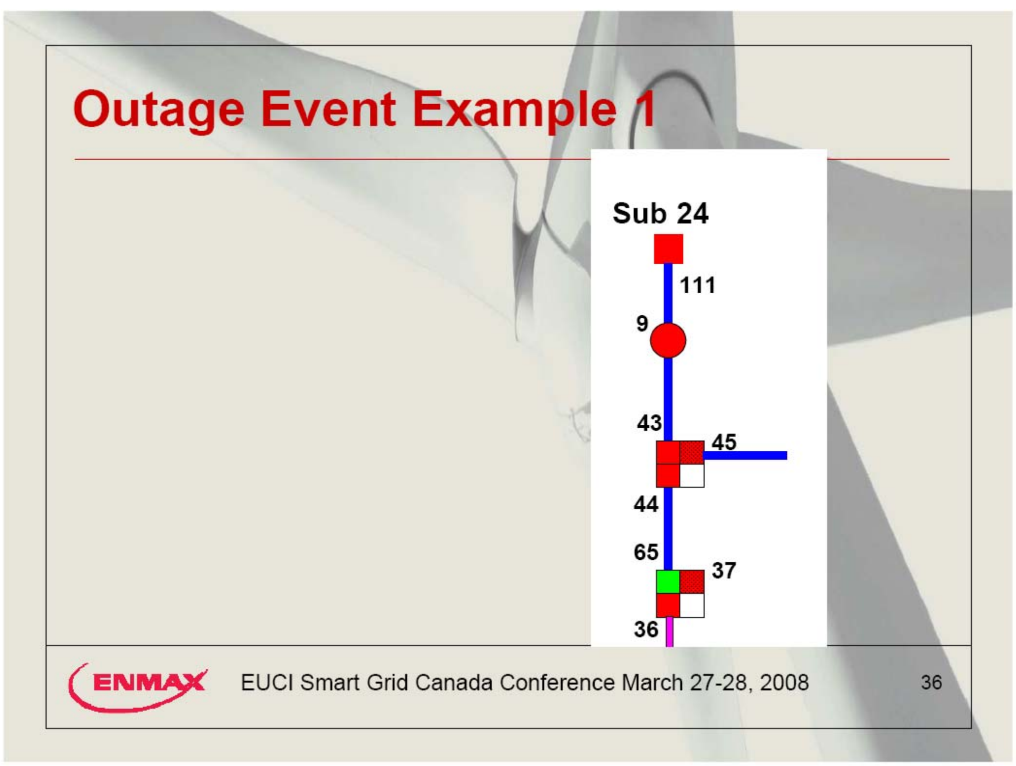
Outage Event Example 1
Sub 24
111
9
43
45
44
65
37
36
ENMAX
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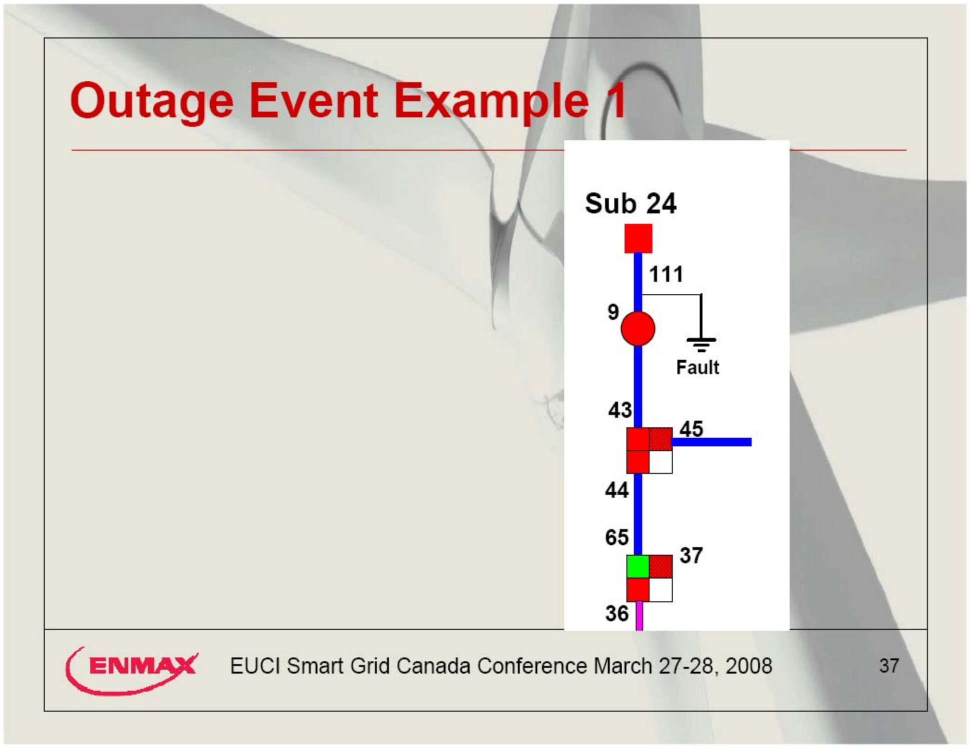
Outage Event Example 1
Sub 24
111
9
Fault
43
45
44
65
37
36
ENMAX
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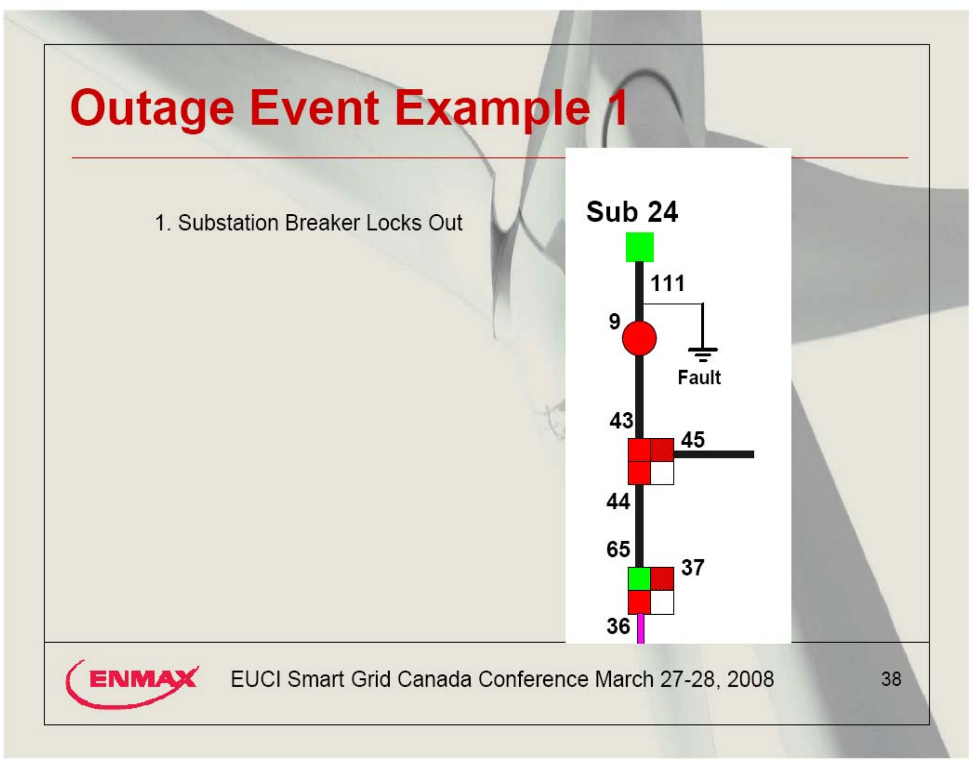
37


Outage Event Example 1
1. Substation Breaker Locks Out
Sub 24
111
9
Fault
43
45
44
65
37
36
ENMAX
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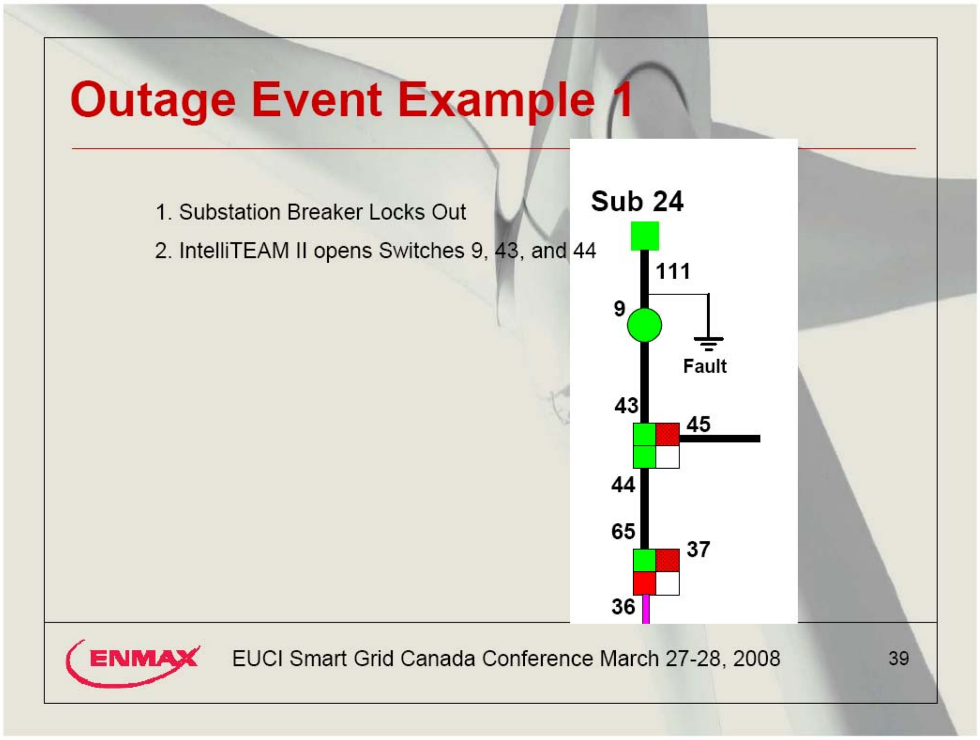
Outage Event Example 1
1. Substation Breaker Locks Out
2. IntelliTEAM II opens Switches 9, 43, and 44
Sub 24
111
9
Fault
43
45
44
65
37
36
ENMAX
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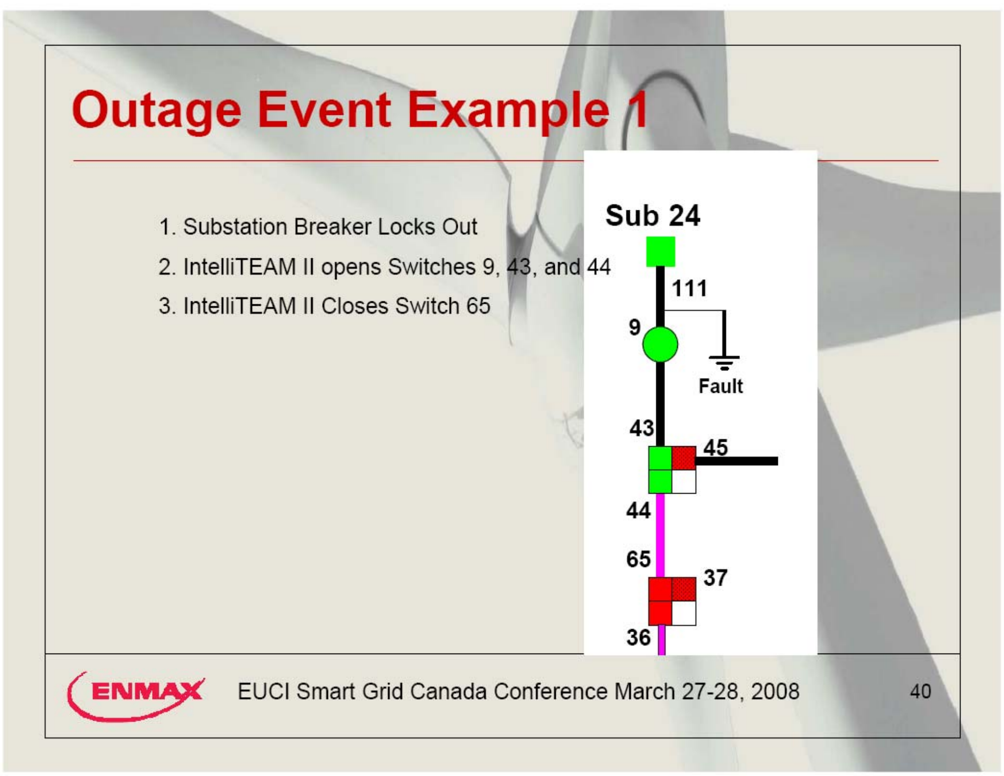
Outage Event Example 1
1. Substation Breaker Locks Out
2. IntelliTEAM II opens Switches 9, 43, and 44
3. IntelliTEAM II Closes Switch 65
Sub 24
111
9
Fault
43
45
44
65
37
36
ENMAX
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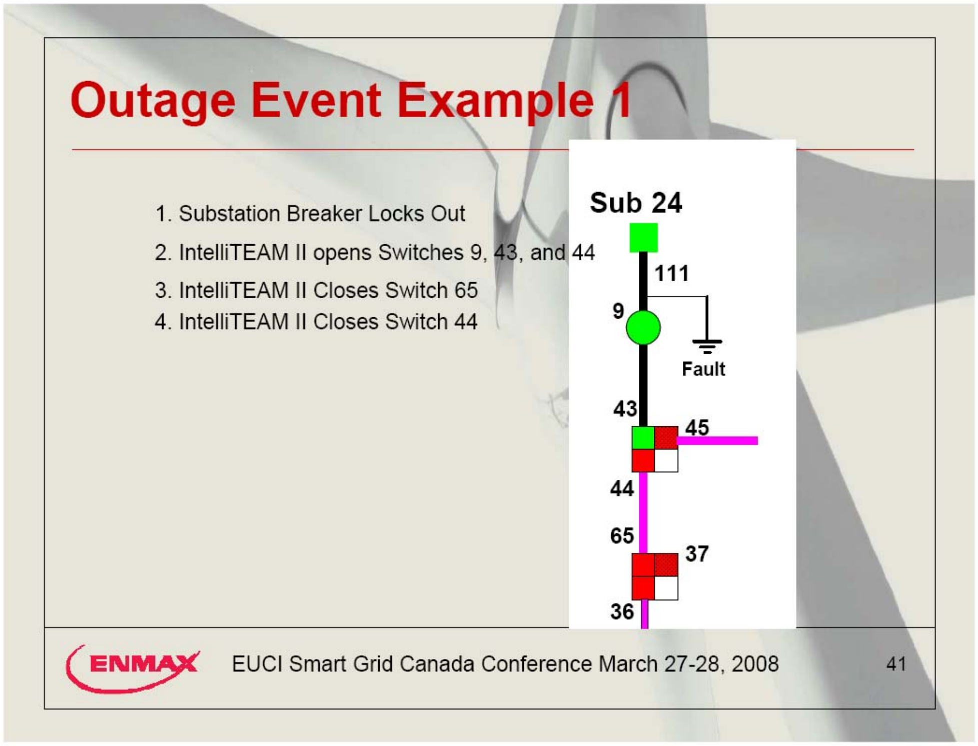
40


Outage Event Example 1
1. Substation Breaker Locks Out
2. IntelliTEAM II opens Switches 9, 43, and 44
3. IntelliTEAM II Closes Switch 65
4. IntelliTEAM II Closes Switch 44
Sub 24
111
9
Fault
43
45
44
65
37
36
ENMAX
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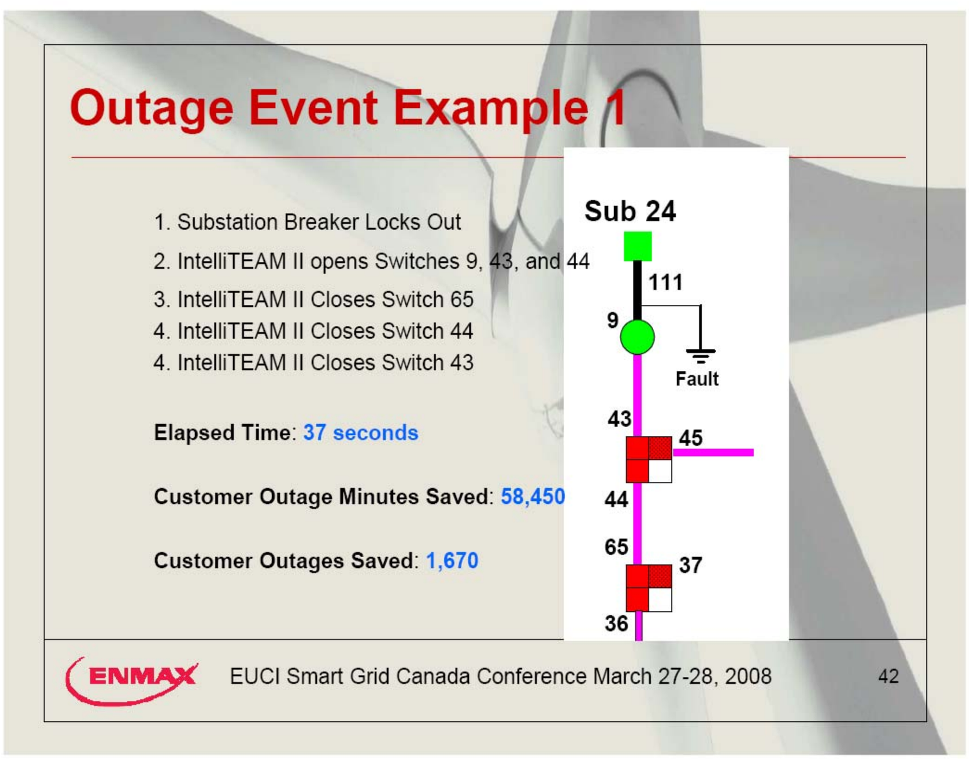
Outage Event Example 1
1. Substation Breaker Locks Out
2. IntelliTEAM II opens Switches 9, 43, and 44
3. IntelliTEAM II Closes Switch 65
4. IntelliTEAM II Closes Switch 44
4. IntelliTEAM II Closes Switch 43
Elapsed Time: 37 seconds
Customer Outage Minutes Saved: 58,450
Customer Outages Saved: 1,670
Sub 24
111
9
Fault
43
45
44
65
37
36
ENMAX
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Outage Event Example 2

Pole Fires, March 16, 2006

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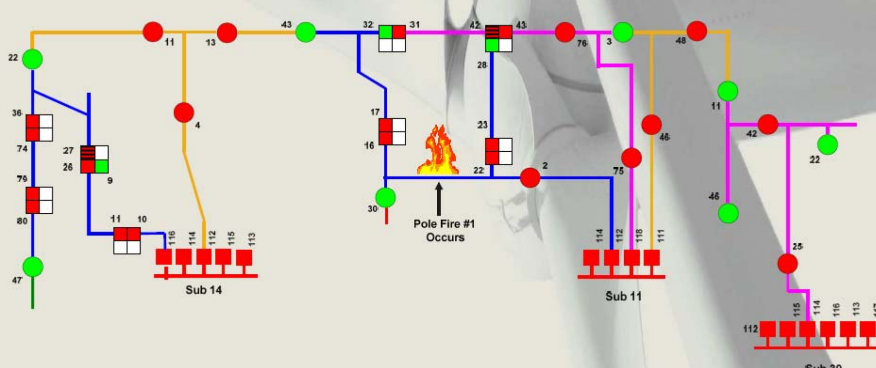
Outage Event Example 2



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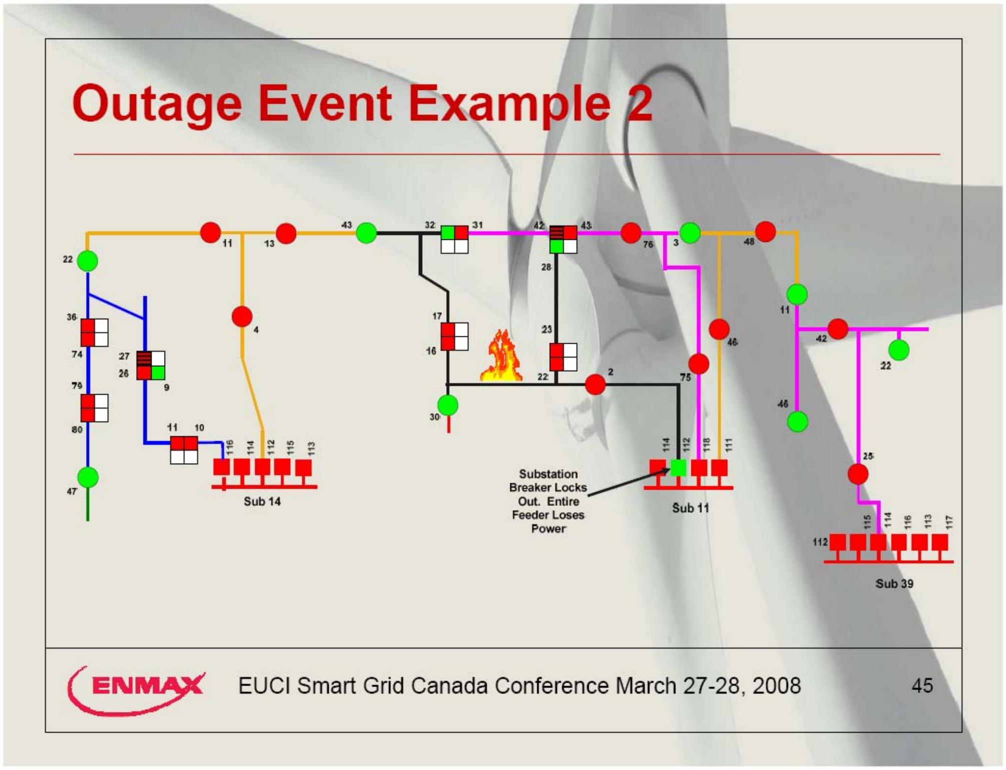
Outage Event Example 2
Sub 14
Substation Breaker Locks Out. Entire Feeder Loses Power
Sub 11
Sub 39
ENMAX
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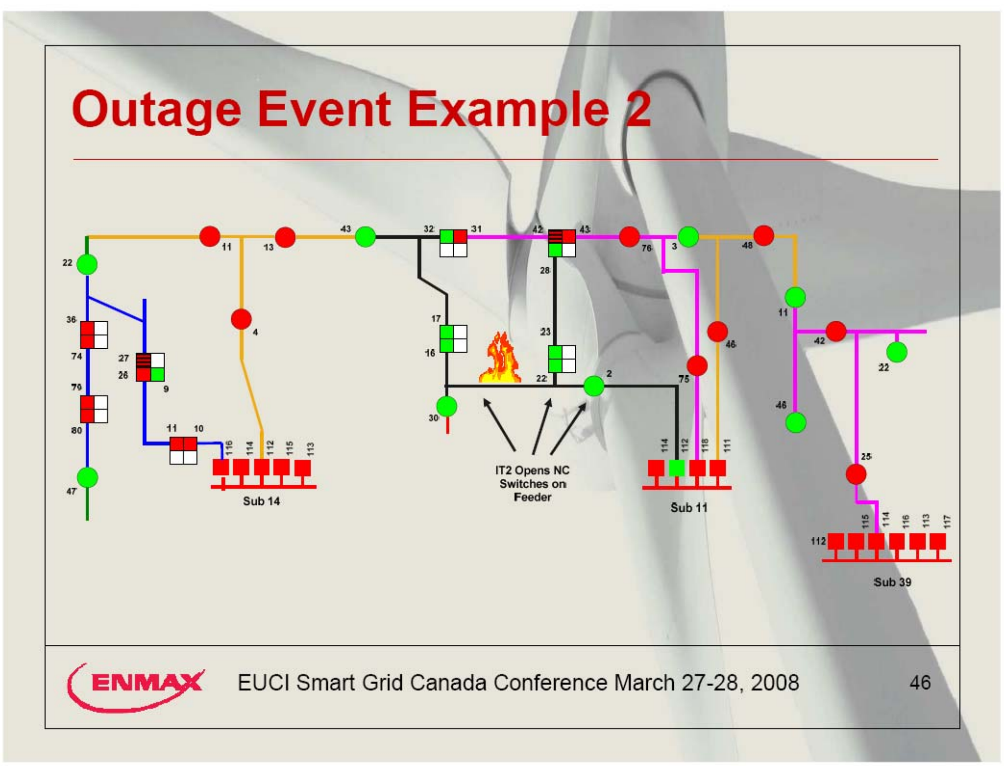
Outage Event Example 2
Sub 14
IT2 Opens NC Switches on Feeder
Sub 11
Sub 39
ENMAX
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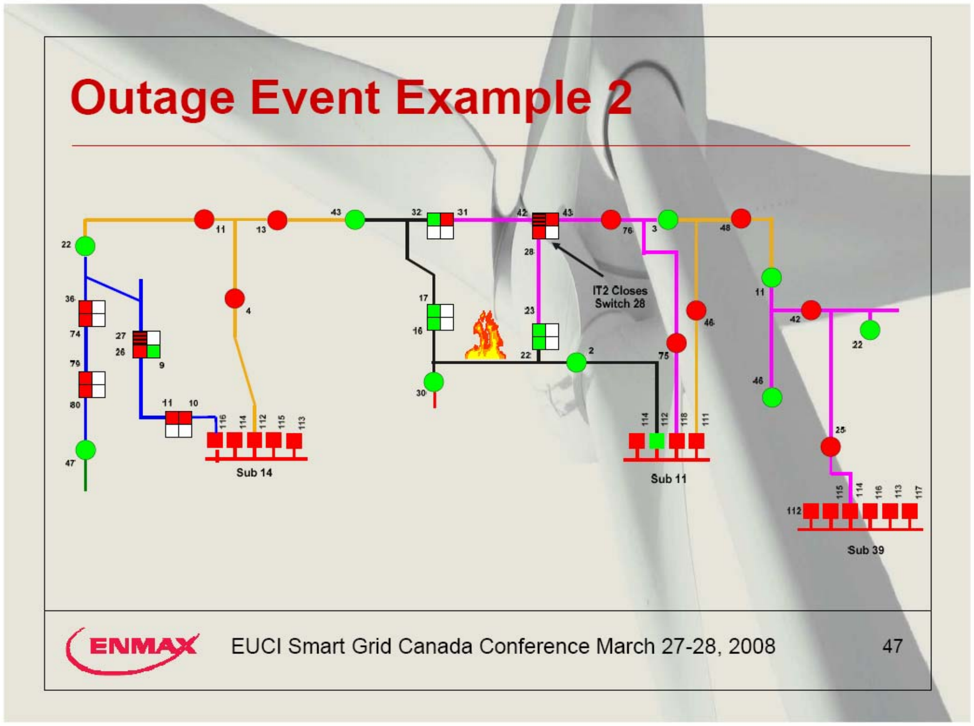
Outage Event Example 2
IT2 Closes
Switch 28
Sub 14
Sub 11
Sub 39
ENMAX
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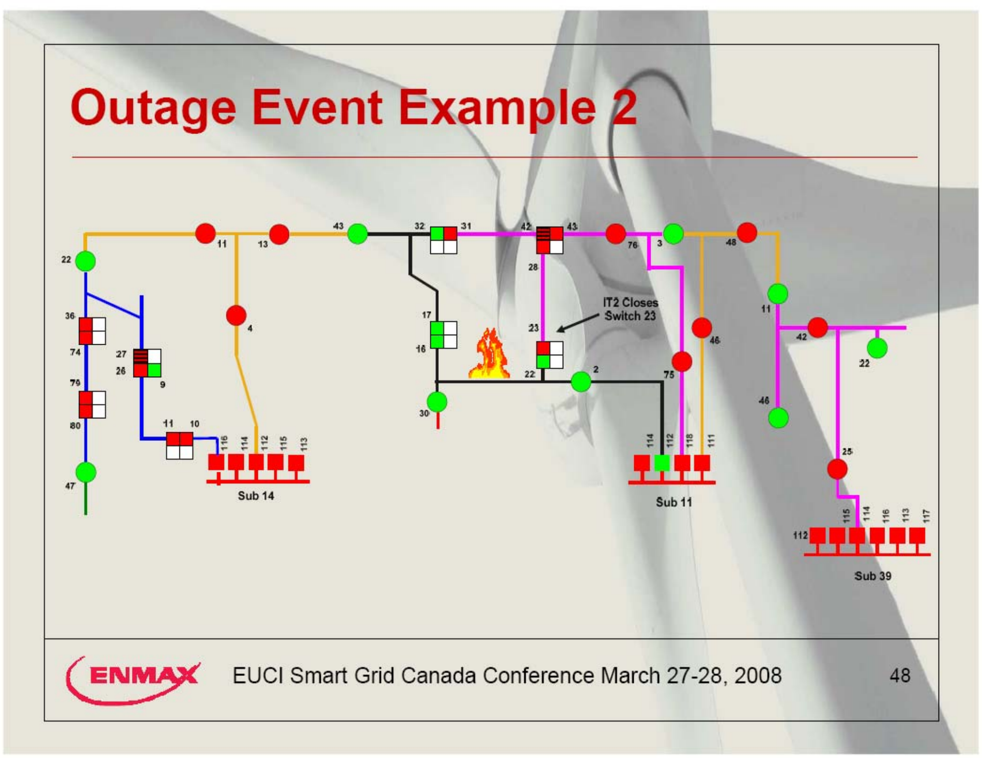
Outage Event Example 2
IT2 Closes
Switch 23
Sub 14
Sub 11
Sub 39
ENMAX
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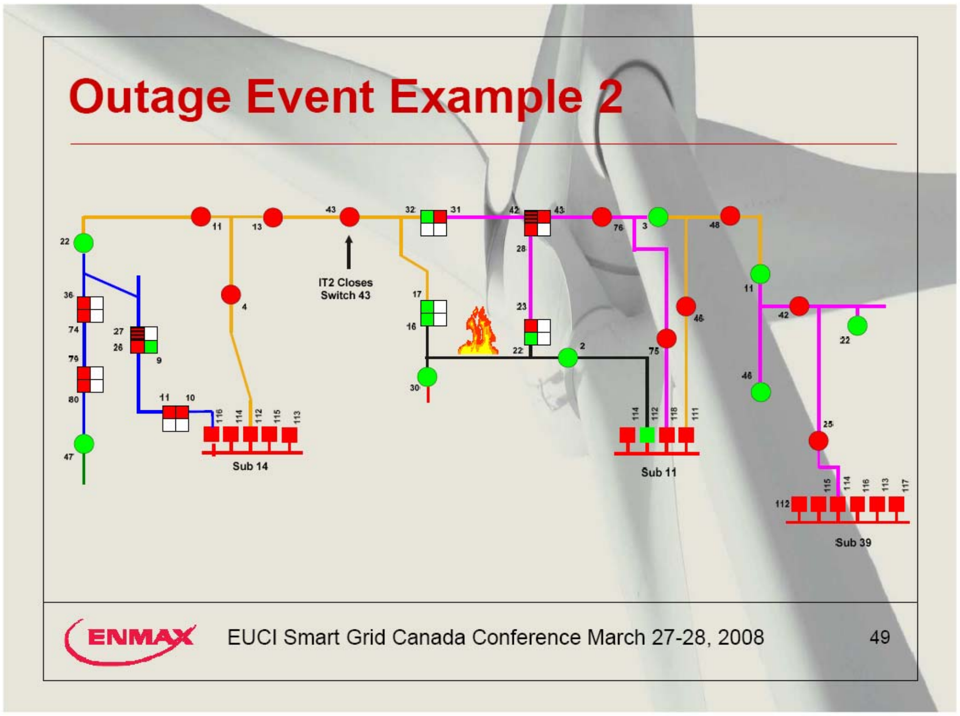
Outage Event Example 2
IT2 Closes Switch 43
Sub 14
Sub 11
Sub 39
ENMAX
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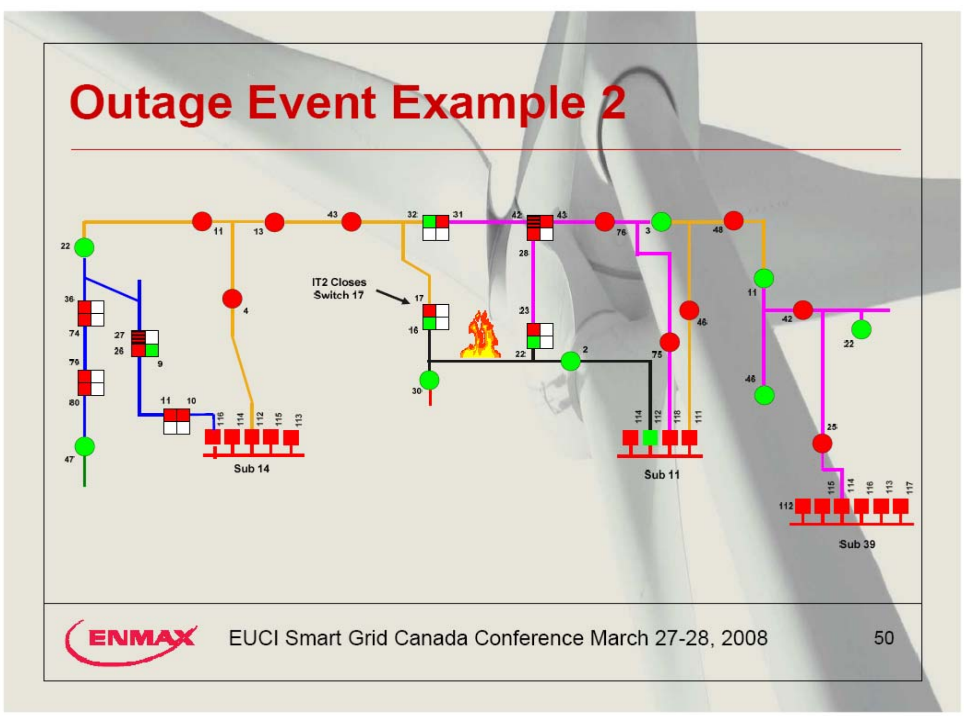
Outage Event Example 2
IT2 Closes Switch 17
Sub 14
Sub 11
Sub 39
ENMAX
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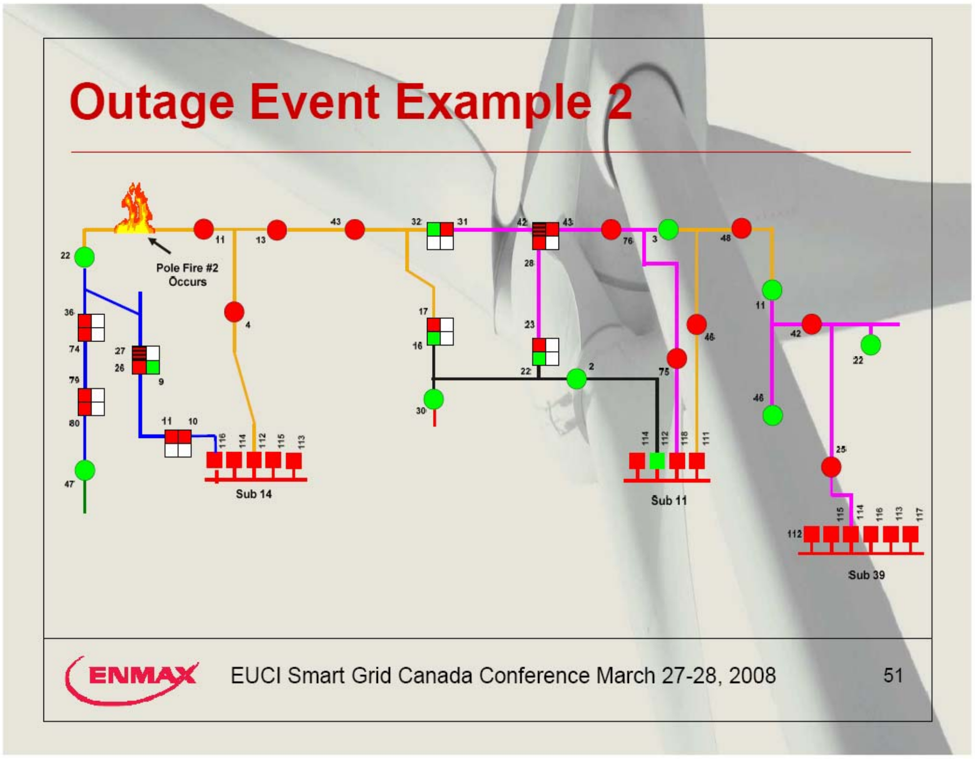
50


Outage Event Example 2
Pole Fire #2 Occurs
Sub 14
Sub 11
Sub 39
ENMAX
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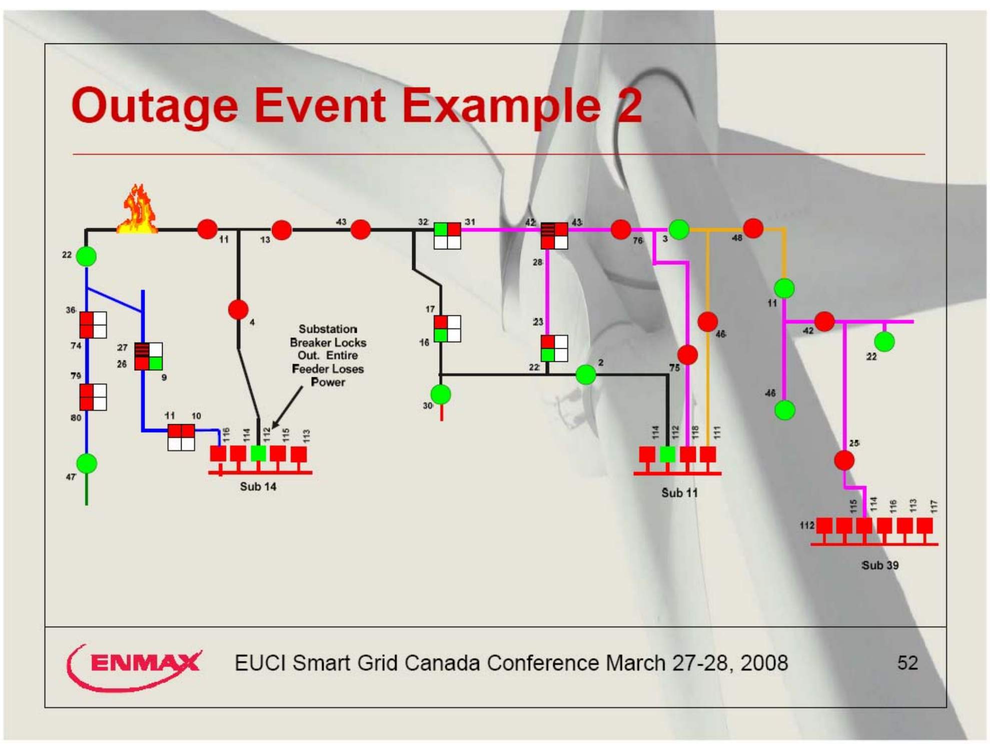
Outage Event Example 2
Substation Breaker Locks Out. Entire Feeder Loses Power
Sub 14
Sub 11
Sub 39
ENMAX
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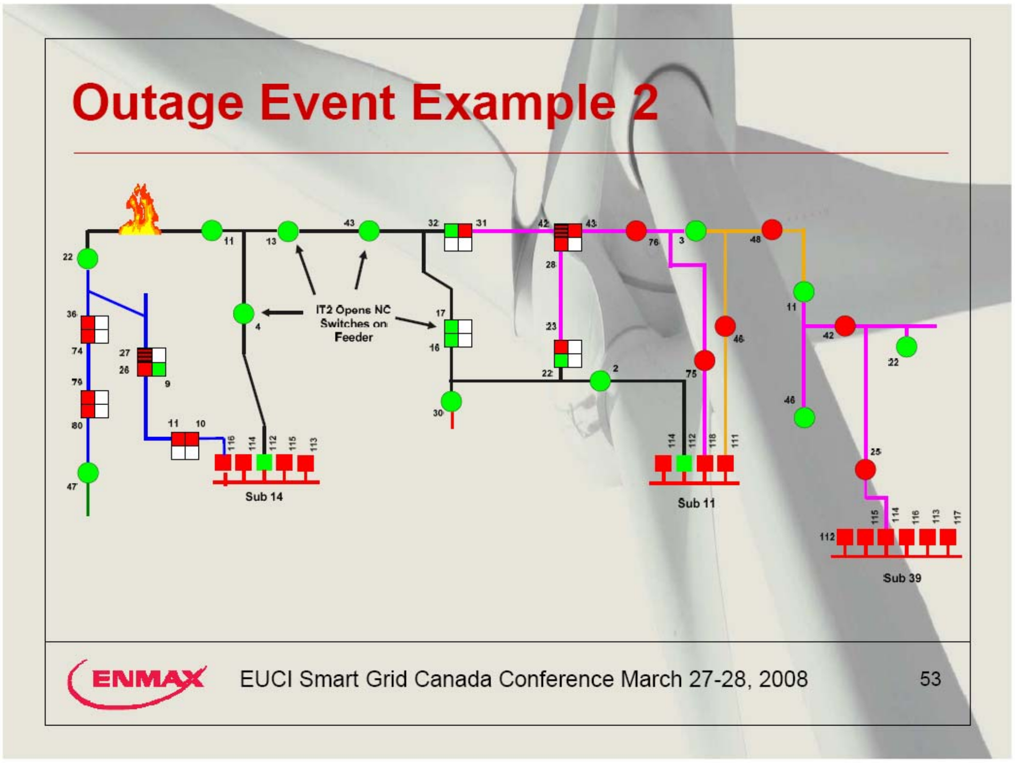
Outage Event Example 2
IT2 Opens NC Switches on Feeder
Sub 14
Sub 11
Sub 39
ENMAX
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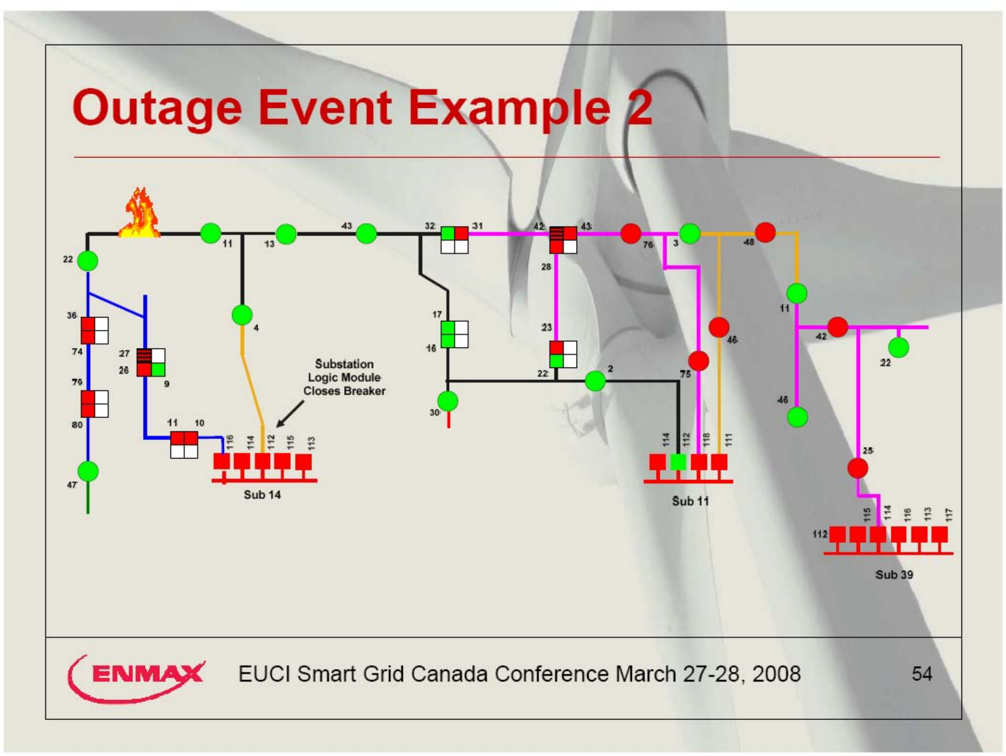
Outage Event Example 2
Substation Logic Module Closes Breaker
Sub 14
Sub 11
Sub 39
ENMAX
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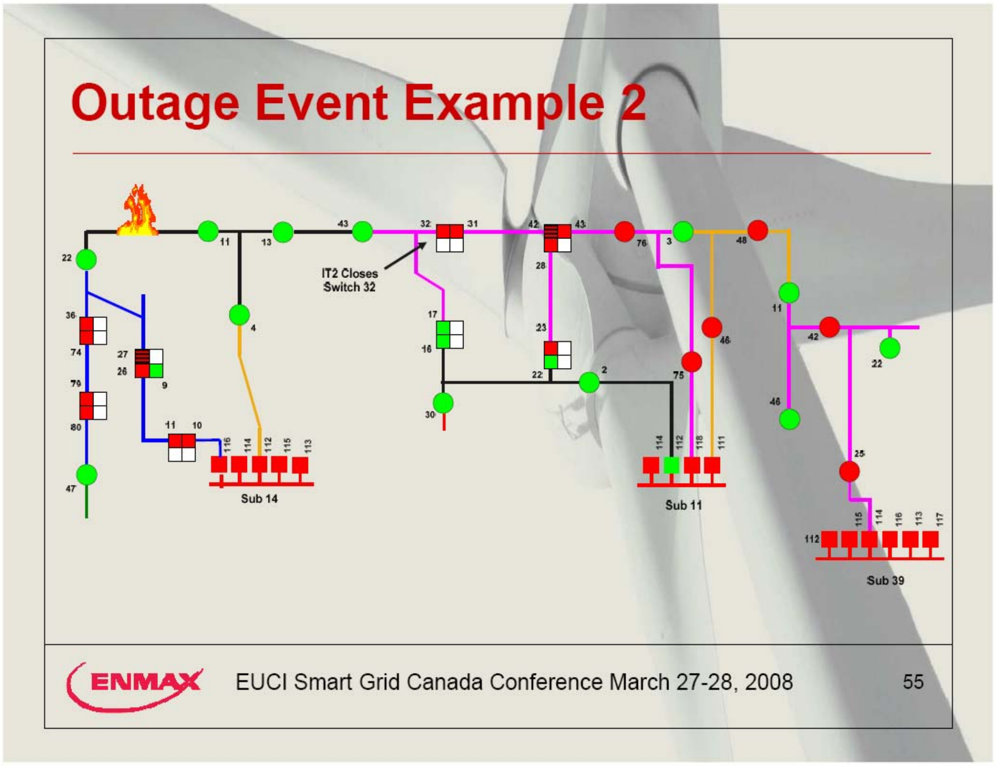
Outage Event Example 2
IT2 Closes
Switch 32
Sub 14
Sub 11
Sub 39
ENMAX
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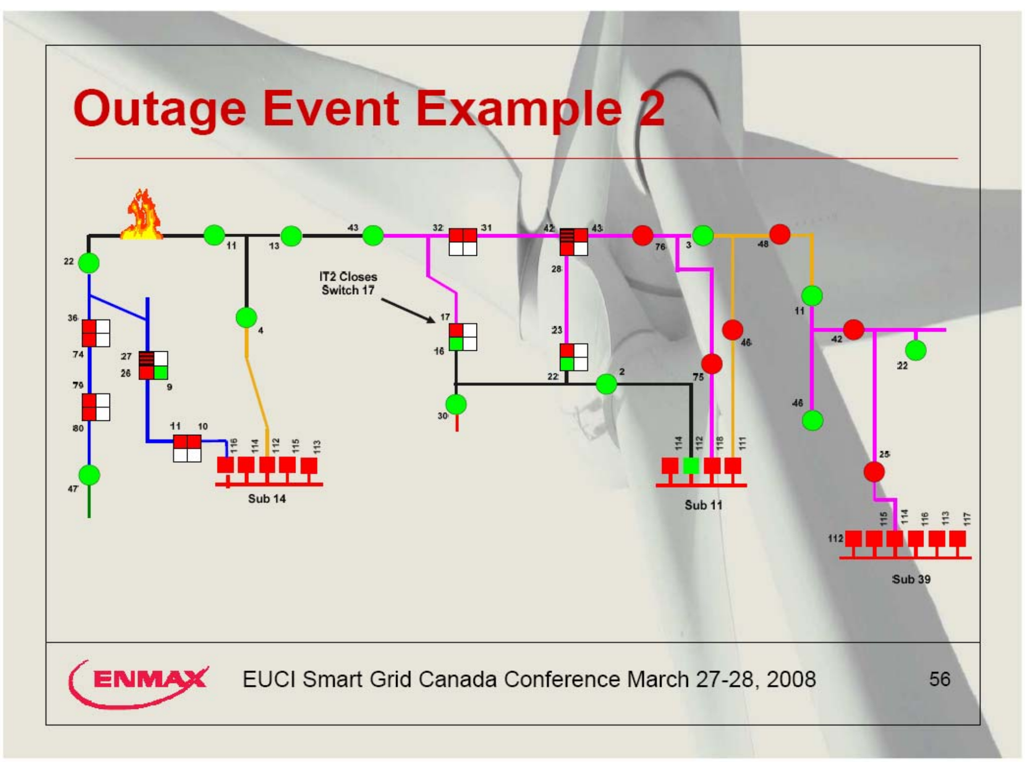
Outage Event Example 2
IT2 Closes
Switch 17
Sub 14
Sub 11
Sub 39
ENMAX
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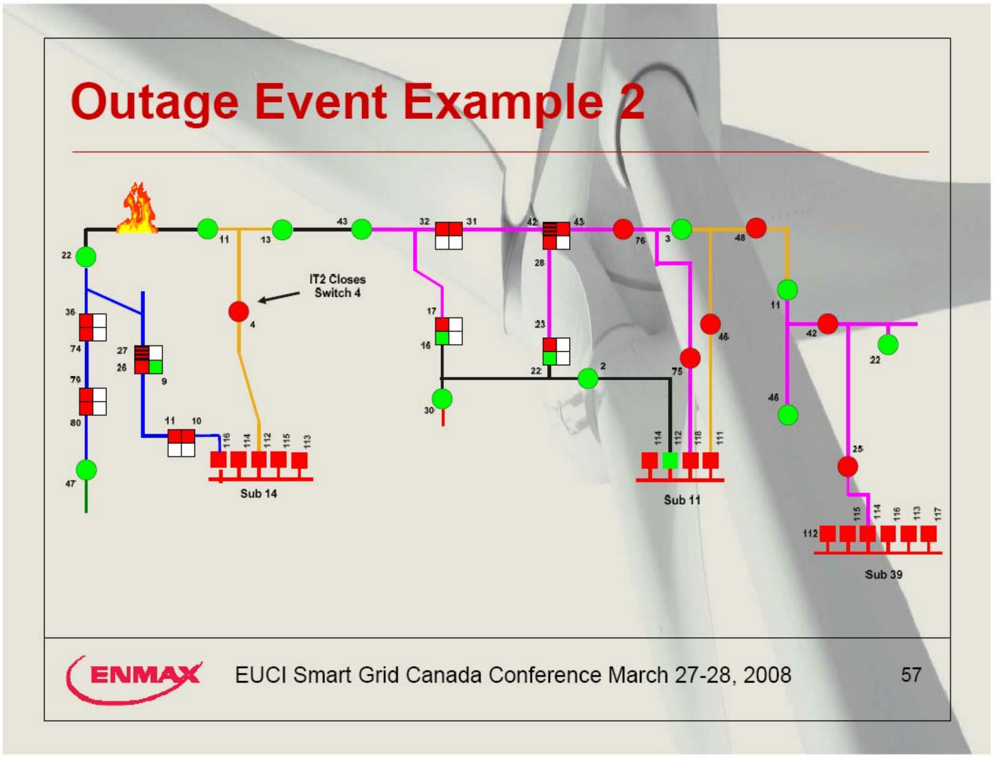
Outage Event Example 2
IT2 Closes
Switch 4
Sub 14
Sub 11
Sub 39
ENMAX
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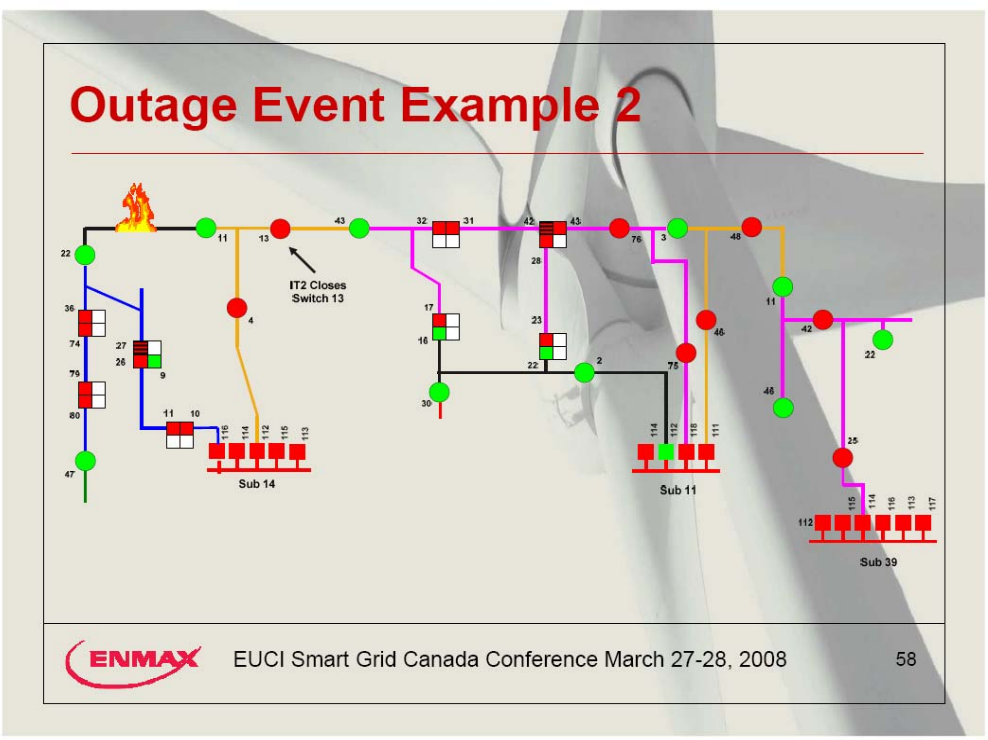
Outage Event Example 2
IT2 Closes
Switch 13
Sub 14
Sub 11
Sub 39
ENMAX
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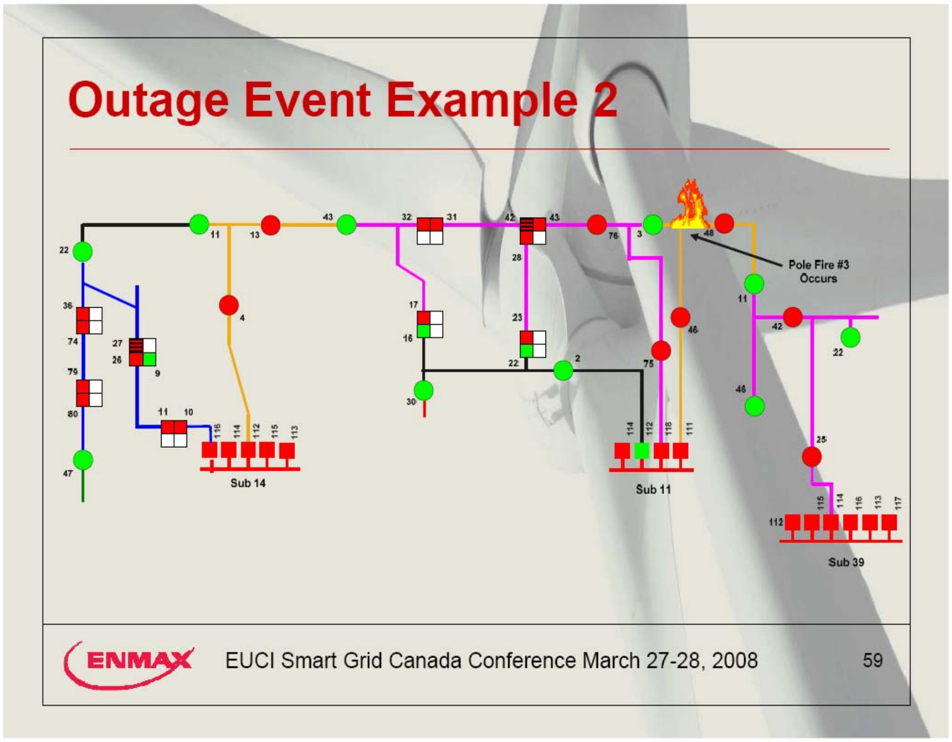
Outage Event Example 2
Pole Fire #3 Occurs
Sub 14
Sub 11
Sub 39
ENMAX
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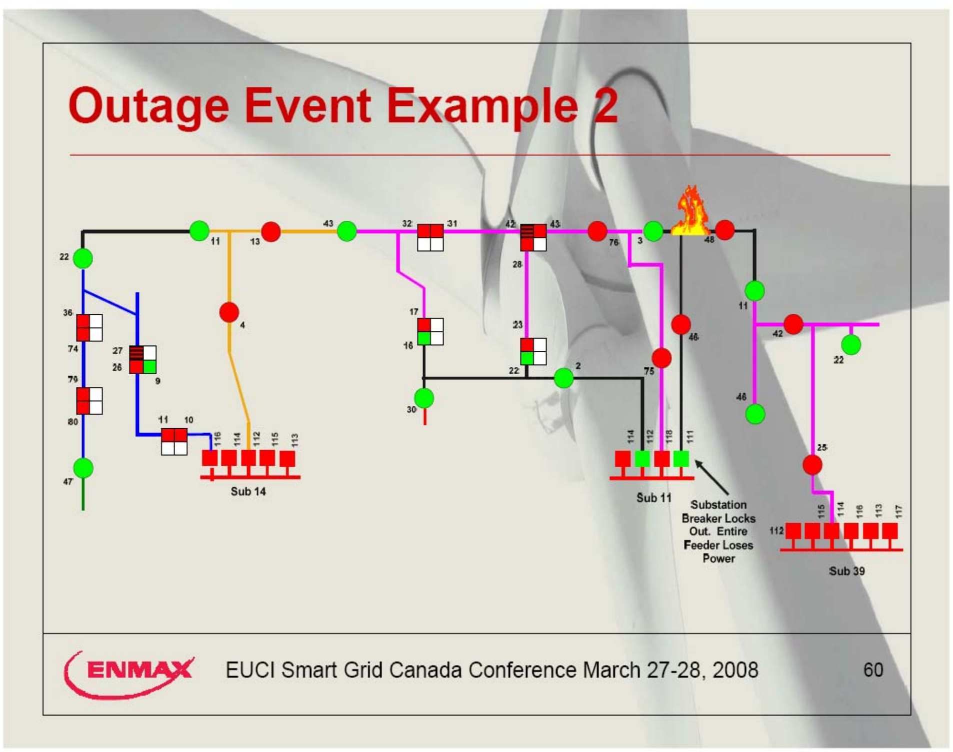
Outage Event Example 2
Substation Breaker Locks Out. Entire Feeder Loses Power
Sub 14
Sub 11
Sub 39
ENMAX
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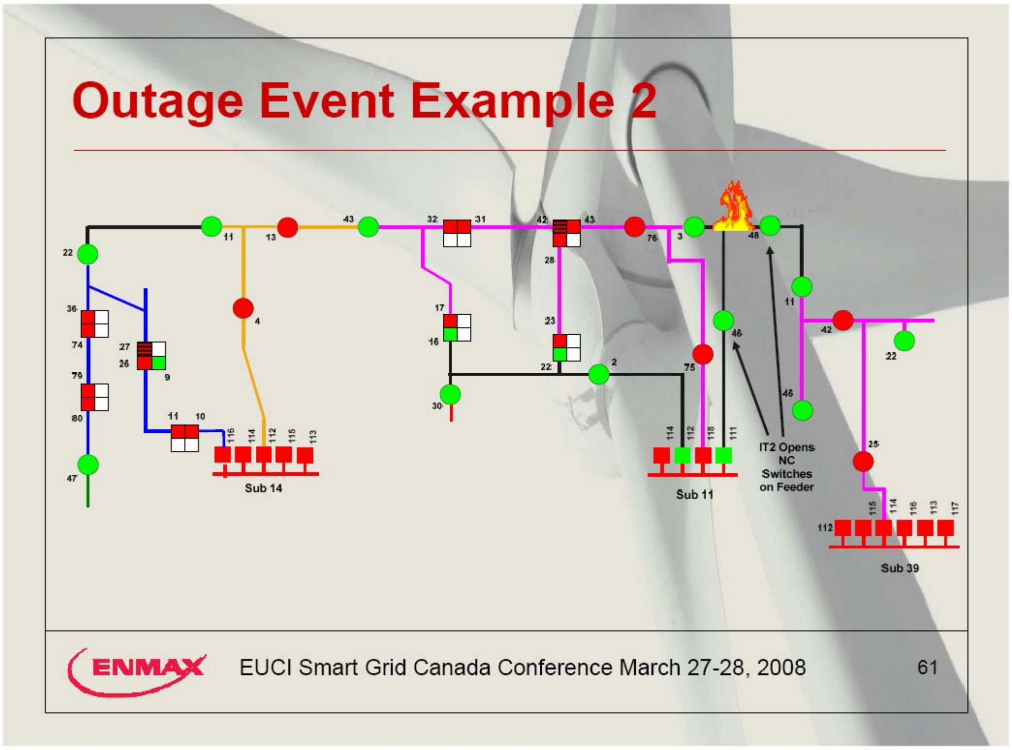
Outage Event Example 2
IT2 Opens NC Switches on Feeder
Sub 14
Sub 11
Sub 39
ENMAX
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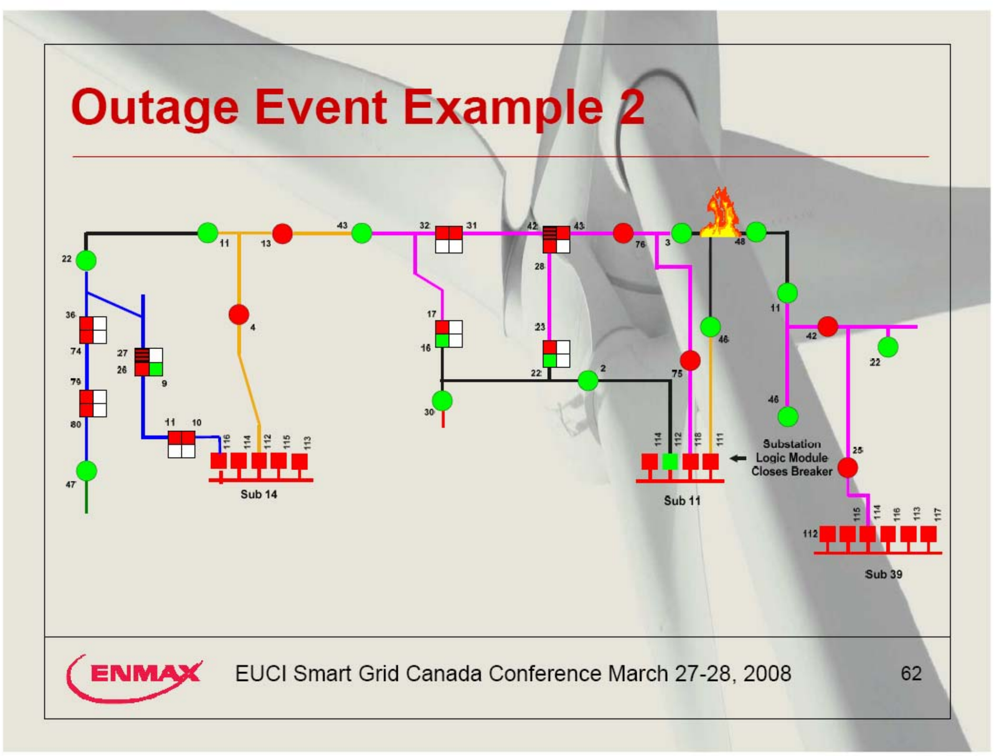
Outage Event Example 2
Substation Logic Module Closes Breaker
Sub 14
Sub 11
Sub 39
ENMAX
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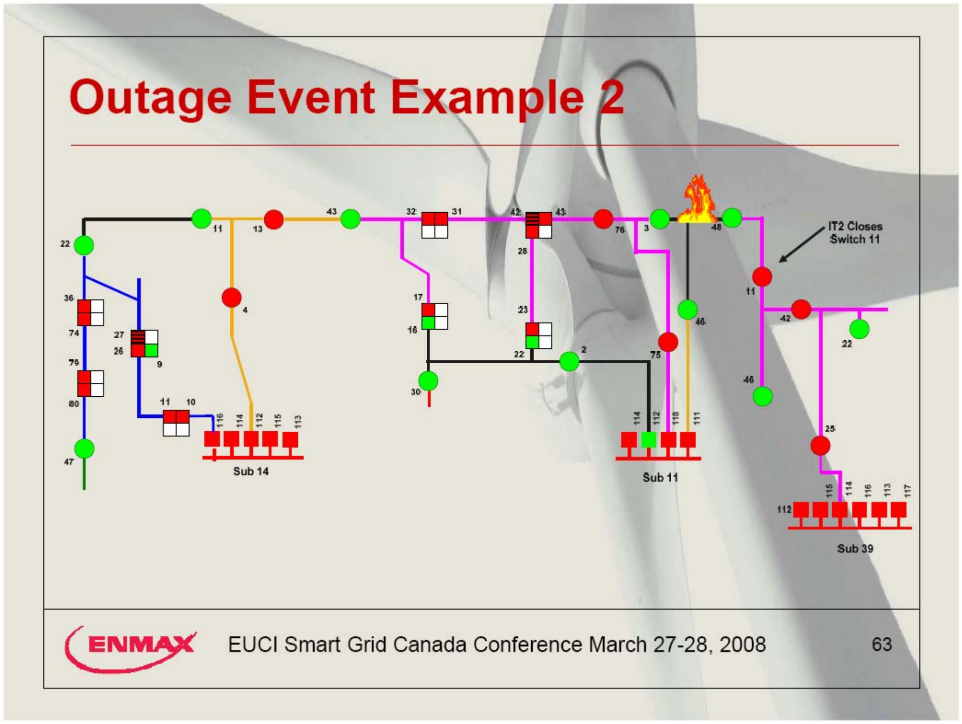
Outage Event Example 2
IT2 Closes Switch 11
Sub 14
Sub 11
Sub 39
ENMAX
EUCI Smart Grid Canada Conference March 27-28, 2008
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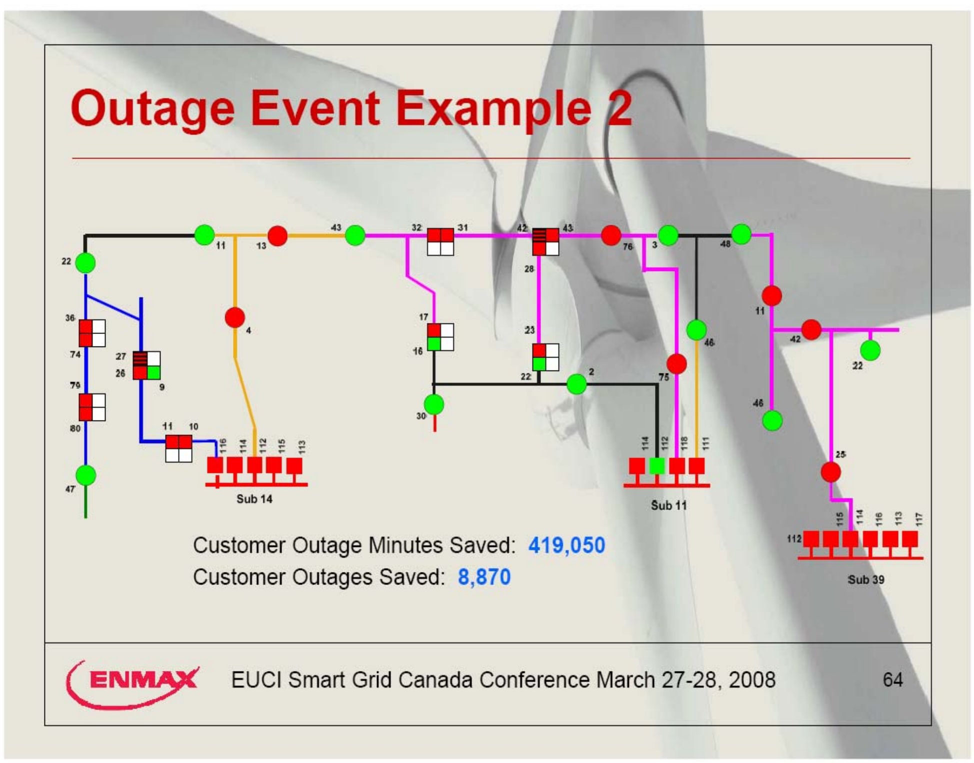
Outage Event Example 2
Sub 14
Sub 11
Sub 39
Customer Outage Minutes Saved: 419,050
Customer Outages Saved: 8,870
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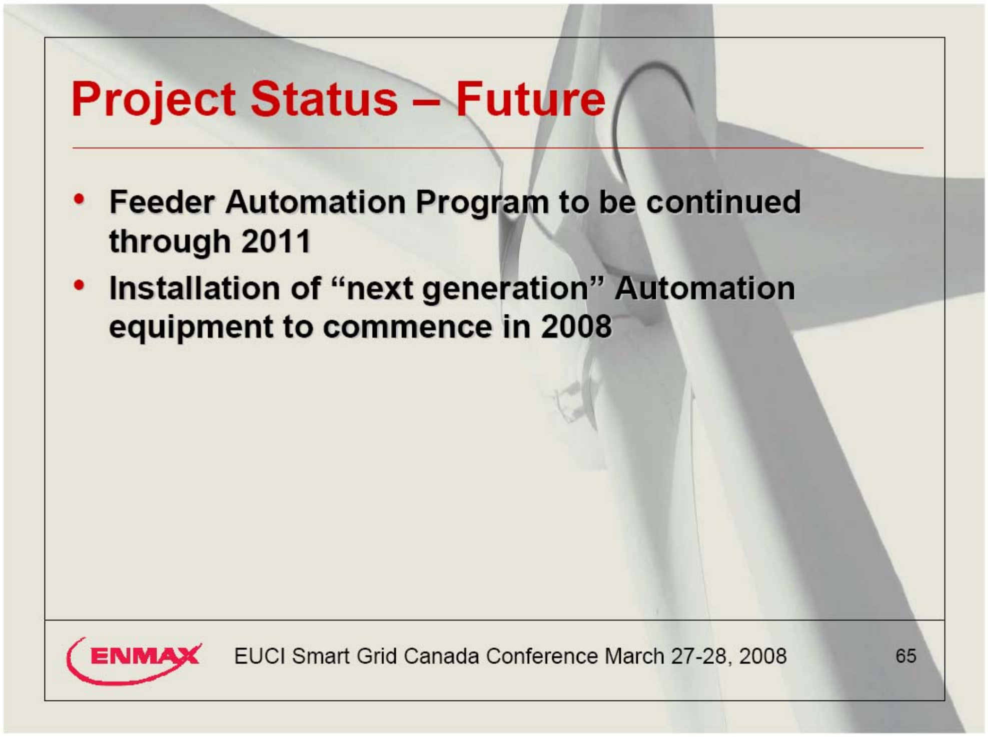
Project Status – Future
• Feeder Automation Program to be continued through 2011
• Installation of "next generation" Automation equipment to commence in 2008
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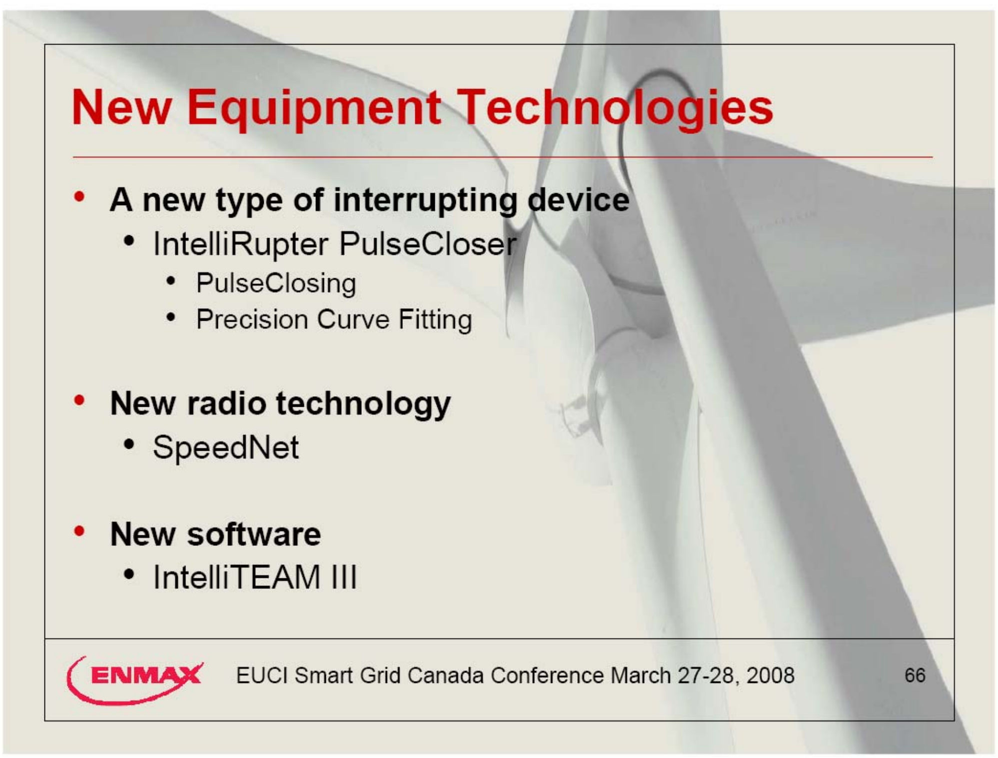
New Equipment Technologies
• A new type of interrupting device
• IntelliRupter PulseCloser
• PulseClosing
• Precision Curve Fitting
• New radio technology
• SpeedNet
• New software
• IntelliTEAM III
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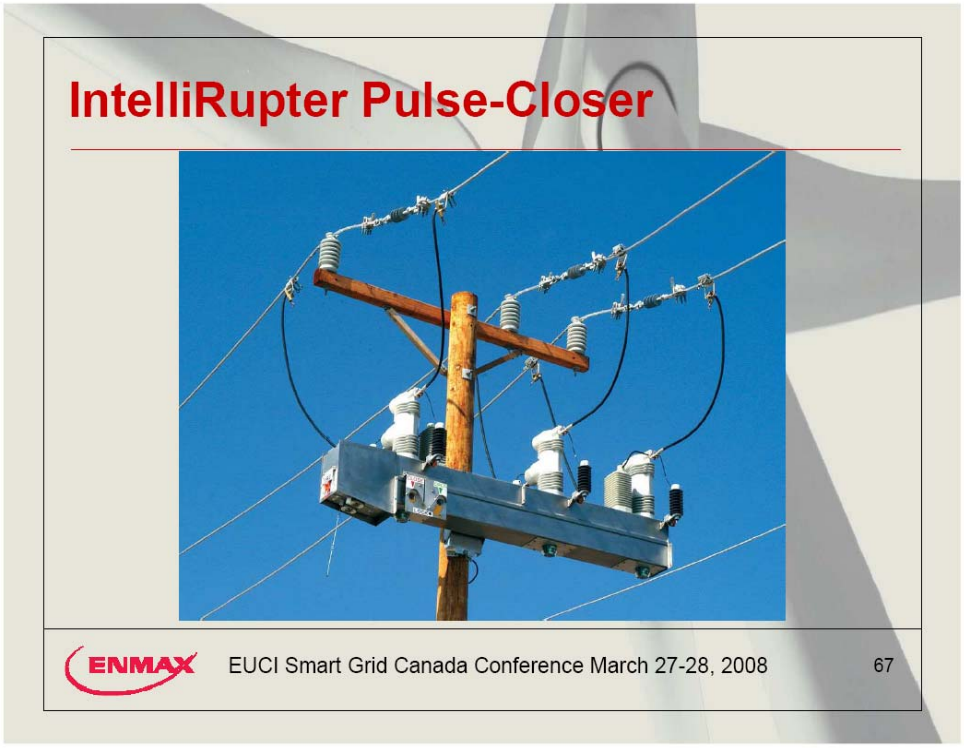
IntelliRupter Pulse-Closer
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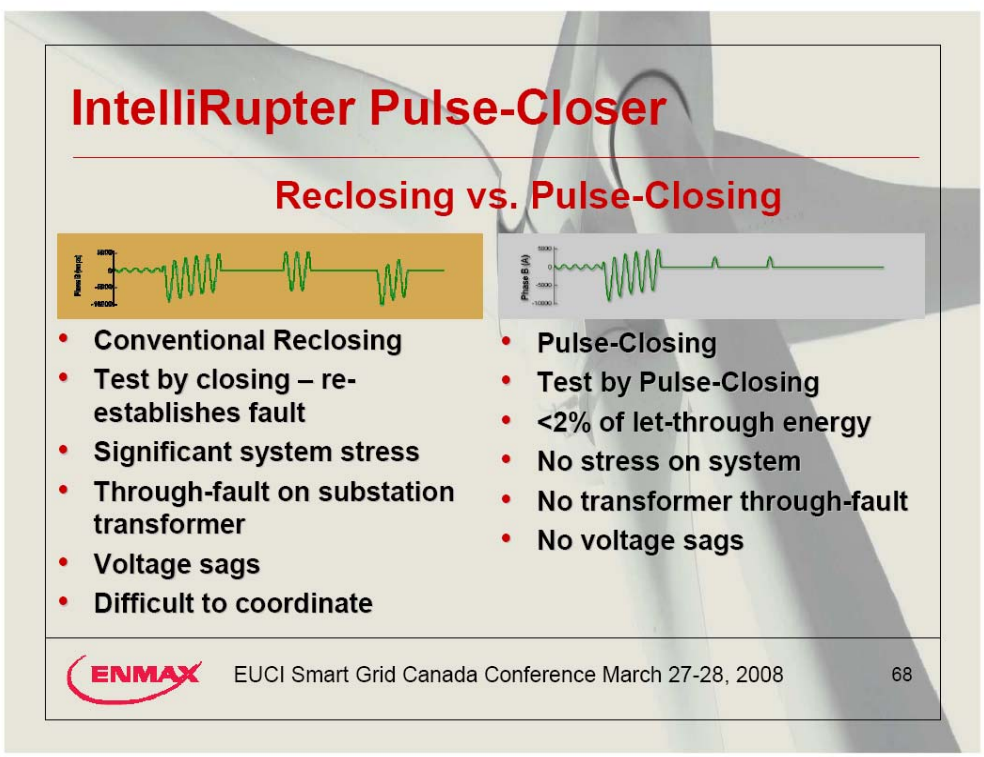
IntelliRupter Pulse-Closer
Reclosing vs. Pulse-Closing
Conventional Reclosing
Test by closing – re-establishes fault
Significant system stress
Through-fault on substation transformer
Voltage sags
Difficult to coordinate
Pulse-Closing
Test by Pulse-Closing
<2% of let-through energy
No stress on system
No transformer through-fault
No voltage sags
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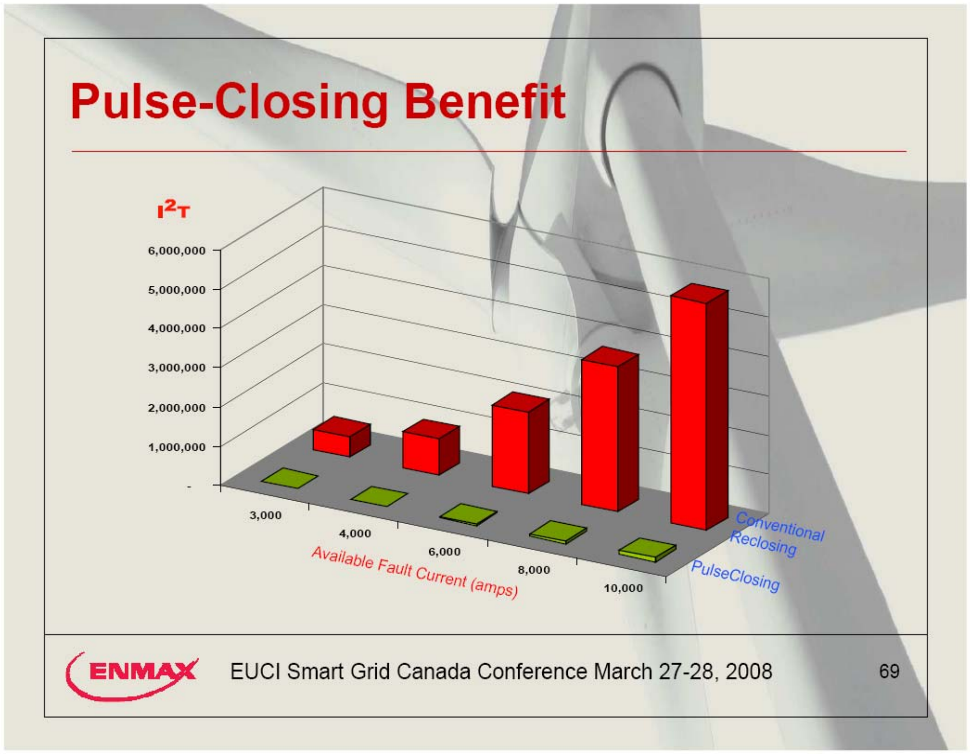
Pulse-Closing Benefit
I²T
6,000,000
5,000,000
4,000,000
3,000,000
2,000,000
1,000,000
-
3,000
4,000
6,000
8,000
10,000
Available Fault Current (amps)
Conventional Reclosing
PulseClosing
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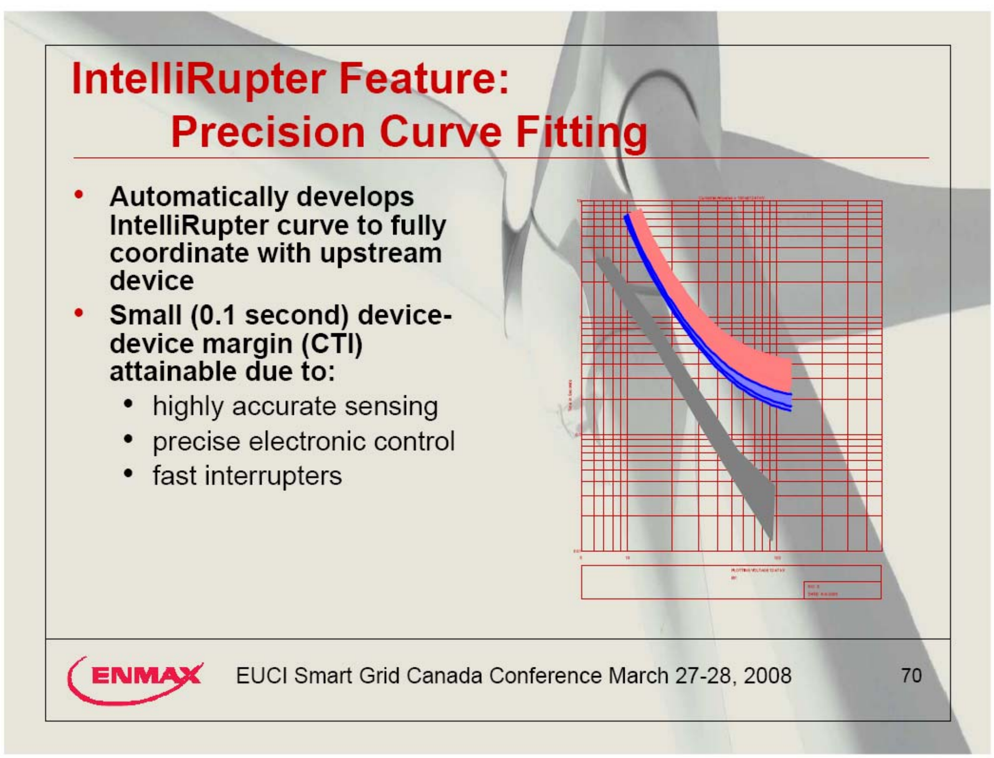
IntelliRupter Feature:
Precision Curve Fitting
• Automatically develops IntelliRupter curve to fully coordinate with upstream device
• Small (0.1 second) device-device margin (CTI) attainable due to:
• highly accurate sensing
• precise electronic control
• fast interrupters
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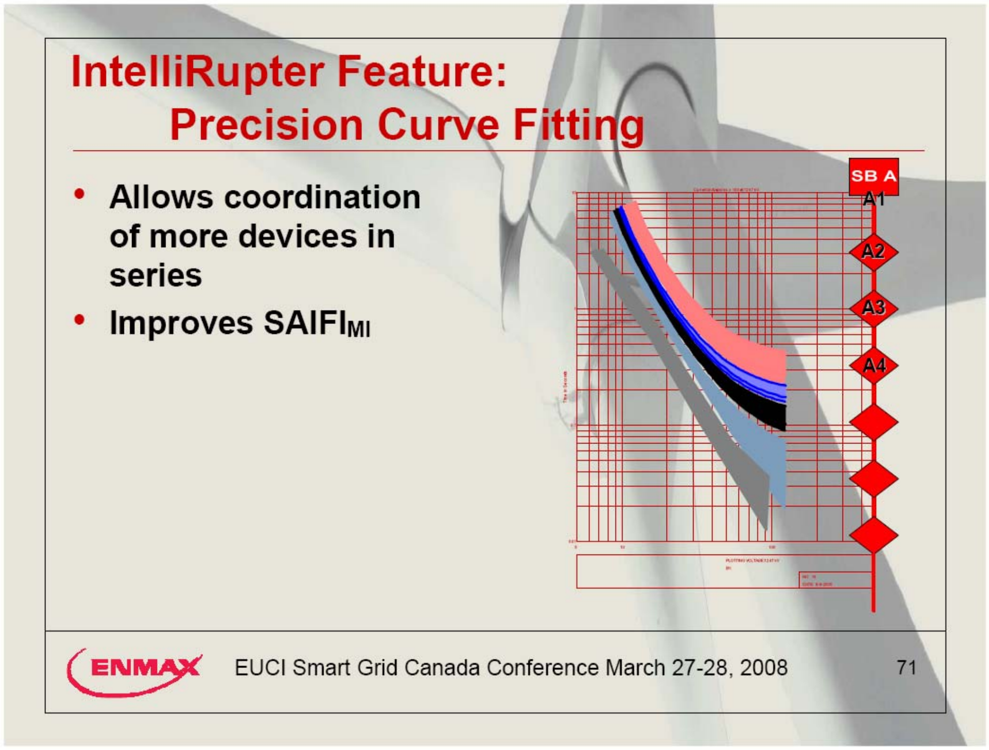
IntelliRupter Feature:
Precision Curve Fitting
• Allows coordination of more devices in series
• Improves SAIFIMI
SB A
A1
A2
A3
A4
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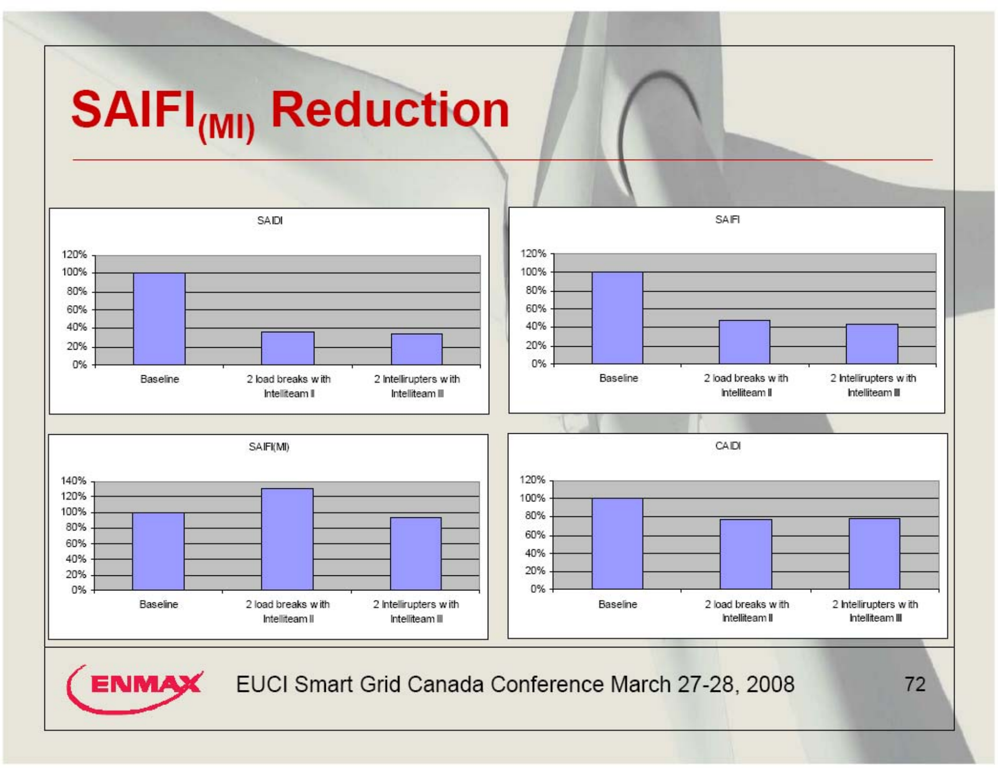
SAIFI(MI) Reduction
SAIDI
SAIFI
SAIFI(MI)
CAIDI
0%
20%
40%
60%
80%
100%
120%
140%
Baseline
2 load breaks with Inteliteam II
2 Intellirupters with Inteliteam III
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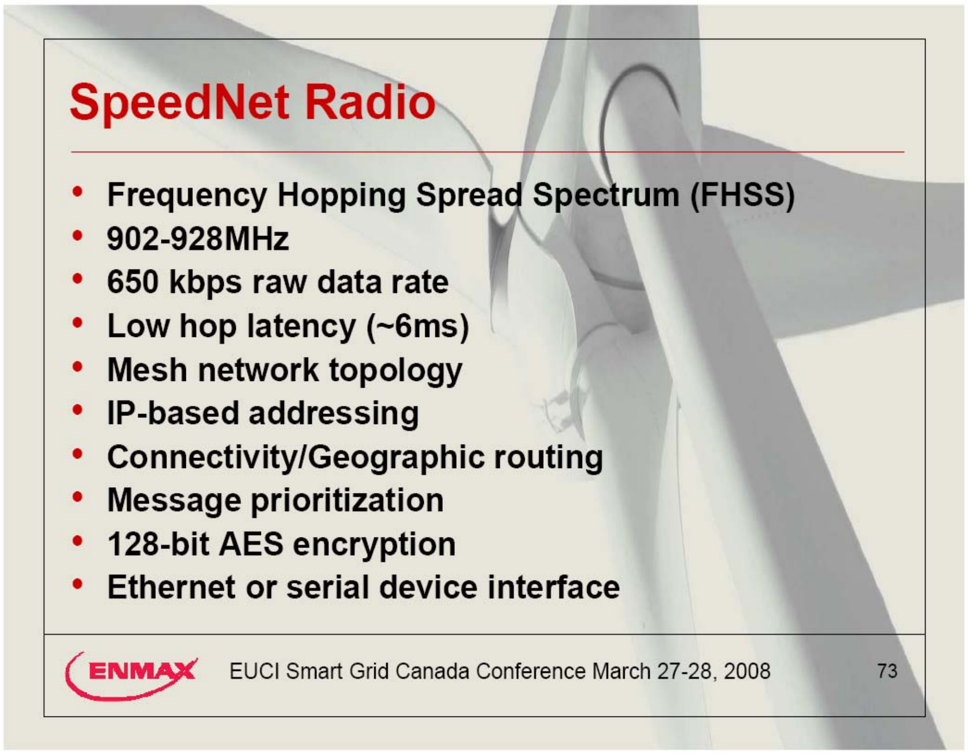
SpeedNet Radio
• Frequency Hopping Spread Spectrum (FHSS)
• 902-928MHz
• 650 kbps raw data rate
• Low hop latency (~6ms)
• Mesh network topology
• IP-based addressing
• Connectivity/Geographic routing
• Message prioritization
• 128-bit AES encryption
• Ethernet or serial device interface
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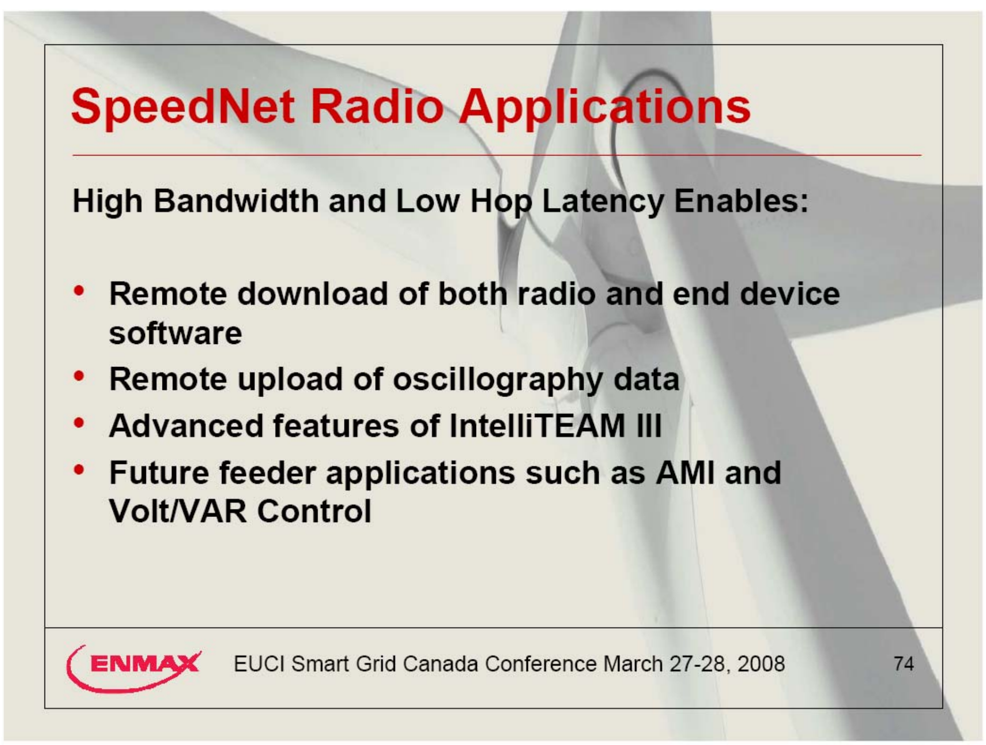
SpeedNet Radio Applications
High Bandwidth and Low Hop Latency Enables:
• Remote download of both radio and end device software
• Remote upload of oscillography data
• Advanced features of IntelliTEAM III
• Future feeder applications such as AMI and Volt/VAR Control
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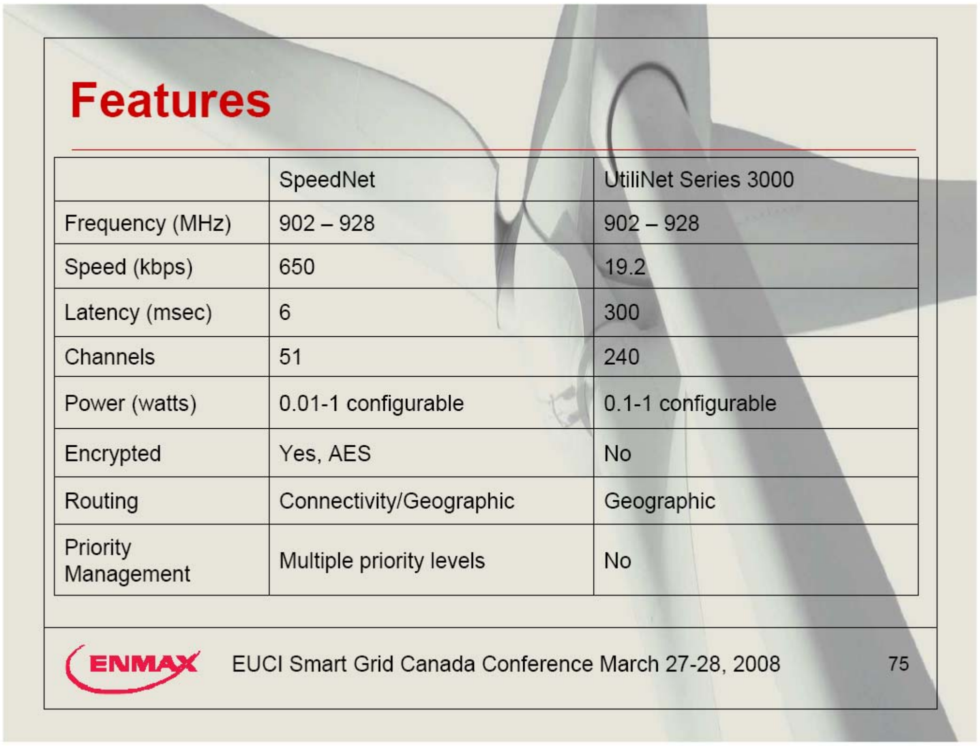
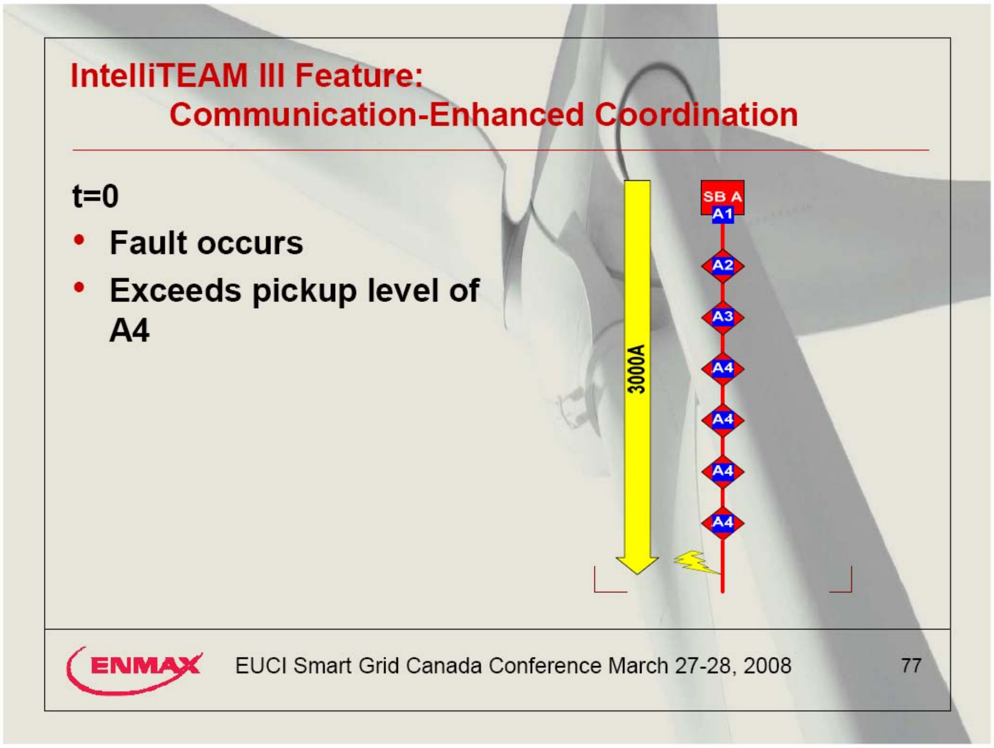


Features

	SpeedNet	UtiliNet Series 3000
Frequency (MHz)	902 – 928	902 – 928
Speed (kbps)	650	19.2
Latency (msec)	6	300
Channels	51	240
Power (watts)	0.01-1 configurable	0.1-1 configurable
Encrypted	Yes, AES	No
Routing	Connectivity/Geographic	Geographic
Priority Management	Multiple priority levels	No

IntelliTEAM III

- **New features:**
  - Extends IntelliTEAM II automatic restoration technology with protection functions
  - Communication Enhanced Coordination
  - Advanced Adaptive Protection


IntelliTEAM III Feature:
Communication-Enhanced Coordination
t=0
• Fault occurs
• Exceeds pickup level of A4
3000A
SB A
A1
A2
A3
A4
A4
A4
A4
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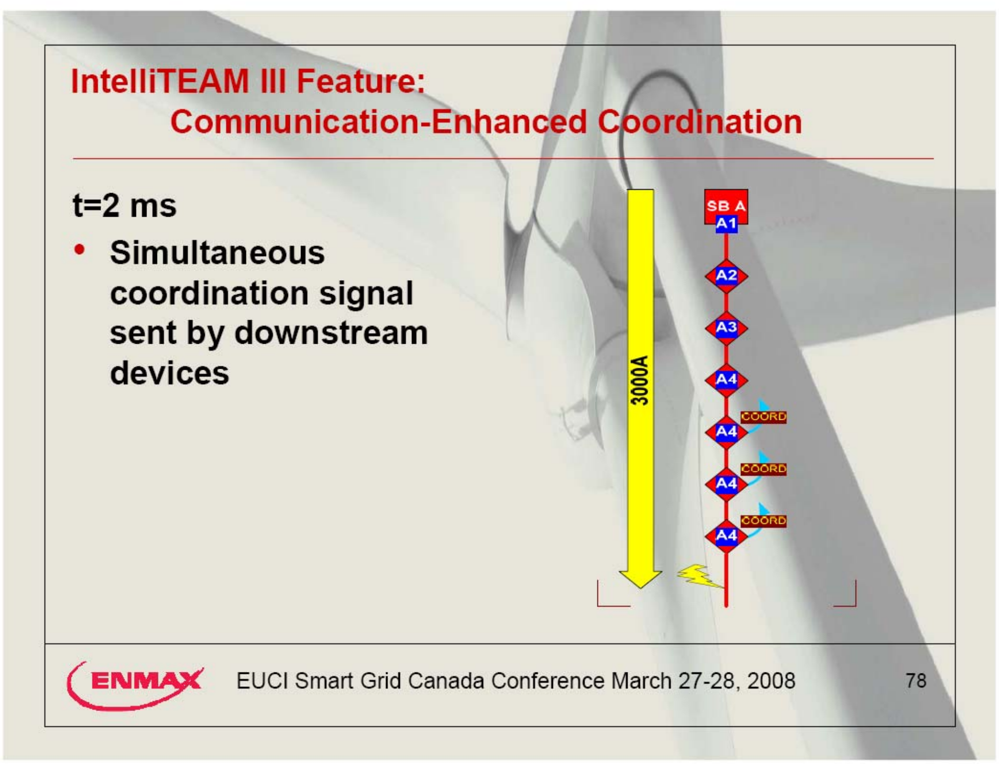
IntelliTEAM III Feature:
Communication-Enhanced Coordination
t=2 ms
• Simultaneous coordination signal sent by downstream devices
3000A
SB A
A1
A2
A3
A4
A4
A4
A4
COORD
COORD
COORD
ENMAX
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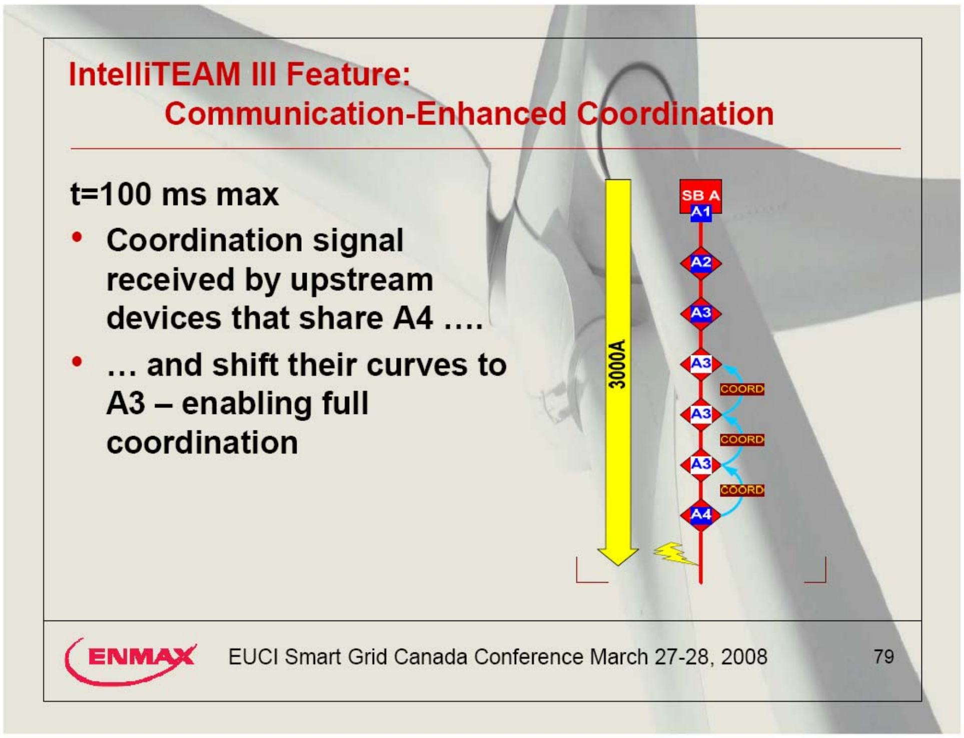
IntelliTEAM III Feature:
Communication-Enhanced Coordination
t=100 ms max
• Coordination signal received by upstream devices that share A4 ….
• … and shift their curves to A3 – enabling full coordination
3000A
SB A
A1
A2
A3
A3
COORD
A3
COORD
A3
COORD
A4
ENMAX
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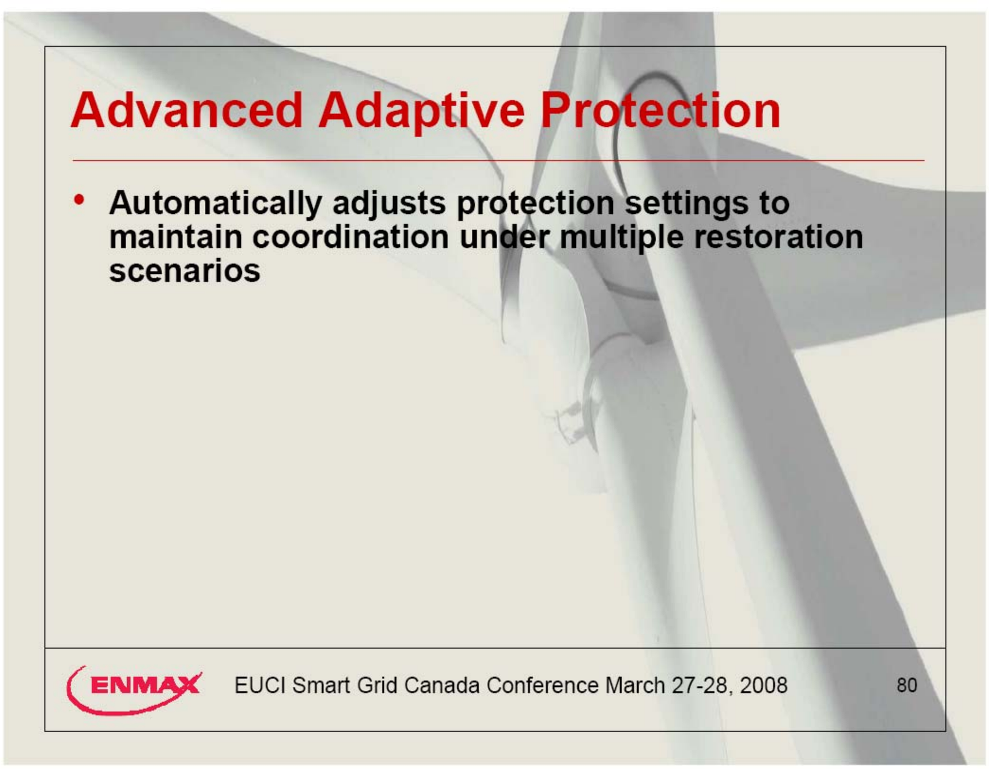
Advanced Adaptive Protection
• Automatically adjusts protection settings to maintain coordination under multiple restoration scenarios
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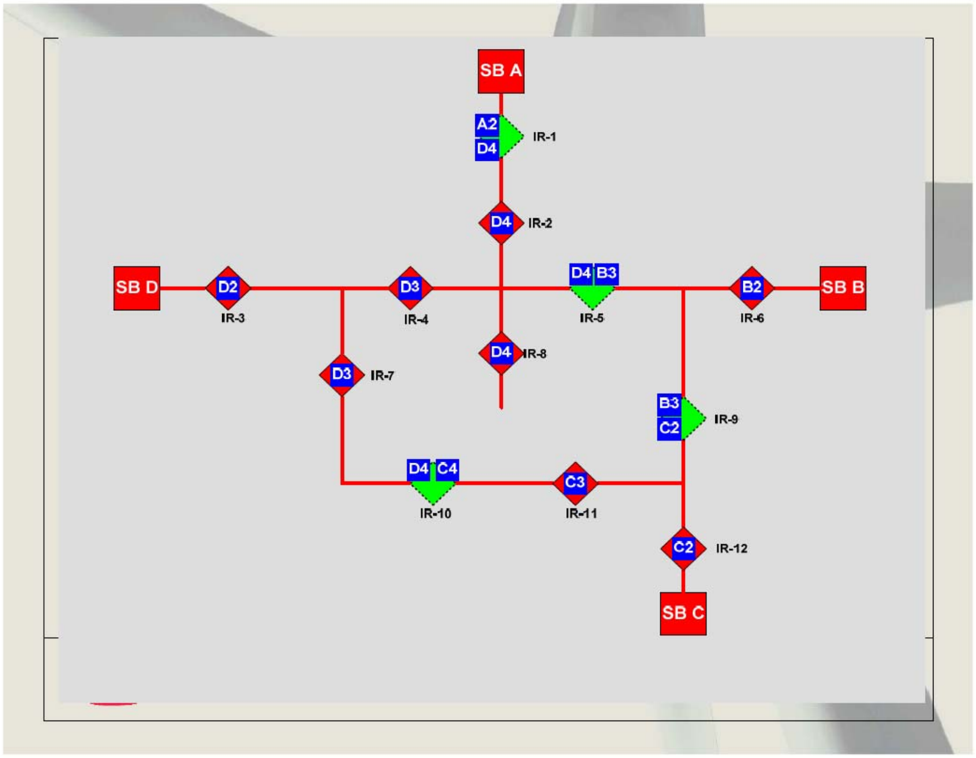
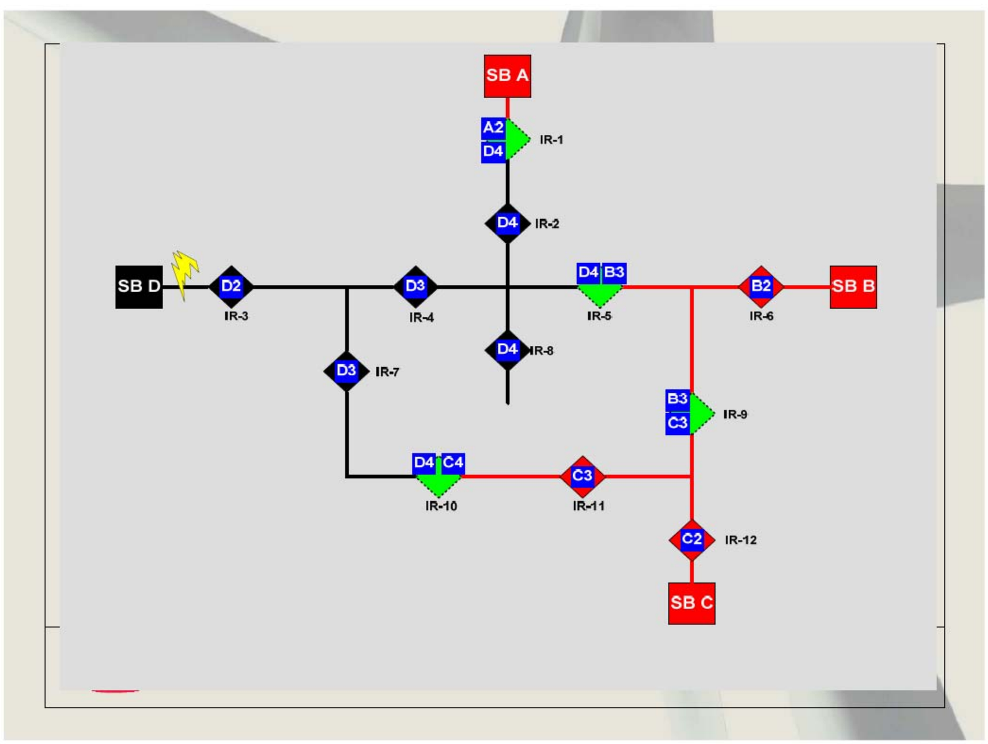
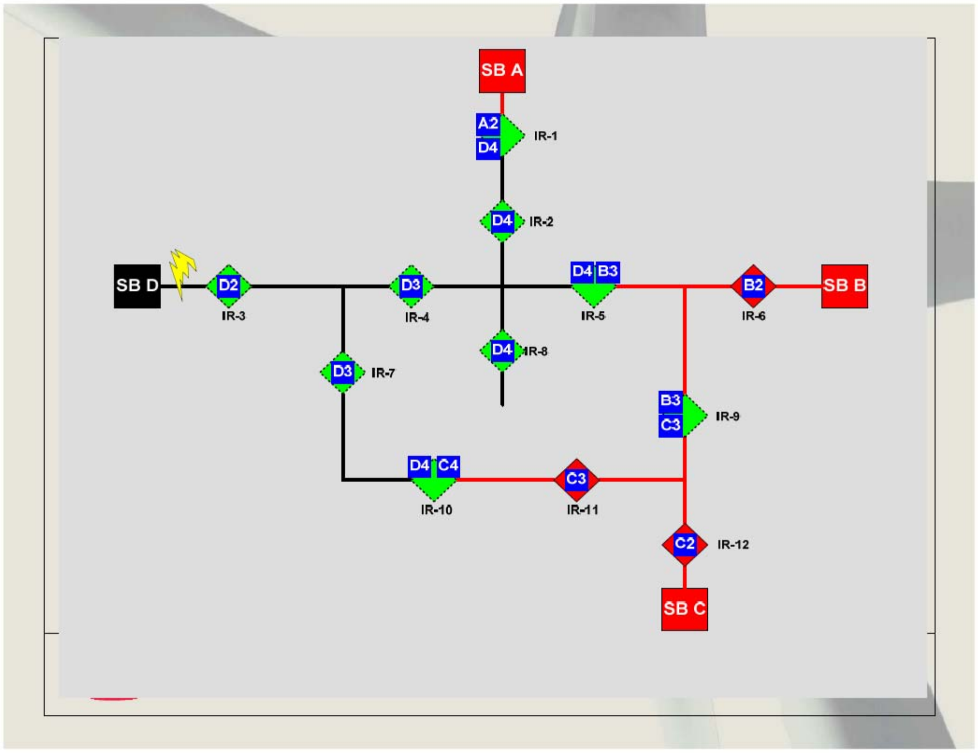
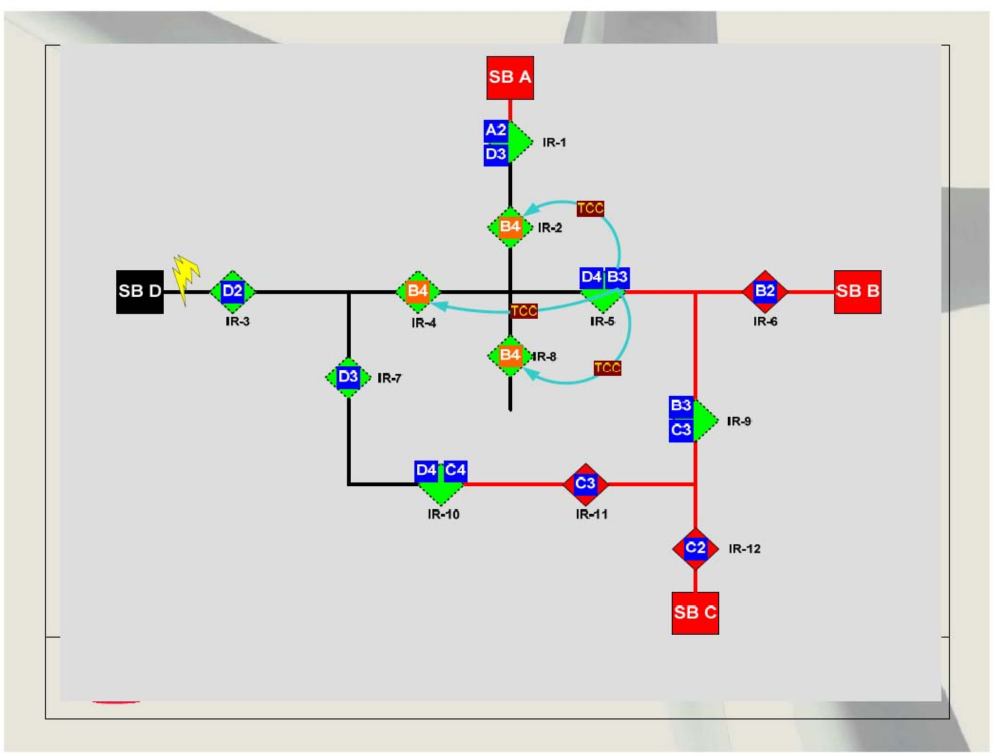
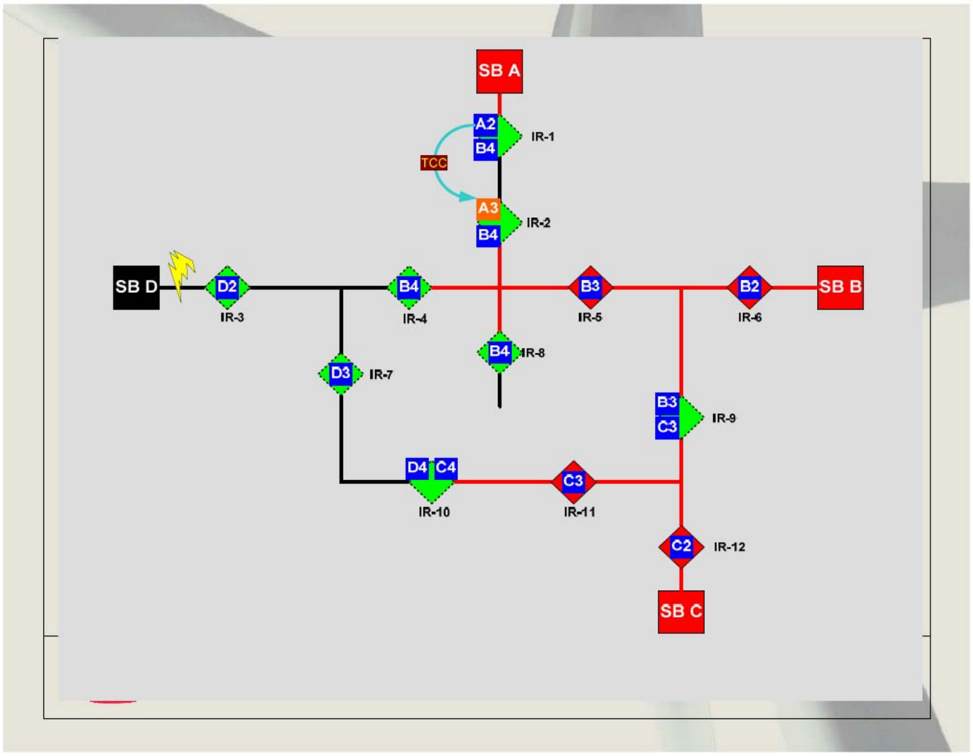
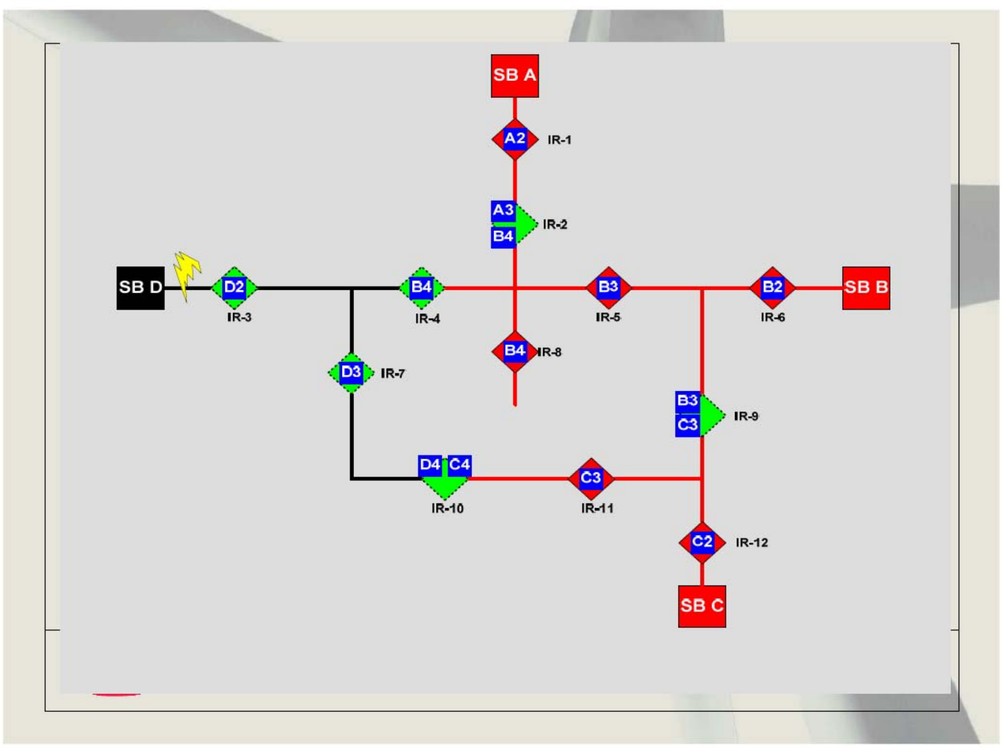

SB A
A2
D4
IR-1
D4
IR-2
SB D
D2
IR-3
D3
IR-4
D4 B3
IR-5
B2
IR-6
SB B
D4
IR-8
D3
IR-7
B3
C2
IR-9
D4 C4
IR-10
C3
IR-11
C2
IR-12
SB C

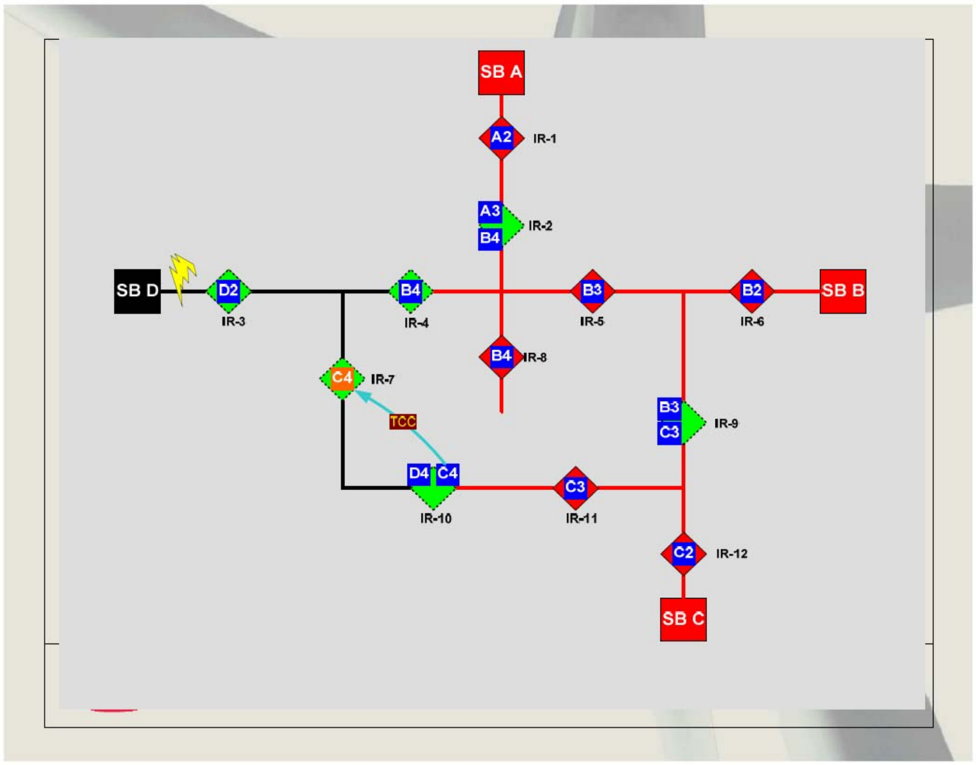

SB A
A2
D4
IR-1
D4
IR-2
SB D
D2
IR-3
D3
IR-4
D4 B3
IR-5
B2
IR-6
SB B
D4
IR-8
D3
IR-7
B3
C3
IR-9
D4 C4
IR-10
C3
IR-11
C2
IR-12
SB C

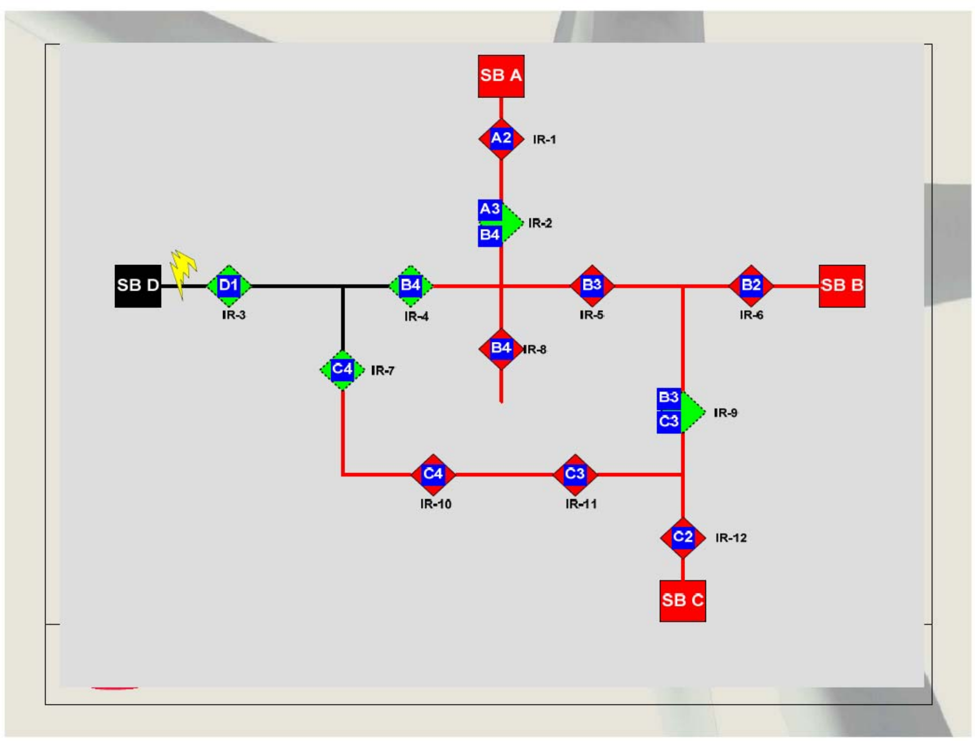

SB A
A2
D4
IR-1
D4
IR-2
SB D
D2
IR-3
D3
IR-4
D4
B3
IR-5
B2
IR-6
SB B
D4
IR-8
D3
IR-7
B3
C3
IR-9
D4
C4
IR-10
C3
IR-11
C2
IR-12
SB C

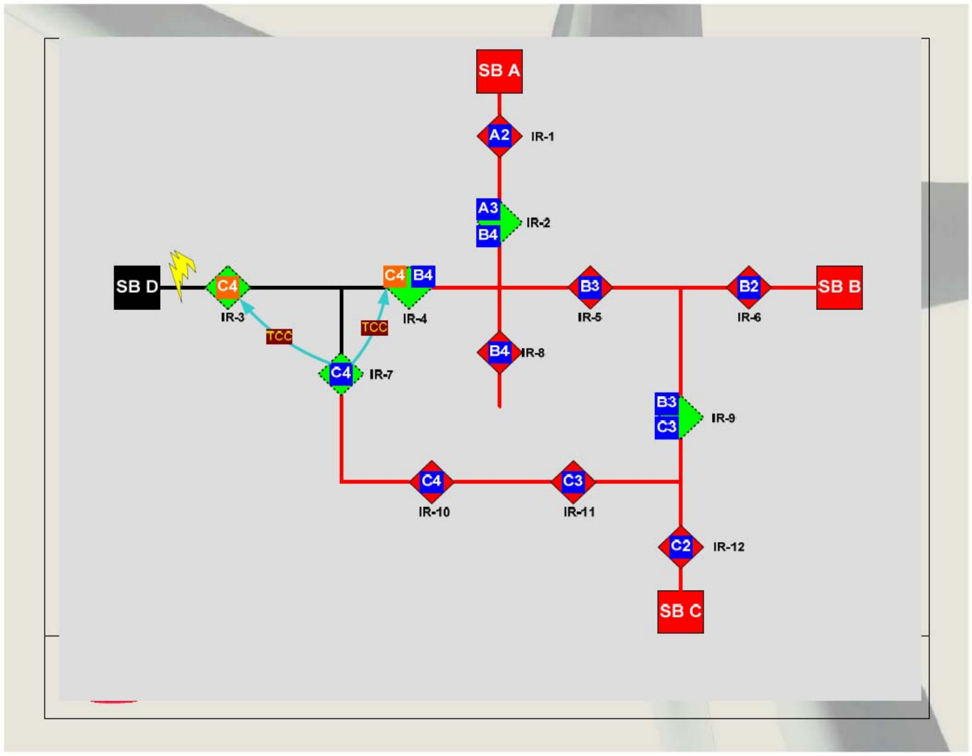

SB A
A2
D3
IR-1
TCC
B4
IR-2
SB D
D2
IR-3
B4
IR-4
TCC
D4
B3
IR-5
B2
IR-6
SB B
B4
IR-8
TCC
D3
IR-7
B3
C3
IR-9
D4
C4
IR-10
C3
IR-11
C2
IR-12
SB C


SB A
A2
B4
IR-1
TCC
A3
B4
IR-2
SB D
D2
IR-3
B4
IR-4
B3
IR-5
B2
IR-6
SB B
B4
IR-8
D3
IR-7
B3
C3
IR-9
D4
C4
IR-10
C3
IR-11
C2
IR-12
SB C


SB A
A2
IR-1
A3
B4
IR-2
SB D
D2
IR-3
B4
IR-4
B3
IR-5
B2
IR-6
SB B
B4
IR-8
D3
IR-7
B3
C3
IR-9
D4
C4
IR-10
C3
IR-11
C2
IR-12
SB C


SB A
A2
IR-1
A3
B4
IR-2
SB D
D2
IR-3
B4
IR-4
B3
IR-5
B2
IR-6
SB B
B4
IR-8
C4
IR-7
TCC
B3
C3
IR-9
D4
C4
IR-10
C3
IR-11
C2
IR-12
SB C


SB A
A2
IR-1
A3
B4
IR-2
SB D
D1
IR-3
B4
IR-4
B3
IR-5
B2
IR-6
SB B
B4
IR-8
C4
IR-7
B3
C3
IR-9
C4
IR-10
C3
IR-11
C2
IR-12
SB C


SB A
A2
IR-1
A3
B4
IR-2
SB D
C4
IR-3
C4
B4
IR-4
B3
IR-5
B2
IR-6
SB B
TCC
TCC
C4
IR-7
B4
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B3
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C4
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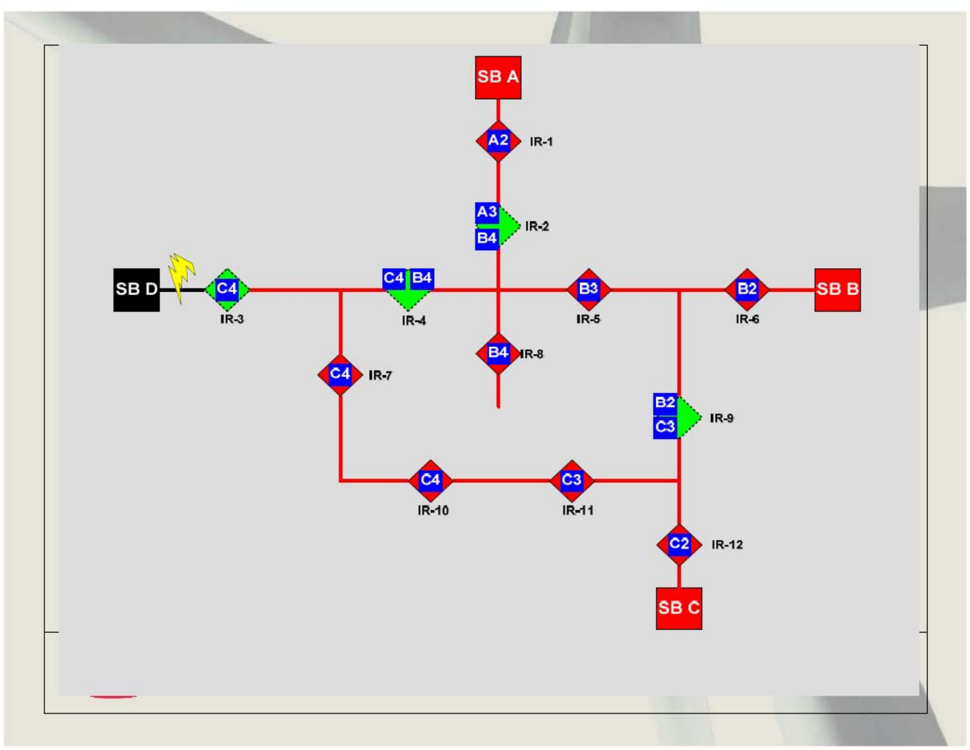
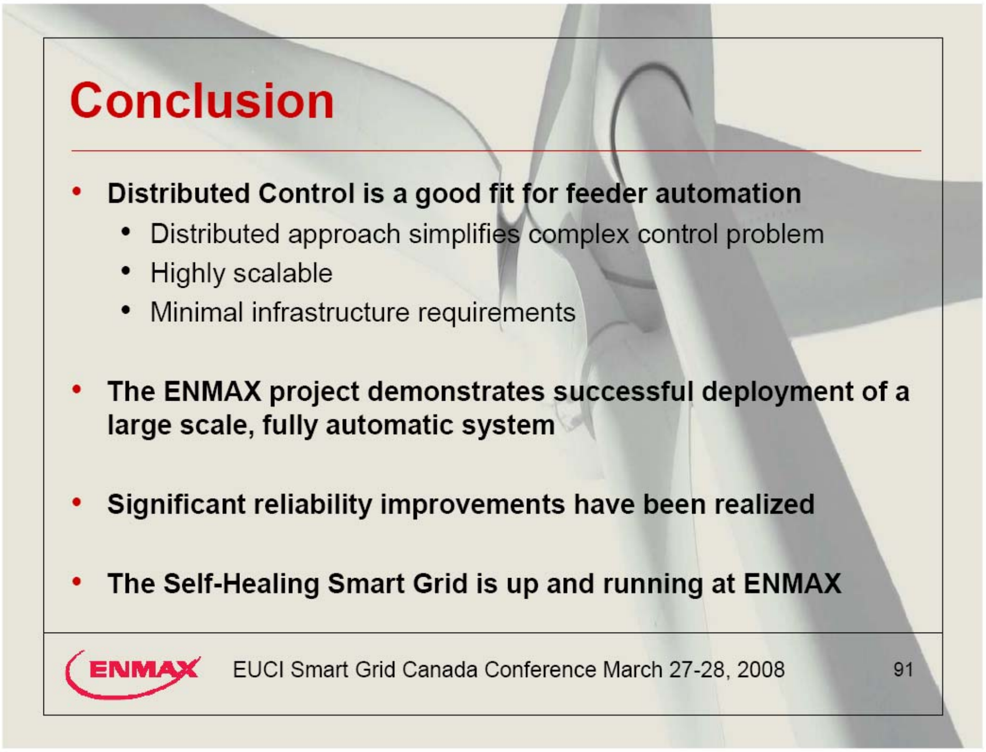
IR-11
C2
IR-12
SB C


SB A
A2
IR-1
A3
B4
IR-2
SB D
C4
IR-3
C4
B4
IR-4
B3
IR-5
B2
IR-6
SB B
C4
IR-7
B4
IR-8
B2
C3
IR-9
C4
IR-10
C3
IR-11
C2
IR-12
SB C


Conclusion
Distributed Control is a good fit for feeder automation
Distributed approach simplifies complex control problem
Highly scalable
Minimal infrastructure requirements
The ENMAX project demonstrates successful deployment of a large scale, fully automatic system
Significant reliability improvements have been realized
The Self-Healing Smart Grid is up and running at ENMAX
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Questions?
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Appendix 3

Feeder Automation (FA) Business Case Evaluation (BCE) Process

The business case evaluation (BCE) process involves the calculation of the net benefit of a capital project which requires comparing the ongoing annualized cost of an asset against the quantified risk cost associated with its failure, which is calculated based upon the assets' probability of failure and the impact of their failure.

Calculation of the probability of failure relies on the assets' Hazard Distribution Function ("HDF"), which represents a conditional probability of an asset failing from the remaining population that has survived up until that time. These functions are validated either directly by THESL or through the assistance of asset life studies from third-party consultants. The impacts of failure are then quantified by accounting for the direct costs associated with the materials and labour required to replace an asset upon failure, as well as the indirect costs. These indirect costs would include the costs of customer interruptions, emergency repairs and asset replacements. The final estimated risk cost is produced that represents the product of a hazard rate function for the given asset and its corresponding impact costs. Lastly, as shown in Figure 17, the lifecycle cost is produced, representing the total operating costs for a new asset, taking into account the annualized risk and capital over its entire lifecycle. The optimal intervention time would then be the red marker at which the Equivalent Annualized Cost ("EAC") is at its lowest.

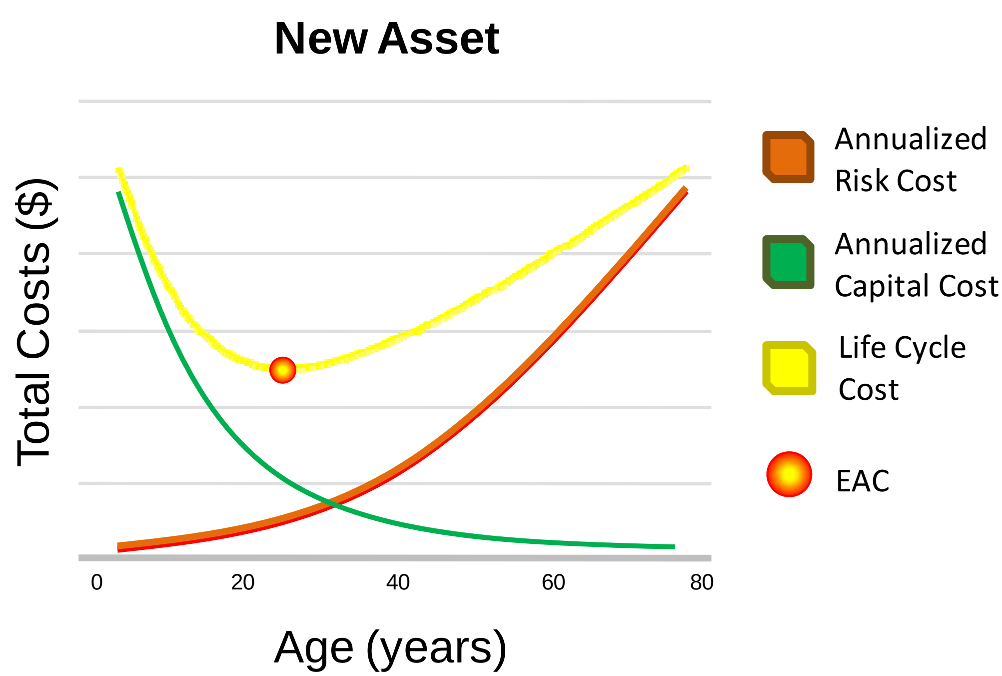


Figure 17: Typical Example of Optimal Intervention Time (New Assets)

This EAC value from the lifecycle cost curve would then need to be cross-referenced against the total costs of the existing asset to determine optimal replacement timing, as shown by the green marker in Figure 18. This specific point in time would indicate that the existing asset has reached its economic end-of-life at 47 years of age and requires intervention. Note that for the existing asset, there is no capital cost component, as this is a sunk cost. Therefore, the existing asset costs are comprised exclusively of the estimated risks that are remaining.

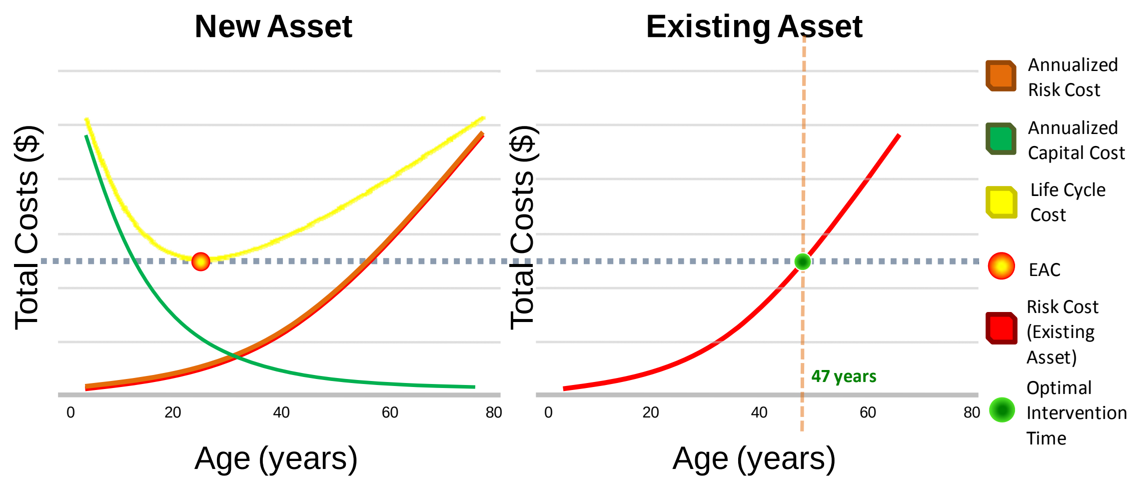


Figure 18: Typical Example of Optimal Intervention Time (Existing Assets)

Note that for the example in Figure 18, should the asset be replaced prior to the 47 year optimal intervention time, this would represent a sacrificed life to the asset. Should the asset be replaced after the optimal intervention time, this would represent an excess estimated risk.

Feeder Automation falls under the "non-in-kind project" category, in which Manual or Scadamate switches (existing state) are replaced or upgraded with FA enabled switches (new state).

Non-in-kind projects are evaluated based on the 'cost of ownership' between the existing state and new state. In order to establish the 'cost of ownership' of a single asset, the estimated annualized risk for the existing asset is plotted along with its 'Equivalent Annual Cost' (EAC), as shown in Figure 19. The EAC defines the cost that is incurred every year, for the ownership of the asset, in a specific design for all future years. For the existing asset, only the risk is taken into account since the replacement cost is a sunk cost. As such, the asset follows its risk cost curve until it reaches its optimal replacement timing, at which point it should be replaced and thus, begins to follow the EAC line. The net present value of these costs from the current age onwards, over a 100-year period, represents the asset-related 'Cost of Ownership' of an asset in a particular design. The cost of ownership is represented by the region shaded blue in Figure 19.

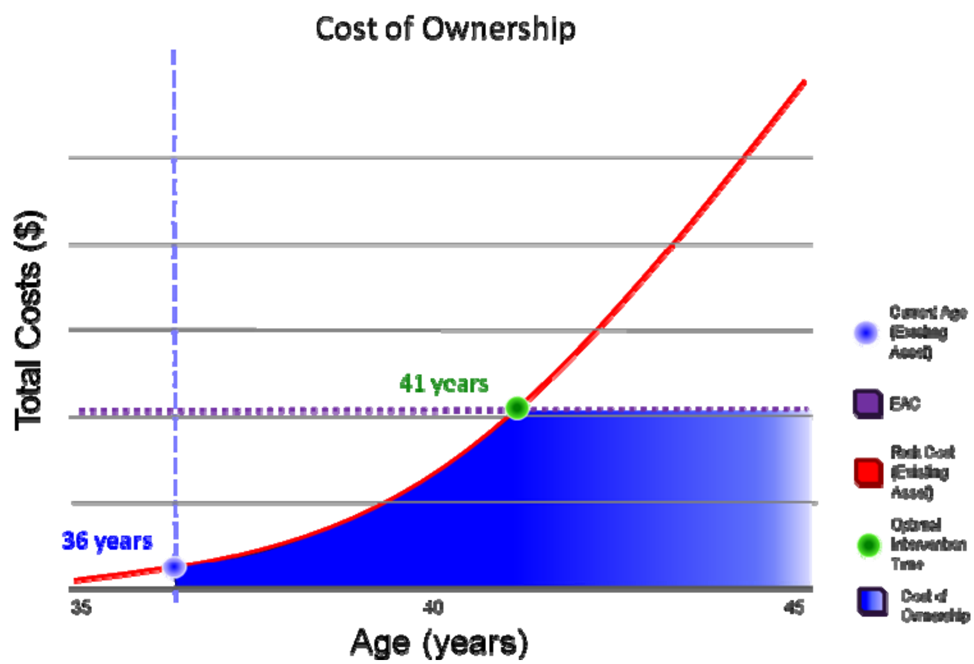


Figure 19: Typical Example of the Cost of Ownership of the Existing Asset

5.1 Data Collection - Procedure

In order to perform a business case evaluation for Feeder Automation (FA), the assets on the feeder trunk circuit that will be impacted due to the FA implementation must be examined before and after the installation and deployment of the FA scheme. This examination involves the individual determination of the estimated probability and impact of failure of each asset along the feeder trunk circuit, in order to ultimately calculate risks of failure. For each asset on the feeder trunk circuit, including poles and switches, different failure modes can be evaluated, and average estimated outage duration values are applied to each failure mode. These values are used as part of the impact quantification, and ultimately integrated into the quantified risk value that is produced.

As previously noted, the quantified risks of asset failure are used as part of the process of calculating the Optimal Intervention Timing (OIT) of the asset, and this OIT value is ultimately used to determine the total cost of ownership of the asset. The implementation of a Feeder Automation scheme will involve the installation and deployment of automated SCADA-controlled switches which are able to communicate with one another to pinpoint the location of the failed feeder trunk asset(s) and isolate this portion of the circuit. These switches effectively form "switching regions", as the region with the failed asset(s) will remain isolated and exposed to the full outage duration while crew workers respond to remedy the situation, while the remaining switching regions are restored in under a minute as the FA system will perform appropriate load transfers with other adjacent feeder trunk circuits. This adjustment to the feeder trunk assets is reflected within the business case evaluation, by re-evaluating the same feeder trunk assets under an FA scheme. The average outage duration for these assets is re-calculated for each asset, based upon the formula shown below:

$$OD_{AVG\_FA} = OD_{AVG} (1 / REGIONS)$$

Where:

OD_{AVG} = Average outage duration of asset prior to FA deployment

OD_{AVG_FA} = Average outage duration of asset following FA deployment

REGIONS = Quantity of switching regions along feeder trunk circuit

As shown in the formula above, it is assumed that depending on the amount of switching regions, only a single switching region will see a full outage, and the remaining assets will see only a momentary and essentially will experience no impact. When these assets are re-assessed with the revised average outage duration value, the risks will be considerably reduced, and will therefore result in a reduced cost of ownership following the deployment of the FA scheme.

In addition to the asset-related risks, by knowing the length and loading of each protected region, the non-asset risks (NAR) of the current and future states can also be calculated.

5.2 Non Asset Risk - Procedure

Non-Asset Risks are risks incurred due to any factor that may lead to an outage on the system that is not directly tied to the assets' age and condition, including animal contact, lightning, adverse weather, and human elements.

These risks are based upon historical failures that were identified to be caused by factors that are considered to be non-asset related. The information regarding the historical failures is attained from ten years worth of historical outage data.

Information regarding the number of outages, customer interruptions (CI) and customer hours interrupted (CHI) are captured at the feeder level from this historical outage data. This information is then normalized over the total length of the feeder, such that this historical non-asset-related information is calculated on a per metre basis for that given feeder. This normalized value is the multiplied by the length of the area of study in order to project this historical non-asset risk information to the area of study.

This information can then be translated into a quantified Non-Asset Risk (NAR) by accounting for the customer interruption costs as well as the installed load within the area of study, measured in kVA, which will be impacted should any of these non-asset-related events take place.

These costs are used as part of a net present value calculation to produce the final quantified non-asset risks (NAR) associated with the area of study. Therefore, it is assumed that these non-asset risks will continue to exist over the entire life cycle of each asset.

The Overhead System and the Underground System have varying non-asset outage causes associated with them because the non-asset factors that affect an overhead system are different from those that affect the underground system. The NAR sources that impact the overhead distribution system include storms, tree contacts, adverse environments (e.g., salt spray), animal/bird contacts, human elements, extreme temperature, and vehicles. However, the underground distribution system is only affected by dig-ins, and then only for underground direct buried cables, because the underground system is sheltered from the majority of risks that face the overhead system. As a result, underground cables located in concrete-encased conduits do not face non-asset risks because the concrete encasement of the cables protects them from dig-ins.

5.3 Project Net Benefit (NPV) Calculation - Procedure

As previously described, the cost of ownership represents the net present value of the various costs associated with the respective existing assets across their life cycles (100-year period). Both asset-related and non-asset-related risk costs are considered as part of this cost of ownership calculation.

As previously mentioned, asset-related risks include the direct and indirect costs associated with asset replacement and resulting outage impacts to customers, while non-asset risks include the indirect costs associated with outage impacts due to weather, animal and human-related events.

Cost of ownership was calculated for each "state" of the assets, before and after the implementation of Feeder Automation. The individual costs of ownership values for each asset are totalled up to represent these respective states.

Cost of ownership was calculated as per the formulas provided below:

- Cost of Ownership for Existing Assets (COO_E) = (NPV1 + NAR1)
- Cost of Ownership for New Assets (COO_N) = (NPV2 + NAR2)

Where:

- NPV1 represents cost of ownership of the existing assets prior to FA implementation, accounting for the assets' probability of failure multiplied with their impacts of failure which include direct and indirect cost attributes associated with in-service asset failures, costs of customer interruptions, emergency repairs and replacement.
- NAR1 represents the NPV calculation of non-asset risks associated with the existing assets, including animal-related, weather-related and human-related impacts taking place over the life cycle of this infrastructure. Further explanation of the Non-Asset Risk calculation is provided in Section 5.2.
- NPV2 represents cost of ownership of the new assets after FA implementation, accounting for the assets' probability of failure multiplied with their impacts of

failure which include direct and indirect cost attributes associated with in-service asset failures, costs of customer interruptions, emergency repairs and replacement.

- NAR2 represents the NPV calculation of non-asset risks associated with the new state, taking into account for the effects of Feeder Automation on the impact cost of non-asset incidents. Further explanation of the Non-Asset Risk calculation is provided in Section 5.2.

The overall project net present value is calculated as per the following formula shown below:

- Project NPV = (COO_E – COO_N) – Project Cost, which is shown as "Project Net Benefit" in Tables D.1 through D.6, below.

The benefit-cost ratio is calculated as per the following formula shown below:

- Benefit-Cost Ratio = (COO_E – COO_N)/Project Cost

Thus, the Project NPV value reflects the difference in the cost of ownership between the existing construction and new construction, after the total cost of the project has been subtracted.

The Tables below show the BC ratios for the work proposed in the various areas. Table D.1 shows the combined BC ratio for all of the work in a given geographic area. Tables D.2 through D.6 show the B/C ratios for each of the specific jobs proposed.

ICM Project | Feeder Automation

1 **Table D.1: Business Case Evaluation (BCE) of FA Target Area Projects**

Project Location	Project Cost Allocated ($)	Project Net Benefit	Option Benefit/Cost Ratio
Etobicoke Grid	$3,042,223	$235,775,857	78.50
North York Grid	$2,537,530	$181,874,571	72.67
Scarborough Grid	$25,919,699	$3,003,075,275	116.86

2 **Table D.2: BCE of Cavanagh T.S. and Agincourt T.S. Job**

Project Location	Project Cost Allocated($)	Project Net Benefit	Option Benefit/Cost Ratio
Cavanagh TS and Agincourt TS	$7,820,666	$1,469,810,870	188.94

3 **Table D.3: BCE for Horner T.S. and Manby T.S. Job**

Project Location	Project Cost Allocated($)	Project Net Benefit	Option Benefit/Cost Ratio
Horner TS and Manby TS	$3,042,223	$235,775,857	78.50

4 **Table D.4: BCE for Fairchild T.S. Job**

Project Location	Project Cost Allocated($)	Project Net Benefit	Option Benefit/Cost Ratio
Fairchild TS	$2,537,530	$181,874,571	72.67

Table D.5: BCE for Cavanagh T.S., Agincourt T.S., Ellesmere T.S., and Malvern T.S.

Project Location	Project Cost Allocated($)	Project Net Benefit	Option Benefit/Cost Ratio
Cavanagh TS to Agincourt TS	$10,722,785	$757,801,166	71.67

Table D.6: BCE of Scarborough East T.S.

Project Location	Project Cost Allocated($)	Project Net Benefit	Option Benefit/Cost Ratio
Scarborough East T.S.	$7,376,248	$775,463,239	106.13

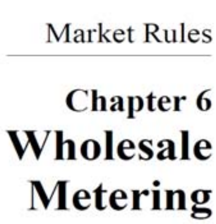
Toronto Hydro-Electric System Limited
EB-2012-0064
Tab 4
Schedule B20
ORIGINAL
(51 pages)

ICM Project

Metering

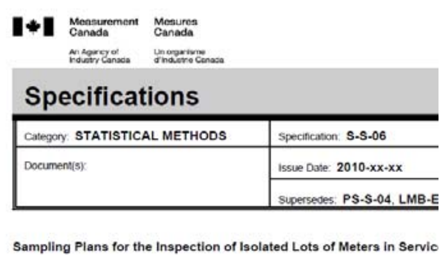
Wholesale Metering Market

Settlement Compliance


Market Rules

Chapter 6
Wholesale
Metering

Seal Expiring Meters


Measurement Canada | Mesures Canada
An Agency of Industry Canada | Un organisme d'Industrie Canada

Specifications

Category: STATISTICAL METHODS	Specification: S-S-06
Document(s):	Issue Date: 2010-xx-xx
	Supersedes: PS-S-04, LMB-E

Sampling Plans for the Inspection of Isolated Lots of Meters in Servic

Toronto Hydro-Electric System Limited (THESL)

TORONTO HYDRO

I EXECUTIVE SUMMARY

1. Project Description

Toronto Hydro Electric System Limited (THESL) has a number of critical needs for incremental capital funding within its Metering portfolio during the IRM period.

1.1. Wholesale Metering Market Settlement Compliance

Wholesale metering is the term used to describe the meters installed at delivery points in the distribution grid. These are locations where electricity is delivered from the Ontario transmission system to either a local distribution company (LDC) or a major power consumer.

As the Metered Market Participant (a responsibility which was assigned to THESL at market opening in 2002) for 106 legacy metering points located at 35 different stations across the City of Toronto, THESL is now responsible for ensuring that every meter and instrument transformer used in a metering installation for settlement purposes has been approved for use by Measurement Canada. Additionally, all wholesale meter installations are required to be compliant with the Market Rules administered by the IESO.

The rules related to wholesale metering were developed to ensure that a high degree of accuracy is achieved, which is especially important due to the large volume of electricity being delivered through these meters.

THESL must replace certain legacy transformers with new transformers between 2012 to 2014 in order to remain in compliance with the IESO Market Rules and Measurement Canada requirements. The purpose of the requested capital funding is to fund that portion of the capital work THESL must complete in order to remain compliant.

- Part II, Section 1 provides detail on the Wholesale Metering Market Settlement Compliance segment.
- Part III, Sections 1 - 20 provide a detailed description of the work by job.

1.2. B. Seal Expiring Meters

THESL is required to comply with the metering requirements set out by Measurement Canada in Sections 9, 11 and 12 of the *Electricity and Gas Inspection Act*. These requirements state that all meters must be resealed at specific intervals in order to ensure that a customer's electricity use is being metered accurately.

Once a seal expires, the meter cannot be legally used for billing and must be either (i) resealed or (ii) re- verified (changed or replaced).

In order for a meter to be resealed, THESL must remove and replace a subset of meters from a sample homogeneous group (Appendix 2 sets out the qualifications required to form a homogeneous sample group). Historically, compliance sample groups of 10,000 to 15,000 meters were formed from homogeneous lots (same meter type, electrical characteristics, manufacturer and seal year). Each year a percentage of the meters in each compliance sample group, would be randomly selected to be tested for accuracy as specified by Measurement Canada standards. When any of the sample groups fails to meet the specified requirements, all meters in that sample group would be replaced.

The subset group of meters that have been removed from service are brought into THESL's meter shop and tested. If they pass, and based on their performance, the seal for the remaining meters out in the field are granted an extension to their seal from one to six years and can legally remain in service. Seals can only be extended by stringently adhering to the above process, otherwise the meters must be re-verified (changed or replaced).

For several meter types (Conventional, GS>50kW, RIMS, Quadlogic, Smart and Other) there are not going to be enough of particular types of meter to use to meet the criteria to form a homogenous lot for a sample group. A number of these meters have seals that will expire in 2012, 2013 and 2014. These meters must be re-verified (changed) in order to remain compliant with Measurement Canada's *Electricity and Gas Inspection Act* requirements. Failure to re-verify meters within the seal period may result in revocation of the THESL Meter Shop's accreditation. This work is non-discretionary and is a requirement of all utilities to ensure accurate customer billing in accordance with the requirements of Measurement Canada.

- Part II, Section 2 provides detail on the Seal Expiring Meters segment.
- Part III, Sections 21-23 provide a detailed description of the work by job.

1.3. C. Summary of Relief Requested

The estimated incremental cost of completing these measures in the 2012-2014 period (which costs are not covered by PCI funded rates) are:

Item	2012	2013	2014	Total
Wholesale Metering Market Settlement Compliance	$0.8M	$6.3M	$9.1M	$16.2M
Seal Expiring Meters	$4.8M	$0.9M	$1.0M	$6.7M
Total	**$5.6M**	**$7.2M**	**$10.1M**	**$22.9M**

2. Why the Project is Needed Now

2.1. Wholesale Metering Market Settlement Compliance

THESL's legacy transformer replacement efforts in 2012-2014 is required to ensure THESL completes the upgrades to its delivery points in 2012, 2013 and 2014 necessary to complete full meter upgrades at all applicable delivery points by 2021 in accordance with its IESO approved proposal. These upgrades are required in response to the following two drivers:

(i) In order to remain in compliance with the Independent Electricity System Operator (IESO) Market Rules, THESL is required to replace its legacy transformers with modern instrument transformers (current transformers and potential transformers) to ensure its wholesale metering points meet all of the criteria set forth in the Market Manuals (MDP_PRO_0022) and the Market Rules (MDP_RUL_0002_06 and MDP_RUL_0002_06A). THESL has committed to a long-term plan with the IESO to complete full meter upgrades at all applicable delivery points by 2021. This plan was initiated by way of a letter to the IESO on August 11, 2009 and approved by the IESO on November 27, 2009. Once wholesale metering upgrades are complete (currently scheduled to continue through 2021), there will be a total of 223 meter installations upgraded (of which 87 have been completed prior to 2012, 67 will be addressed in 2012-2014 (the request that is subject of this ICM filing), leaving 69 metering upgrades remaining for years 2015-2021). If the progress of the upgrades does not meet the satisfaction of the IESO, THESL may be determined to be in breach of the Market Rules.

(ii) Due to requirements imposed by the IESO, THESL must upgrade some of its legacy wholesale meter installations to meet the IESO Metering Installation standards for accuracy as set forth in Chapter 6, Section 4.1 of the Market Rules which provides, in part, that each metering installation shall:

"4.1.1.1 contain meters that are of a type that are described on the list of conforming meters established by the IESO;

4.1.1.2 be comprised of two meters, at least one of which shall be a revenue meter that meets or exceeds the 0.2% accuracy class of ANSI standard C12.20;"

2.2. Seal Expiring Meters

Funding is required to replace a number of specified meter types which have too small of a number to form a homogenous sample group to maintain compliance with Measurement Canada requirements set out in the *Electricity and Gas Inspection Act* and Measurement Canada's statistical methods specification S-S-06. These establish the requirements that are applicable to in-service isolated lots of homogeneous electricity or gas meters, where a meter owner utilizes sampling inspection for the purposes of extending the reverification period of an in-service lot of meters.

3. Why the Project is the Preferred Alternative?

For both the Wholesale Metering Market Settlement Compliance segment and the Seal Expiring Meters segment, THESL is required to replace the legacy equipment with new equipment that meets existing regulatory requirements imposed by the IESO and Measurement Canada. There is no practical alternative to completing this work by THESL, which is a requirement for THESL to remain in compliance with applicable law.

II DETAILED PROJECT INFORMATION

1. Wholesale Metering Market Settlement Compliance

Wholesale metering is the term used to describe the meters installed at delivery points in the distribution grid. These are locations where electricity is delivered from the Ontario transmission system to either a local distribution company (LDC) or a major power consumer. When the wholesale electricity market opened on May 1, 2002, responsibility for wholesale metering operations was transferred from Hydro One Networks Inc. (HONI) to each individual Metered Market Participant (MMP). In many cases, LDCs became the Meter Service Provider (MSP) for additional metered points previously serviced by HONI. At the time of the transition, THESL assumed responsibility for 106 metering points located at 35 different stations across the City of Toronto. Figure 1 below shows these locations.

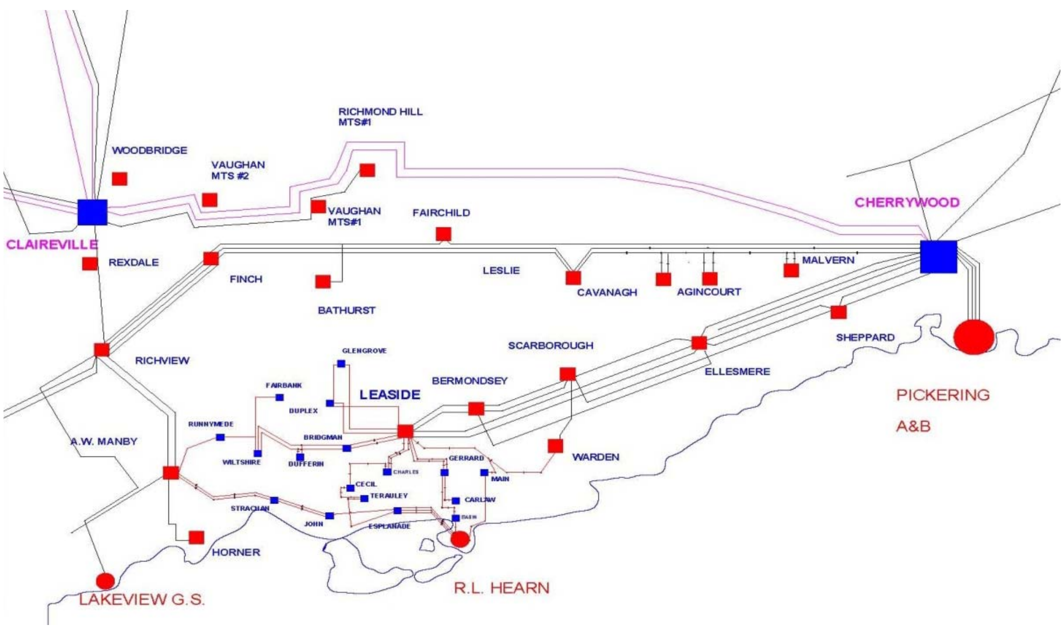


Figure 1: THESL Wholesale Metering Locations

As a MMP, THESL is responsible to ensure that every meter and instrument transformer used in a metering installation for settlement purposes has been approved for use by Measurement Canada. Additionally, all wholesale meter installations are required to be compliant with the Market Rules administered by the IESO. These requirements form part of the IESO Market Rules that govern the wholesale electricity market and compliance is mandatory for all market participants.

The rules related to wholesale metering were developed to ensure that a high degree of accuracy is achieved, which is especially important due to the large volume of electricity being delivered through these meters. The requirements are set out in detail in Chapter 6 of the Market Rules titled *Wholesale Metering Compliance Requirements*.[1] Specifically, Subsection 4 specifies the Metering Installation Standards, including the requirement of a Check/Alternate Meter and the Metering accuracy class, including the Instrument Transformer accuracy class.

For example, Subsections 4.1.1.1 and 4.1.1.2 of Chapter 6 of the Market Rules provides:

> 4.1.1 Subject to sections 4.1.2, 4.4, and 4.6, each metering installation shall:
>
> 4.1.1.1 contain meters that are of a type that are described on the list of conforming meters established by the IESO;
>
> 4.1.1.2 be comprised of two meters, at least one of which shall be a revenue meter that meets or exceeds the 0.2% accuracy class of ANSI standard C12.20;

The IESO has also established a Conforming Meter List – See Appendix 1 for details.

Figure 2 below shows an example of a THESL wholesale meter installation.

[1] For instance, Section 2 sets out the metering installation requirements. Section 3 of Chapter 6 sets out the obligation to participate in the real time administered IESO market as a metered market participant. Section 4 sets out the meter installation standards for both main and alternate meters. In addition, the Chapter 6 Appendices set forth the obligations of metered market participants and metering service providers in respect of metering. Finally, Market Manual 2: Market Administration Part 2.6 MDP_PRO_0022: Treatment of Compliance Issues, this procedure provides the steps required for the treatment of compliance issues by both Market Participants and the IESO.

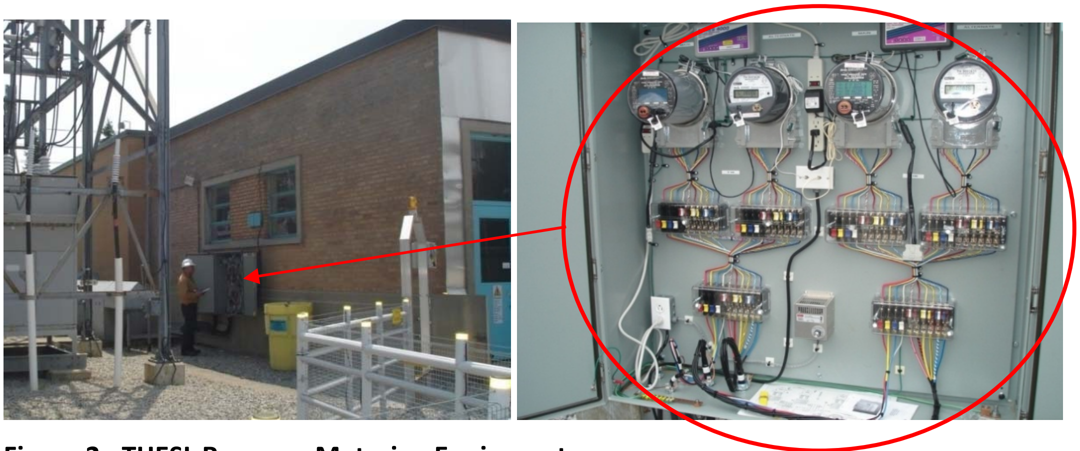


Figure 2: THESL Revenue Metering Equipment

In addition, the IESO requires main and alternate meters for each metering installation with the main meter having a 0.2% accuracy class and the alternate meter having 0.5% accuracy class, as per Section 5.1.1b and Section 5.2.1 of the IESO Wholesale Revenue Metering Standard – Hardware (Issue 9.0 – MDP_STD_0004). These accuracy requirements are also included in the Market Rules, Chapter 6 Wholesale Metering (Section 4) and the Market Rules, Chapter 6 Wholesale Metering – Appendices (Section 1.2).

Many of THESL's legacy installations do not meet these requirements. In addition, many existing legacy transformers used for wholesale metering inherited by THESL do not meet current American National Standards Institute (ANSI) 0.3% accuracy class required by Section 1.7, Chapter 6 Wholesale Metering - Appendices.

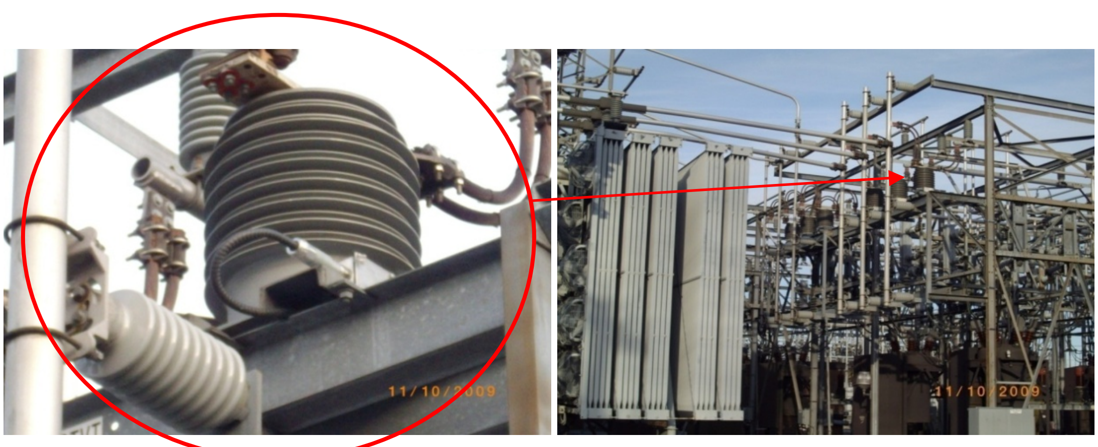


Figure 3: Modern Revenue Metering Instrument Transformer

Figure 3 above shows an example of a modern instrument transformer (current transformer and potential transformer combination unit).

In addition, due to requirements imposed by Measurement Canada as detailed in the *Electricity and Gas Inspection Act* (which requirements are discussed further part 2 below), THESL must upgrade some of its legacy wholesale meter installations to increase accuracy by ensuring that a separate meter is installed at each delivery point.

THESL has committed to a long-term plan with the IESO to complete full meter upgrades at all applicable delivery points. This plan was initiated by a letter submitted to the IESO on August 11, 2009, and approved by the IESO on November 27, 2009. In addition, Hydro One has committed additional resources in 2012, 2013 and 2014 to achieve this for particular sites. Once wholesale metering upgrades are complete (currently scheduled to continue through 2021), there will be a total of 223 meter installations upgraded (of which 87 have been completed prior to 2012, 67 will be addressed in 2012-2014 as per this ICM filing, leaving 69 metering upgrades remaining for years 2015-2021) across the 35 stations mentioned above.

The purpose of the requested ICM capital funding for the Wholesale Metering Market Settlement Compliance Project is to fund that portion of the capital work THESL is required to complete in accordance with its IESO approved meter upgrades plan for 2012, 2013 and 2014 to replace existing legacy meters and transformers with equipment that meets current Measurement Canada and IESO requirements for wholesale metering before 2021.

If the progress of the upgrades does not meet the satisfaction of the IESO, THESL may be found to be in breach of the Market Rules and face a compliance action.

Where a breach of the Market Rules is alleged, the Market Assessment and Compliance Division (MACD) of the IESO can impose financial penalties in accordance with Market Manual 2: *Market Administration, Part 2.6: Treatment of Compliance Issues*. MACD exercises all authorities concerning alleged breaches and non-compliance letters. The IESO imposes penalties on market-participants when they are in contravention of the Ontario Electricity Market Rules. The potential fines can range from $2,000 per breach for low impact issues with low severity/breach history to $1,000,000 per occurrence for high impact breaches. There is also the potential for a market participant to be suspended.

THESL is required to upgrade its wholesale meter installations to bring the original Ontario Hydro meter installations to current IESO meter installation standards as specified by the requirements in Chapter 6 of the Market Rules for *Wholesale Metering Compliance Requirements*. Subsection 4.1.1 specifies Metering and Instrument Transformer accuracy class.

> Subject to sections 4.1.2, 4.4, and 4.6, each metering installation shall:
> "4.1.1.1 contain meters that are of a type that are described on the list of conforming meters established by the IESO;
> 4.1.1.2 be comprised of two meters, at least one of which shall be a revenue meter that meets or exceeds the 0.2% accuracy class of ANSI standard C12.20;"

In order to remain a Market Participant in the IESO administered Market, Toronto Hydro is required to ensure its wholesale metering points meet all of the criteria set forth in the Market Manuals and the Market Rules for the Ontario Electricity Market as noted below:

> Market Rules Chapter 6 Wholesale Metering Compliance Requirements MDP_RUL_0002_06:
> Subsection 2 Metering Installation Requirements,
> Subsection 3 the Obligations to participate in the real time administered IESO market as a Metered Market Participant,
> Subsection 4 Meter Installation Standards Main and Alternate Meters,

> Market Rules Chapter 6 Wholesale Metering –Appendices MDP_RUL_0002_06A sets forth the obligations of metered market participants and metering service providers in respect of metering

> Market Manual 2: Market Administration Part 2.6 MDP_PRO_0022: Treatment of Compliance Issues, this procedure provides the steps required

for the treatment of compliance issues by both Market Participants and the IESO.

THESL views this work as non-discretionary work that is required to remain compliant with the requirements of Measurement Canada and the IESO Market Rules. THESL should perform the work in accordance with the schedule outlined in Table 2. Any delay in this scope of work could easily delay the overall implementation of compliant wholesale metering across the entire THESL service territory. If the IESO does not perceive progress on this compliance effort, this could in turn result in fines if THESL is found to be in non-compliance with the IESO Mark Rules that could range from $10,000 to more than $100,000 for each wholesale transformer station depending on the number of meters and metering equipment in breach. THESL would incur these penalties in addition to the requirements to perform this work should THESL fail to stay on schedule. The fines/penalties would escalate if THESL does not address any Market Rules breaches expeditiously to the point of suspension or termination of THESL's Market Participant status.

THESL will upgrade meter installations by replacing instrument transformers and meters, installing and splitting existing metering points such that each individual delivery point has a dedicated meter. The number of upgrades required in each of 2012, 2013 and 2014 is provided in Table 1 below.

Table 1: Wholesale Metering Upgrades

	Test Year 2012	**Test Year 2013**	**Test Year 2014**	**Total**
Number of Wholesale Metering Points	6	28	33	67

A detailed schedule of wholesale metering upgrades by location is provided in Table 2 below.

1 **Table 2: Wholesale Metering Upgrades by Location**

Job Estimate Number	Job Title	Job Year	Cost Estimate ($M)
TH4038	IESO Compliant Metering at Leslie TS (T4J and T4Q)	2012	$0.48
P0057669	IESO Compliant Metering at Strachan TS (T15-A9A10 and T13-A9A10)	2012	$0.18
P0055759	IESO Compliant Metering at Wiltshire TS (T5-A11A12 and T2-A11A12)	2012	$0.18
TH 7009	IESO Compliant Metering at Bermondsey TS (T1J, T1Q, T2J, T2Q, T3B, T3Y, T4B, T4Y)	2013	$1.80
TH7006	IESO Compliant Metering at Scarboro TS (T21J, T21Q, T22J, T22Q, T23B, T23Y, T24B, T24Y)	2013	$1.80
TH7010	IESO Compliant Metering at Dufferin TS (T2A5A6, T2A7A8, T4A5A6, T4A7A8)	2013	$0.90
TH7015	IESO Compliant Metering at Fairbank TS (Y Bus, Z Bus, B Bus, Q Bus)	2013	$0.90
TH7007	IESO Compliant Metering at Ellesmere TS (T3J, T3Q, T4J, T4Q)	2013	$0.90
TH7021	IESO Compliant Metering at Gerrard TS (T1A4A5, T2A2A2, T3A1A2 and T4A4A5)	2014	$1.00
TH7017	IESO Compliant Metering at Warden TS (J Bus and Q Bus)	2014	$0.40
TH7008	IESO Compliant Metering at Basin TS (T3A5A6, T3A7A8, T5A5A6, T5A7A8)	2014	$1.00
TH7013	IESO Compliant Metering at Main TS (T3 and T4)	2014	$1.20
TH7005	IESO Compliant Metering at Manby TS (T13 and T14)	2014	$0.50
TH7016	IESO Compliant Metering at Runnymede TS (T3 and T4)	2014	$0.50

Job Estimate Number	Job Title	Job Year	Cost Estimate ($M)
TH7011	IESO Compliant Metering at Bridgman TS (T5 and T11)	2014	$1.00
TBD	IESO Compliant Metering at Leaside TS (M1, M2, M3, M4, M8, T19, T20, T21)	2014	$1.80
TBD	IESO Compliant Metering at Esplanade TS (M11, M12, M13)	2014	$0.70
TBD	IESO Compliant Metering at Terauley TS (T2, T3)	2014	$0.50
TBD	IESO Compliant Metering at Strachan TS (T13, T15)	2014	$0.50
2012-2014	Total ICM Metering projects	Total:	$16.24

2. Seal Expiring Meters

THESL is required to comply with the metering requirements set out by Measurement Canada in Sections 9, 11 and 12 of the *Electricity and Gas Inspection Act*. These requirements state that all meters must be resealed at specific intervals in order to ensure that a customer's electricity use is being metered accurately.

Specifically:

Subsection 9(1) provides:

> "Subject to subsections (2) and (3), where a contractor or purchaser intends to use or cause to be used a meter for the purpose of obtaining the basis of a charge for electricity or gas supplied by or to him, the meter shall not, until it has been verified and sealed in accordance with this Act and the regulations, be put into service."

Subsection 11(2) provides:

> "Any approval granted under subsection 9(3) or (4) or accreditation granted under section 10 may, by notice given in prescribed manner, be revoked by

the Minister for failure to comply with any conditions to which that approval or accreditation has been made subject in accordance with the regulations."

Subsection 12(1) provides:

"Within

(a) the period of eight years from verification, and the period of eight years from each reverification, of a meter used for the purpose of obtaining the basis of a charge for electricity,

[…], or

(c) such other period from any or each verification or reverification of a meter as may be determined in any case or class of cases by the director, the meter shall be submitted to reverification, together with resealing or marking, or to cancellation of the seal or mark, as the case may require, under this Act and the regulations."

Once a seal expires, the meter cannot be legally used for billing and must be either resealed or re- verified (changed). In order for a meter to be resealed, THESL must remove and replace a subset of meters from a sample homogeneous group (see Appendix 2 for qualifications required to form a homogeneous sample group).

Historically, compliance sample groups of 10,000 to 15,000 meters were formed from homogeneous lots (same meter type, electrical characteristics, manufacturer and seal year). Each year a percentage of the meters in each compliance sample group, would be randomly selected to be tested for accuracy as specified by Measurement Canada standards. When any of the sample groups fails to meet the specified requirements, all meters in that sample group would be replaced.

The subset group of meters that have been removed from service are brought into THESL's meter shop and tested. If they pass, and based on their performance, the seal for the remaining meters out in the field are granted an extension to their seal from one to six years and can legally remain in service. Seals can only be extended by stringently adhering to the above process, otherwise the meters must be re-verified (changed).

There are no longer enough conventional meters in use to meet the criteria to form a homogeneous lot for a sample group (there are scattered conventional meters remaining and homogenous lots do not exist), the remaining meters have seals that will expire in 2012 onwards. These meters must be re-verified (changed) in order to remain compliant with Measurement Canada's *Electricity and Gas Inspection Act*. Failure to re-verify meters within the seal period may result in revocation of the THESL Meter Shop's accreditation.

The QuadLogic Meters (suite meters) have been installed since 2006 and have a six year re-verification cycle. In 2012, THESL will commence a re-verification process. As the numbers are quite small, there are not enough to form a homogenous sample group so replacements will be required until 2014. Beginning in 2014 the number of meters is expected to be sufficient to allow for sampling rather than re-verification.

The number of meters by meter type for 2012 to 2014 that require replacement due to expired seals are shown in Table 3 below. The only meters that would have a large enough homogenous group to create a sample lot for seal extensions by sample lot re-verification would be 2014 QuadLogic Meters. All other meters would need to be replaced.

Table 3: Meter Replacement Requirements by Meter Type only the 2014 QuadLogic Meters would have a large enough homogeneous lot size to support reverification all others would require meter changes

Meter Type	2012	2013	2014	Total
Conventional*	5,989	0	0	5,989
General Service > 50kW **	70	0	0	70
RIMS	13	327	304	644
Quadlogic	336	1,376	4,703 ***	6,415
Smart and Other	0	6	292	298
Total	**6,408**	**1,709**	**5,299**	**13,416**

*846 have asbestos backer boards

**46 have asbestos backer boards

***sampling only

The estimated costs include the removal of asbestos backer boards as they pose a potential safety threat to our crews and customers. Asbestos is a designated substance covered under Ontario Regulation 278/05 made under the *Occupational Health and Safety Act*.

The work outlined for seal expiring meters is required to comply with the regulations that govern entities that charge for utility usage.

Failure to change meters with expired seals would make THESL non-compliant with the *Electricity and Gas Inspection Act*. These requirements are enforced by Measurement Canada. This could result in penalties, if convicted, as described in the chapter on Offenses and Punishment of the Act.

In addition to the regulatory obligations, it is the responsibility of THESL to ensure all customers are metered and billed accurately.

As noted above, some of the meters are mounted on asbestos backer boards (See Figure 4, Figure 5 and Figure 6 for illustrative examples) and it is prudent for THESL to remove this potential hazard when completing the meter replacement. This is expected to mitigate, if not eliminate this safety issue, as any activity to change or bi-pass these meters may result in creation of asbestos air-born particles, which present a potential safety risk to THESL crews and to the public. Furthermore, if a meter with an asbestos board fails it may not be possible to replace immediately on a reactive basis, resulting in an extended power outage to the customer.

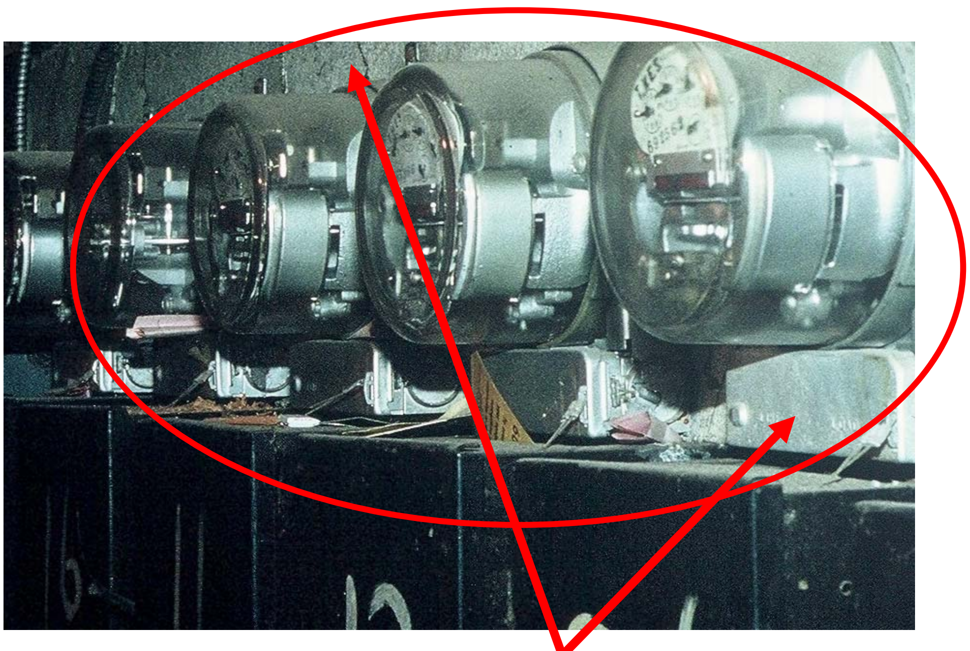


Figure 4: Example of Meters installed on Asbestos Backer Boards #1

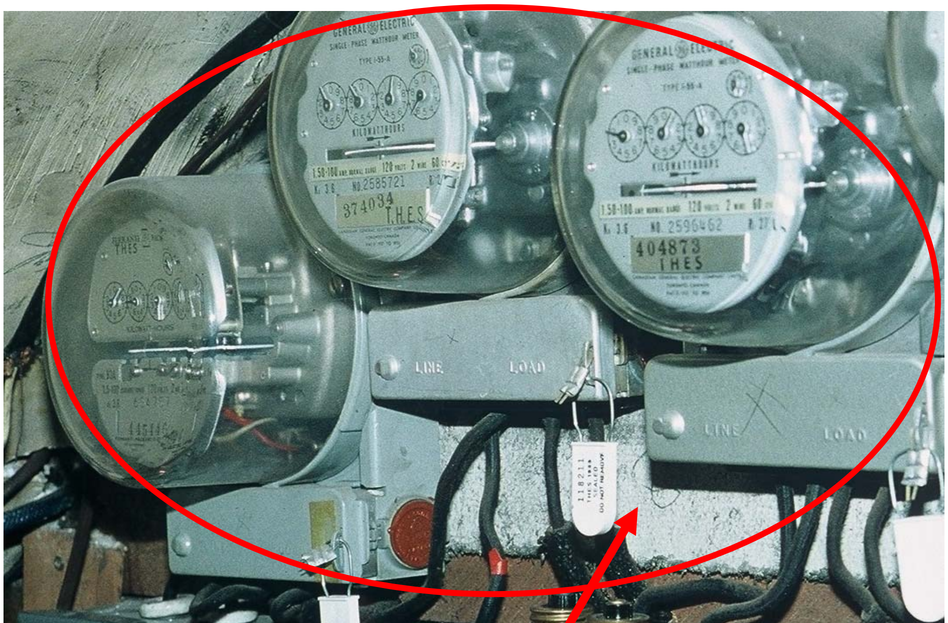


Figure 5: Example of meters installed on Asbestos Backer Boards #1

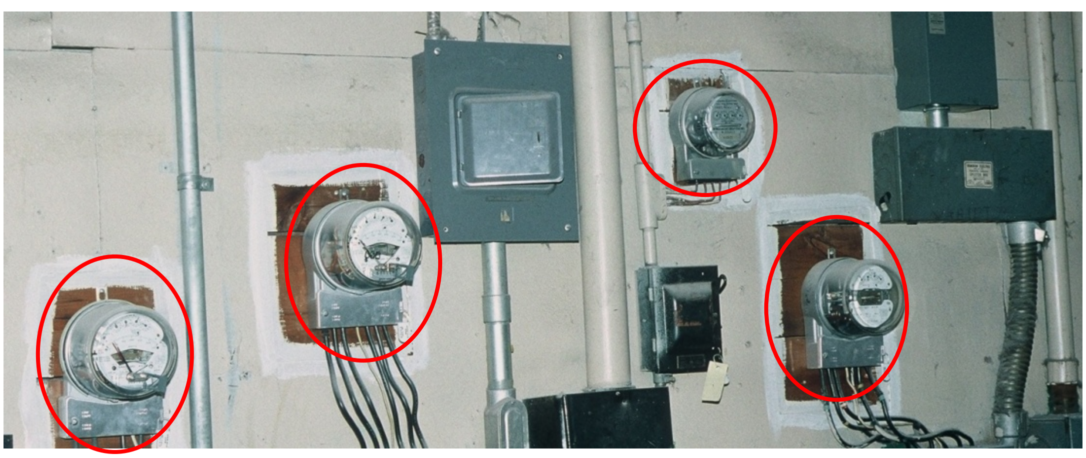


Figure 6: Example of a Completed Asbestos Safety Project Ready for New Smart Meters

III DESCRIPTION OF WORK

1. Listing of all Jobs

Project Estimate Number	Job Title	Job Year	Cost Estimate ($M)
TH4038	IESO Compliant Metering at Leslie TS (T4J and T4Q)	2012	$0.48
P0057669	IESO Compliant Metering at Strachan TS (T15-A9A10 and T13-A9A10)	2012	$0.18
P0055759	IESO Compliant Metering at Wiltshire TS (T5-A11A12 and T2-A11A12)	2012	$0.18
25315 25316	ICM re-verification/reseal	2012	$4.80
TH 7009	IESO Compliant Metering at Bermondsey TS (T1J, T1Q, T2J, T2Q, T3B, T3Y, T4B, T4Y)	2013	$1.80
TH7006	IESO Compliant Metering at Scarborough TS (T21J, T21Q, T22J, T22Q, T23B, T23Y, T24B, T24Y)	2013	$1.80
TH7010	IESO Compliant Metering at Dufferin TS (T2A5A6, T2A7A8, T4A5A6, T4A7A8)	2013	$0.90
TH7015	IESO Compliant Metering at Fairbank TS (Y Bus, Z Bus, B Bus, Q Bus)	2013	$0.90
TH7007	IESO Compliant Metering at Ellesmere TS (T3J, T3Q, T4J, T4Q)	2013	$0.90
24983	2013 RC4250 Re-verification Meter Replacement New	2013	$0.90
TH7021	IESO Compliant Metering at Gerrard TS (T1A4A5, T2A2A2, T3A1A2 and T4A4A5)	2014	$1.00
TH7017	IESO Compliant Metering at Warden TS (J Bus and Q Bus)	2014	$0.40

Project Estimate Number	Job Title	Job Year	Cost Estimate ($M)
TH7008	IESO Compliant Metering at Basin TS (T3A5A6, T3A7A8, T5A5A6, T5A7A8)	2014	$1.00
TH7013	IESO Compliant Metering at Main TS (T3 and T4)	2014	$1.20
TH7005	IESO Compliant Metering at Manby TS (T13 and T14)	2014	$0.50
TH7016	IESO Compliant Metering at Runnymede TS (T3 and T4)	2014	$0.50
TH7011	IESO Compliant Metering at Bridgman TS (T5 and T11)	2014	$1.00
TBD	IESO Compliant Metering at Leaside TS (M1, M2, M3, M4, M8, T19, T20, T21)	2014	$1.80
TBD	IESO Compliant Metering at Esplanade TS (M11, M12, M13)	2014	$0.70
TBD	IESO Compliant Metering at Terauley TS (T2, T3)	2014	$0.50
TBD	IESO Compliant Metering at Strachan TS (T13, T15)	2014	$0.50
24985	2014 RC4250 Re-verification Meter Replacement New	2014	$1.00
2012-2014	**Total ICM Metering Project**	**Total:**	**$22.94**

2. Proposal for Leslie TS – Replace T4J and T4Q Wholesale Revenue Metering

2.1. Job Objectives

THESL is the MSP and intends to exit from Hydro One Networks Inc. (HONI)-owned wholesale revenue metering installations. THESL intends to abandon the metering installations and build new low voltage installations. This proposal is for the work associated with de-registering the existing two wholesale revenue metering points and with making ready two new fully compliant IESO wholesale metering installations.

2.2. Job Scope of Work

The switchyard site is a 230/27.6 kV transformer station supplying local loads. There are two transformers, designated as T4J and T4Q connected via 230kV lines. Both transformers T4J and T4Q are the subject of this revenue metering upgrade.

2.3. Location

The assets being replaced are located at Leslie TS, 5655 Leslie Street, Toronto, Ontario, M2H 1W6.

2.4. Required Capital Costs

Estimate Number	Job Phase		Estimated Cost ($M)
TH4038	Leslie TS – Replace T4J and T4Q Wholesale Revenue Metering		$0.48
		Total:	**$0.48**

3. Proposal for Strachan TS – IESO Compliant Metering at Strachan TS (T13-A9A10 and T15-A9A10)

3.1. Job Objectives

THESL is the MSP and expects to exit from the above mentioned HONI-owned wholesale revenue metering installations. THESL expects to abandon the above mentioned metering installations and build new low voltage installations inside Strachan TS. This proposal is for the work associated with de-registering the existing one wholesale revenue metering points and with making ready two new fully-compliant IESO wholesale metering installations.

3.2. Job Scope of Work

The site is a 115/13.8 kV transformer station supplying local loads. There are two transformers, designated as T13 and T15, connected via 115kV lines. Both transformers T13 and T15 are the subject of this revenue metering upgrade.

3.3. Location

The assets being replaced are located at Strachan TS, 6 Strachan Avenue, Toronto, Ontario, M6K 3N8.

3.4. Required Capital Costs

Estimate Number	Job Phase	Estimated Cost ($M)
P0057669	Strachan TS – Replace T13-A9A10 and and T15-A9A10 Wholesale Revenue Metering	$0.18
	Total:	**$0.18**

4. Proposal for Wiltshire TS – IESO Compliant Metering at Strachan TS (T2-A11A12 and T5-A11A12)

4.1. Job Objectives

THESL is the MSP and expects to be exiting from the above mentioned HONI-owned wholesale revenue metering installations. THESL expects to abandon the above mentioned metering installations and build new low voltage installations inside Wiltshire TS. This proposal is for the work associated with de-registering the existing one wholesale revenue metering points and with making ready two new fully-compliant IESO wholesale metering installations.

4.2. Job Scope of Work

The site is a 115/13.8 kV transformer station supplying local loads. There are two transformers, designated as T2 and T5, connected via 115kV lines. Both transformers T2 and T6 are the subject of this revenue metering upgrade.

4.3. Location

The assets being replaced are located at Wiltshire TS, 27 Wiltshire Avenue, Toronto, Ontario, M6N 2V7.

4.4. Required Capital Costs

Estimate Number	Job Phase		Estimated Cost ($M)
P0055759	Wiltshire TS – Replace T2-A11A12 and and T5-A11A12 Wholesale Revenue Metering		$0.18
		Total:	**$0.18**

5. Proposal for Bermondsey TS – Replace T1J, T1Q, T2J, T2Q, T3B, T3Y, T4B and T4Y Wholesale Revenue Metering

5.1. Job Objectives

THESL is the MSP and expects to be exiting from the above mentioned HONI-owned wholesale revenue metering installations. THESL expects to abandon the above mentioned metering installations and build new low voltage installations inside Bermondsey TS. This proposal is for the work associated with de-registering the existing four wholesale revenue metering points and with making ready eight new fully-compliant IESO wholesale metering installations.

5.2. Job Scope of Work

The switchyard site is a 230/27.6 kV transformer station supplying local loads. There are two transformers, designated as T1 and T2, connected via 230kV, 60 Hz lines C14L and C17L. Both transformers T1 and T2 are the subject of this revenue metering upgrade.

5.3. Location

The assets being replaced are located at Bermondsey TS, 176 Bermondsey Road, Toronto, Ontario, M4A 1Y1.

5.4. Required Capital Costs

Estimate Number	Job Phase	Estimated Cost ($M)
TH7009	Bermondsey TS – Replace T1J, T1Q, T2J, T2Q, T3B, T3Y, T4B and T4Y Wholesale Revenue Metering	$1.80
	Total:	**$1.80**

6. Proposal for Scarborough TS – Replace T21J, T21Q, T22J, T22Q, T23B, T23Y, T24B and T24Y Wholesale Revenue Metering

6.1. Job Objectives

THESL is the MSP and expects to be exiting from the above mentioned HONI-owned wholesale revenue metering installations. THESL expects to abandon the above mentioned metering installations and build new low voltage installations inside Scarborough TS. This proposal is for the work associated with de-registering the existing four wholesale revenue metering points and with making ready eight new fully-compliant IESO wholesale metering installations.

6.2. Project Scope of Work

Scarborough TS, Area 1 switchyard site is a 230/27.6 kV transformer station supplying local loads. There are two transformers, designated as T21 and T22, connected via 230 kV, 60 Hz lines C14L and C2L. Both transformers T21 and T22 are the subject of this revenue metering upgrade

6.3. Location

The assets being replaced are located at Scarborough TS, 2411 Lawrence Avenue East, Toronto, Ontario, M1P 4X1.

6.4. Required Capital Costs

Estimate Number	Job Phase	Estimated Cost ($M)
TH7006	Scarborough TS – Replace T21J, T21Q, T22J, T22Q, T23B, T23Y, T24B and T24Y Wholesale Revenue Metering	$1.80
	Total:	**$1.80**

7. Proposal for Dufferin TS – Replace T2A5A6, T2A7A8, T4A5A6 and T4A7A8 Wholesale Revenue Metering

7.1. Job Objectives

THESL is the MSP and expects to be exiting from the above mentioned HONI-owned wholesale revenue metering installations. THESL expects to abandon the above mentioned metering installations and build new low voltage installations inside Dufferin TS. This proposal is for the work associated with de-registering the existing four wholesale revenue metering points and with making ready four new fully-compliant IESO wholesale metering installations.

7.2. Job Scope of Work

Toronto Dufferin steps 115kV transmission down to 13.8kV distribution to supply local loads. Four power transformers (T1, T2, T3 and T4) provide transformation from the 115 kV system to the 13.8kV three-phase four-wired system. Transformers T2 and T4 are within the scope of this revenue metering upgrade.

7.3. Location

The assets being replaced are located at Dufferin TS, 1045 Dufferin Street, Toronto, Ontario, M6H 4B5.

7.4. Required Capital Costs

Estimate Number	Job Phase	Estimated Cost ($M)
TH7010	Dufferin TS – Replace T2A5A6, T2A7A8, T4A5A6 and T4A7A8 Wholesale Revenue	$0.90
	Total:	**$0.90**

8. Proposal for Fairbank TS (NT35) – Replace Y Bus, Z Bus, B Bus and Q Bus Wholesale Revenue Metering

8.1. Job Objectives

THESL is the MSP and expects to be exiting from the above mentioned HONI-owned wholesale revenue metering installations. THESL expects to abandon the above mentioned metering installations and build new low voltage installations inside Fairbank TS. This proposal is for the work associated with de-registering the existing four wholesale revenue metering points and with making ready four new fully-compliant IESO wholesale metering installations.

8.2. Job Scope of Work

Toronto Fairbank TS, (South and North Area switchyards) is 115/27.6 kV transformer station supplying local loads. There are four transformers, designated as T1, T2, T3 and T4, connected via 115kV, 60 Hz lines K1W and K3W. All four transformers are the subject of this revenue metering upgrade.

8.3. Location

The assets being replaced are located at Fairbank TS, 950 Roselawn Avenue, Toronto, Ontario, M6B 1B9.

8.4. Required Capital Costs

Estimate Number	Job Phase	Estimated Cost ($M)
TH7010	Proposal for Fairbank TS (NT35) – Replace Y Bus, Z Bus, B Bus and Q Bus Wholesale Revenue Metering	$0.90
	Total:	**$0.90**

9. Proposal for Ellesmere TS (NAH9) – Replace T3J, T3Q, T4J and T4Q Wholesale Revenue Metering

9.1. Job Objectives

THESL is the MSP and expects to be exiting from the above mentioned HONI-owned wholesale revenue metering installations. THESL expects to abandon the above mentioned metering installations and build new low voltage installations inside Ellesmere TS. This proposal is for the work associated with de-registering the existing four wholesale revenue metering points and with making ready four new fully-compliant IESO wholesale metering installations.

9.2. Job Scope of Work

Ellesmere TS, (South and North Area switchyards) is 115/27.6 kV transformer station supplying local loads. There are four transformers, designated as T1, T2, T3 and T4, connected via 115kV, 60 Hz lines K1W and K3W. All four transformers are the subject of this revenue metering upgrade.

9.3. Location

The assets being replaced are located at Ellesmere TS, 2501 Ellesmere Road, Toronto, Ontario, M1G 3M9.

9.4. Required Capital Costs

Estimate Number	Job Phase	Estimated Cost ($M)
TH7007	Proposal for Ellesmere TS (NAH9) – Replace T3J, T3Q, T4J and T4Q Wholesale Revenue Metering	$0.90
	Total:	**$0.90**

10. Proposal for Gerrard TS (NT33) – Replace T1A4A5, T2A1A2, T3A1A2, and T4A4A5 Wholesale Revenue Metering

10.1. Job Objectives

THESL is the MSP and expects to be exiting from the above mentioned HONI-owned wholesale revenue metering installations. THESL expects to abandon the above mentioned metering installations and build new low voltage installations inside Gerrard TS. This proposal is for the work associated with de-registering the existing four wholesale revenue metering points and with making ready four new fully-compliant IESO wholesale metering installations.

10.2. Job Scope of Work

The switchyard site is a 115/13.8 kV, 60 Hz TS supplying local loads. There are four power transformers (T1, T2, T3 and T4) providing step down transformation from the 115 kV system to 13.8 kV system. All are within the scope of this revenue metering upgrade.

10.3. Location

The assets being replaced are located at Gerrard Terminal Station(TS), located in the City of Toronto, at 20 Blackburn Street, Toronto, Ontario, M4M 1X7.

10.4. Required Capital Costs

Estimate Number	Job Phase	Cost ($M)
TH7021	Gerrard TS (NT33) – Replace T1A4A5, T2A1A2, T3A1A2, and T4A4A5 Wholesale Revenue Metering	$1.00
	Total:	$1.00

11. Proposal for Warden TS – Replace J Bus and Q Bus Wholesale Revenue Metering

11.1. Job Objectives

THESL is the MSP and expects to be exiting from the above mentioned HONI-owned wholesale revenue metering installations. THESL expects to abandon the above mentioned metering installations and build new low voltage installations inside Warden TS. This proposal is for the work associated with de-registering the existing four wholesale revenue metering points and with making ready four new fully-compliant IESO wholesale metering installations.

11.2. Job Scope of Work

The switchyard site is a 230/27.6 kV, 60 Hz transformer station supplying local loads. There are two power transformers (T3 and T4) providing step down transformation from the 230 kV system to 27.6 kV system. Both transformers are within the scope of this revenue metering upgrade.

11.3. Location

The assets being replaced are located at Warden TS, 699 Warden Avenue, Toronto, Ontario, M1L 3Z5.

11.4. Required Capital Costs

Estimate Number	Job Phase		Estimated Cost ($M)
TH7017	Warden TS – Replace J Bus and Q Bus Wholesale Revenue Metering		$0.40
		Total:	**$0.40**

12. Proposal for Basin TS (NT4) – Replace T3A5A6, T3A7A8, T5A5A6, and T5A7A8 Wholesale Revenue Metering

12.1. Job Objectives

THESL is the MSP and expects to be exiting from the above mentioned HONI-owned wholesale revenue metering installations. THESL expects to abandon the above mentioned metering installations and build new low voltage installations inside Basin TS. This proposal is for the work associated with de-registering the existing four wholesale revenue metering points and with making ready four new fully-compliant IESO wholesale metering installations.

12.2. Job Scope of Work

The switchyard site is a 115/13.8 kV, 60 Hz TS supplying local loads. There are two power transformers (T3 and T5) providing step down transformation from the 115 kV system to the THESL owned 13.8 kV system. Both transformers are within the scope of this revenue metering upgrade.

12.3. Location

The assets being replaced are located at Basin TS, 25 Basin Street, Toronto, Ontario, M4M 1A1.

12.4. Required Capital Costs

Estimate Number	Job Phase	Estimated Cost ($M)
TH7008	Proposal for Gerrard TS (NT33) – Replace T1A4A5, T2A1A2, T3A1A2, and T4A4A5 Wholesale Revenue Metering	$1.00
	Total:	**$1.00**

13. Proposal for Main TS – Replace T3 and T4 Wholesale Revenue Metering

13.1. Job Objectives

THESL is the MSP and expects to be exiting from the above mentioned HONI-owned wholesale revenue metering installations. THESL expects to abandon the above mentioned metering installations and build new low voltage installations inside Main TS. This proposal is for the work associated with de-registering the existing four wholesale revenue metering points and with making ready two new fully-compliant IESO wholesale metering installations.

13.2. Job Scope of Work

The switchyard site is a 115/13.8 kV transformer station supplying local loads. There are two transformers, designated as T3 and T4, connected via 115 kV, 60 Hz lines. They are both subject of this revenue metering upgrade.

13.3. Location

The assets being replaced are located at Main TS, 131 Stephenson Avenue, Toronto, Ontario, M4C 1G2.

13.4. Required Capital Costs

Estimate Number	Job Phase	Estimated Cost ($M)
TH7013	Proposal for Main TS – Replace T3 and T4 Wholesale Revenue Metering	$1.20
	Total:	**$1.20**

14. Proposal for Manby TS (NA38) – Replace T13 and T14 Wholesale Revenue Metering

14.1. Job Objectives

THESL is the MSP and expects to be exiting from the above mentioned HONI-owned wholesale revenue metering installations. THESL expects to abandon the above mentioned metering installations and build new low voltage installations inside Manby TS. This proposal is for the work associated with de-registering the existing two wholesale revenue metering points and with making ready two new fully-compliant IESO wholesale metering installations.

14.2. Job Scope of Work

Manby TS (T13/T14) consists of two 220/28 kV, 50/67/93 MVA power transformers, each with a winter 10-day Limited Time Rating (LTR) of 120.6 MVA. A meter only upgrade of the T13/T14 2EL metering installation was done in 2008 but a full metering upgrade is now needed to satisfy the requirements of Market Rules. Before beginning work Hydro One will complete a detailed design of two new IESO compliant metering installations; one to meter the energy being delivered by transformer T13 and the other to meter that of transformer T14.

14.3. Location

The assets being replaced are located Manby TS, located in the City of Toronto, at 850 Kipling Avenue, Toronto, Ontario, M8Z 5G5.

14.4. Required Capital Costs

Estimate Number	Job Phase	Estimated Cost ($M)
TH7005	Manby TS (NA38) – Replace T13 and T14 Wholesale Revenue Metering	$0.50
	Total:	**$0.50**

15. Proposal for Runnymede (NT11) – Replace T3 and T4 Wholesale Revenue Metering

15.1. Job Objectives

THESL is the MSP and expects to be exiting from the above mentioned HONI-owned wholesale revenue metering installations. THESL expects to abandon the above mentioned metering installations and build new low voltage installations inside Runnymede TS. This proposal is for the work associated with de-registering the existing one wholesale revenue metering points and with making ready two new fully compliant IESO wholesale metering installations.

15.2. Job Scope of Work

Runnymede TS is a 115/27.6 kV transformer station supplying local loads. There are two transformers, designated as T3 and T4, connected via 115kV, 60 Hz lines K11W and K12W. Both transformers are the subject of this revenue metering upgrade.

15.3. Location

The assets being replaced are located at Runnymede (TS), located in the City of Toronto, on 99 Woolner Avenue, South of Eglinton Avenue and east from Jane Street.

15.4. Required Capital Costs

Estimate Number	Job Phase	Estimated Cost ($M)
TH7016	Runnymede (NT11) – Replace T3 and T4 Wholesale Revenue Metering	$0.50
	Total:	**$0.50**

16. Proposal for Bridgman TS – Replace T5A4A6HL and T11A5A6HL Wholesale Revenue Metering

16.1. Job Objectives

THESL is the MSP and expects to be exiting from the above mentioned HONI-owned wholesale revenue metering installations. THESL expects to abandon the above mentioned metering installations and build new low voltage installations inside Bridgman TS. This proposal is for the work associated with de-registering the existing two wholesale revenue metering points and with making ready two new fully-compliant IESO wholesale metering installations which is further described in detail in the attached Scope of Work.

16.2. Job Scope of Work

The switchyard site is a 115/13.8 kV, 60 Hz TS supplying local loads. There are two power transformers (T5 and T11) providing step down transformation from the 115 kV system to 13.8 kV system. Both are within the scope of this revenue metering upgrade.

16.3. Location

The assets being replaced are located at Bridgman TS, located in the City of Toronto, at 254 MacPherson Avenue, Toronto, Ontario, M4V 1A7.

16.4. Required Capital Costs

Estimate Number	Job Phase		Estimated Cost ($M)
TH7011	Bridgman TS – Replace T5A4A6HL and T11A5A6HL Wholesale Revenue		$1.00
		Total:	**$1.00**

17. Proposal for Leaside TS – Replace M1, M2, M3, M4, M8, T19, T20 and T21 Wholesale Revenue Metering

17.1. Job Objectives

THESL is the MSP and expects to be exiting from the above mentioned HONI-owned wholesale revenue metering installations. THESL expects to abandon the above mentioned metering installations and build new low voltage installations inside Leaside TS. This proposal is for the work associated with de-registering the existing two wholesale revenue metering points and with making ready six new fully-compliant IESO wholesale metering installations

17.2. Job Scope of Work

The switchyard site is a 230/13.8 kV and 230/27.6 kV, 60 Hz TS supplying local loads. There are three (3) power transformers (T19, T20 and T21) providing step down transformation from the 230 kV system to 13.8 kV and 27.6 kV system. All are within the scope of this revenue metering upgrade.

17.3. Location

The assets being replaced are located at Leaside (TS), located in the City of Toronto, at 1080 Millwood Avenue, Toronto, Ontario, M4H 1A2.

17.4. Required Capital Costs

Estimate Number	Job Phase	Estimated Cost ($M)
TBD	Leaside TS – Replace M1, M2, M3, M4, M8, T19, T20 and T21 Wholesale Revenue Metering	$1.80
	Total:	**$1.80**

18. Proposal for Esplanade TS – Replace T11, T12 and T13 Wholesale Revenue Metering

18.1. Job Objectives

THESL is the MSP and expects to be exiting from the above mentioned HONI-owned wholesale revenue metering installations. THESL expects to abandon the above mentioned metering installations and build new low voltage installations inside Esplanade TS. This proposal is for the work associated with de-registering the existing three wholesale revenue metering points and with making ready three new fully-compliant IESO wholesale metering installations.

18.2. Job Scope of Work

The switchyard site is a 115/13.8 kV, 60 Hz TS supplying local loads. There are three power transformers (T11, T12 and T13) providing step down transformation from the 115 kV system to the 13.8 kV system. All are within the scope of this revenue metering upgrade.

18.3. Location

The assets being replaced are located at Esplanade (TS), located in the City of Toronto, at 106 Lower Sherbourne Street, Toronto, Ontario, M5A 4S8.

18.4. Required Capital Costs

Estimate Number	Job Phase	Estimated Cost ($M)
TBD	Esplanade TS – Replace T11, T12 and T13 Wholesale Revenue Metering	$0.70
	Total:	**$0.70**

19. Proposal for Terauley TS – Replace T2 and T3 Wholesale Revenue Metering

19.1. Job Objectives

THESL is the MSP and expects to be exiting from the above mentioned HONI-owned wholesale revenue metering installations. THESL expects to abandon the above mentioned metering installations and build new low voltage installations inside Terauley TS. This proposal is for the work associated with de-registering the existing two wholesale revenue metering points and with making ready two new fully-compliant IESO wholesale metering installations.

19.2. Job Scope of Work

The switchyard site is a 115/13.8 kV, 60 Hz TS supplying local loads. There are two power transformers (T2 and T3) providing step down transformation from the 115 kV system to the 13.8 kV system. All are within the scope of this revenue metering upgrade.

19.3. Location

The assets being replaced by this project are located at Esplanade (TS), located in the City of Toronto, at 532 Bay Street, Toronto, Ontario, M7A 2C7.

19.4. Required Capital Costs

Estimate Number	Job Phase	Estimated Cost ($M)
TBD	Terauley TS – Replace T2 and T3 Wholesale Revenue Metering	$0.50
	Total:	**$0.50**

20. Proposal for Strachan TS – Replace T13 and T15 Wholesale Revenue Metering

20.1. Job Objectives

THESL is the MSP and expects to be exiting from the above mentioned HONI-owned wholesale revenue metering installations. THESL expects to abandon the above mentioned metering installations and build new low voltage installations inside Strachan TS. This proposal is for the work associated with de-registering the existing two wholesale revenue metering points and with making ready two new fully-compliant IESO wholesale metering installations.

20.2. Job Scope of Work

The switchyard site is a 115/13.8 kV, 60 Hz TS supplying local loads. There are two power transformers (T13 and T15) providing step down transformation from the 115 kV system to the 13.8 kV system. All are within the scope of this revenue metering upgrade.

20.3. Location

The assets being replaced by this project are located at Strachan TS, located in the City of Toronto, at 6 Strachan Avenue, Toronto, Ontario, M6K 3N8.

20.4. Required Capital Costs

Estimate Number	Job Phase	Estimated Cost ($M)
TBD	Strachan TS – Replace T13 and T15 Wholesale Revenue Metering	$0.50
	Total:	**$0.50**

21. Measurement Canada Compliance and Smart Meter Program – Mandatory Replacement Program in 2012

21.1. Job Objectives

To maintain THESL compliance with the Minister of Energy's directive regarding smart meter installations and to remain compliant with Measurement Canada requirements for seal expired meters in 2012.

21.2. Job Scope of Work

To replace the 6,408 meters that have expired seals.

Type of Work	2012
Seal Expired Meters	6,408

21.3. Job Locations

These assets are located various specific locations dispersed throughout THESL's service area.

21.4. Required Capital Costs

Estimate Number	Job Phase	Estimated Cost ($M)
25315 25316	Meter Re-verifications and reseals - 2012	$4.80
	Total:	**$4.80**

21.5. Conclusions

This work must be completed for THESL to remain in compliance with Measurement Canada meter sealing re-verification program.

22. Measurement Canada– Mandatory Replacement Program in 2013

22.1. Job Objectives

To maintain THESL compliance with Measurement Canada requirements for seal expired meters in 2013.

22.2. Job Scope of Work

To replace the 1,709 meters that have expired seals.

Type of Work	2013
Seal Expired Meters	1,709

22.3. Job Locations

These assets are located throughout Toronto Hydro's service area.

22.4. Required Capital Costs

Estimate Number	Job Phase		Estimated Cost ($M)
24983	Re-verification Replacement - 2013		$0.90
		Total:	**$0.90**

22.5. Conclusions

This work must be completed for THESL to remain in compliance with Measurement Canada.

23. Measurement Canada Compliance– Mandatory Replacement Program in 2014

23.1. Job Objectives

To maintain THESL compliance with Measurement Canada requirements for seal expired meters in 2014.

23.2. Job Scope of Work

To replace the 5,299meters that have expired seals.

Type of Work	2014
Seal Expired Meters	5,299

23.3. Job Locations

These assets are located throughout Toronto Hydro's service area.

23.4. Required Capital Costs

Estimate Number	Job Phase		Estimated Cost ($M)
24985	Re-verification Replacement		$1.00
		Total:	**$1.00**

23.5. Conclusions

This work must be completed for THESL to remain in compliance with the Measurement Canada.

V APPENDICES

Appendix 1 – Conforming Meters List – IESO “Wholesale Revenue Metering”

Appendix 2 – Meter Lot Homogeneity Requirements

APPENDIX 1

Conforming Meter List

The *Market Rules* require each metering installation that is used for settlement purposes in the IESO-administered markets to contain meters that are of a type described on the list of conforming meters established by the IESO.

The Conforming Meter List is the list of meters that are permitted to be used as the "main" or "alternate" meter, as the case may be, in metering installations provided that all applicable conditions of acceptance as noted are met in respect of a given meter. The IESO standard *Wholesale Revenue Metering Standard - Hardware* contains a description of the functions for each of the "main" and "alternate" meters that must form part of a metering installation, and the *Market Rules* and the policies and standards established by the IESO, including the IESO standard *Wholesale Revenue Metering Standard – Hardware*, describe the accuracy and other requirements for meters and metering installations.

In addition to other requirements, the Meters included on the list have been sample tested by the IESO to verify that the meters are by design compatible with the IESO's metering communication facilities and software when the conditions of acceptance noted are met.

Metered Market Participants and Metering Service Providers are solely responsible for ensuring that their metering installations comply in all respects with the applicable provisions of the *Market Rules* and of any policy or standard established by the IESO pursuant to the *Market Rules*, including as to sealing by an accredited meter verifier and as to containing meters obtained from a manufacturer that has obtained approval of type from Measurement Canada.

Inclusion of a meter on the Conforming Meter List attached does not represent or warrant that any individual meter is accurate or complies fully with the requirements of the *Market Rules* or of any such policy or standard. The IESO reserves the right to:

- refuse registration of a metering installation in the event of non-compliance with the *Market Rules*or any such policy or standard; and
- take such other action as may be permitted by the *Market Rules* in respect of a non-compliant metering installation

even if the metering installation contains meters that are on the list attached.

Below for information purposes only and as a convenience for Metered Market Participants and Metering Service Providers, is a list of contact information for manufacturers or suppliers of meters contained on the Conforming Meter List.

Last Updated: June 8, 2011

Meters Conforming to the Requirements of the IESO Market		
Elster Metering	Make Model Firmware Version Market Category Date Listed Conditions of Acceptance	(1) ALPHA Plus (1) A1RLQ+ and A1RL+ (1) 2.3 (2) 2.4 (3) 2.7 **Alternate** (1) March 20, 2000 (2) February 9, 2004 (3) August 3, 2006 None. 2 wire accepted for 1-phase service.
Elster Metering	Make Model Firmware Version Market Category Date Listed Conditions of Acceptance	A3 ALPHA (1) A3RAL, A3RALN, A3RALNQ and A3RALQ (1) 3.03 (2) 4.02 **Alternate** (1) January 20, 2011 (2) May 30, 2011 None
Elster Metering	Make Model Firmware Version Market Category Date Listed Conditions of Acceptance	ION (1) 8300 (2) 8400 (3) 8500 (1) 8300V232 (2) 8400V232 (3) 8500V232 **Main and Alternate** August 6, 2003 None. 2.5 element accepted for missing V^2h.**Note:** Identical to PML Models 8300, 8400 and 8500 with same firmware.

GE Canada Inc.	Make Model Firmware Version Market Category Date Listed Conditions of Acceptance	GE (1) KV2 (2) KV2c (1) 1.2 (2) 1.3 **Alternate** July 7, 2004 None
Schneider Electric/PML	Make Model Firmware Version Market Category Date Listed Conditions of Acceptance	ION (1) 8300 (2) 8400 (3) 8500 (1) 8300V232 (2) 8400V232 (3) 8500V232 **Main and Alternate** August 6, 2003 None. 2.5 element accepted for missing V^2h.
	Make Model Firmware Version Market Category Date Listed Conditions of Acceptance	ION (1) 8300 (2) 8400 (3) 8500 (1) 8300V261 (2) 8400V261 (3) 8500V261 **Main and Alternate** November 7, 2005 None. 2.5 element accepted for missing V^2h.

	Make Model Firmware Version Market Category Date Listed Conditions of Acceptance	ION (1) 8300 (2) 8400 (3) 8500 (1) 8300V262 (2) 8400V262 (3) 8500V262 **Main and Alternate** November 7, 2005 None. 2.5 element accepted for missing V^2h.
	Make Model Firmware Version Market Category Date Listed Conditions of Acceptance	ION (1) 8300 (2) 8400 (3) 8500 (1) 8300V281 (2) 8400V281 (3) 8500V281 **Main and Alternate** May 1, 2008 None. 2.5 element accepted for missing V^2h.
	Make Model Firmware Version Market Category Date Listed Conditions of Acceptance	ION 8600 (1) 8600V311 (2) 8600V321 (3) 8600V332 **Main and Alternate** (1) April 11, 2006 (2) July 23, 2008 (3) Jan 20, 2011 None. 2.5 element accepted for missing V^2h.

Itron Canada	Make	QUANTUM
	Model	Q1000
	Firmware Version	2.0
	Market Category	**Alternate**
	Date Listed	March 31, 2000
	Conditions of Acceptance	Version 2.0 may not be used as Main
	Make	QUANTUM
	Model	Q1000
	Firmware Version	(1) 3.03a (2) 4.01i
	Market Category	**Main and Alternate**
	Date Listed	(1) December 21, 2000 (2) May 22, 2001
	Conditions of Acceptance	None
	Make	QUANTUM
	Model	Q1000 with RS485
	Firmware Version	4.01i
	Market Category	**Main and Alternate**
	Date Listed	May 3, 2002
	Conditions of Acceptance	Version 2.0 and 3.03a do not qualify
	Make	QUANTUM
	Model	Q1000
	Firmware Version	(1) 5.01c (2) 5.01m
	Market Category	**Main and Alternate**
	Date Listed	(1) June 10, 2002 (2) March 21, 2003
	Conditions of Acceptance	None

	Make Model Firmware Version Market Category Date Listed Conditions of Acceptance	SENTINEL SENTINEL (1) 2.050 (2) 2.053 (3) 2.070 (4) 3.21 (5) 5.0 (6) 5.02 **Alternate** (1) February 3, 2003 (2) May 26, 2003 (3) November 11, 2003 (4) July 22, 2004 (5) November 7, 2005 (6) December 3, 2007 May not daisy-chain meters utilizing phone-line sharing; Requires internal modem option.
AMETEK/Scientific-Columbus	Make Model Firmware Version Market Category Date Listed Conditions of Acceptance	AMETEK JEMStar 04.02.01 **Main and Alternate** March 4, 2008 Main meter must have Extended Memory functionality

APPENDIX 2

Measurement Canada

Category: **STATISTICAL METHODS** Specification: **S-S-06** Page: **8 of 12**

Document(s): **S-S-06 Implementation,**

Information Bulletin (2010-02-08)

Issue Date: **2010-06-21** Effective Date: **2011-01-01**

Supersedes: **PS-S-04, LMB-EG-04**

Annex A

(normative)

A.1 Lot Homogeneity Requirements

Where applicable, the meters in the lot shall be homogeneous with respect to the following characteristics:

Electricity Meters

(a) type (transformer or self contained);

(b) manufacturer and model, unless otherwise authorized in accordance with clause A.1.1;

(c) voltage or voltage range;

(d) maximum current range, unless otherwise authorized in accordance with clause A.1.1;

(e) measurement functions (e.g. measured quantities, energy, demand), unless otherwise authorized in accordance with clause A.1.1;

(f) firmware version, unless otherwise authorized in accordance with clause A.1.1;

(g) frequency rating;

(h) same model or type of telemetering device (if so equipped), unless otherwise authorized in accordance with clause A.1.1;

(i) configuration / form (i.e. number of elements*, wye, delta or auto configuration);

(j) status at time of last inspection (i.e. new, renewed, or reserviced);and

(k) seal year (same seal year or two consecutive seal years, provided both are valid);

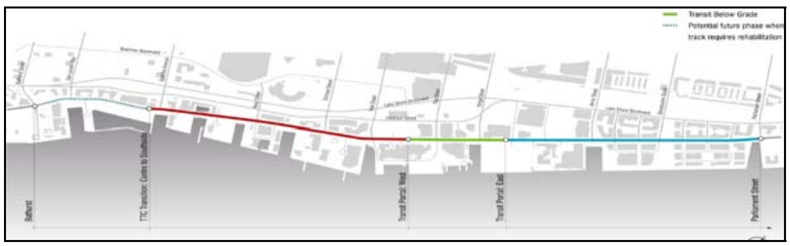
***With the exception that 1-element and 1.5-element meters may be mixed to form a lot.**

Available online at: http://strategis.ic.gc.ca/eic/site/mc-mc.nsf/vwapj/CS-S-06-eng.pdf/$file/CS-S-06-eng.pdf

ICM Project

Externally-Initiated Plant Relocations and Expansions

Waterfront Toronto



Go Transit / Metrolinx

Minsitry of Transportiation / City of Toronto

Ontario

ServiceOntario
e-Laws

Français

Public Service Works on Highways Act

R.S.O. 1990, CHAPTER P.49

Consolidation Period: From June 22, 2006 to the e-Laws currency date.

Last amendment: 2006, c.19, Sched.C, s.1 (1).

Definitions

1. In this Act,

"appliances or works" means poles, wires, conduits, transformers, pipes, pipe lines or any other works, structures or appliances placed on or under a highway by an operating corporation; ("appareils ou ouvrages")

"cost of labour" means,

Toronto Hydro-Electric System Limited (THESL)

ICM Project | Externally-Initiated Plant Relocations and Expansions

I EXECUTIVE SUMMARY

1. Project Description

Construction by governmental and other agencies within the City of Toronto frequently require THESL to relocate its facilities. In addition to relocations, externally driven construction projects provide an opportunity for THESL to expand its infrastructure for future provisions in conjunction with a relocation project. Where no relocations are required, planned expansions can often be completed as a coordinated project with the agency work. This often offers a more prudent and cost-effective solution for ratepayers. The construction initiated by the agencies includes works to maintain, upgrade, expand and improve existing public infrastructure such as roads, bridges, highways, and rail crossings. Entities initiating this work include Waterfront Toronto, the City of Toronto, the Ontario Ministry of Transportation (MTO), and GO Metrolinx (GO Transit). THESL has a responsibility to work with public entities to facilitate their projects to moving forward in a timely manner to promote the maintenance and improvement of public infrastructure.

(a) Waterfront Toronto and GO Metrolinx

Projects initiated by an organization other than a Road Authority (as defined below) are not covered under the *Public Service Works on Highways Act* (the Act). Where THESL infrastructure is on private property, or right of ways held by other organizations, individual agreements are typically reviewed on a case by case basis. This is the case with the GO Transit expansion projects discussed below where THESL infrastructure crosses the GO Transit rail right of way. Crossing agreements between utility companies and railway corporations typically indicate that the utility is required to pay 100% of relocation costs when requested to move by the railway corporation.

When requested to relocate its infrastructure, THESL works with the agencies initiating the work to find an acceptable solution to accommodate the new agency project. Where relocation is required, THESL endeavours to relocate its existing facilities on a 'like for like' basis, so as to facilitate keeping the capacity of the electrical distribution system intact.

(i) Waterfront Toronto

One particularly large segment where THESL needs to expand its infrastructure in addition to relocations is with the Central Waterfront Revitalization Project initiated by Waterfront Toronto. The segment includes the revitalization and enhancement of Queens Quay Boulevard between Yo Yo Ma Lane and Parliament Street. If THESL did not expand its infrastructure during the revitalization, THESL would likely be required to relocate certain portions of the existing infrastructure to accommodate Waterfront Toronto Plans. Concurrent expansion work is expected to satisfy the relocation requirements and increase capacity to meet anticipated growth in demand at a lower net-cost, bringing the largest benefit to the rate payers.

- Part II, Section 1 provides detailed information on the Waterfront Toronto relocation and expansion jobs.

(ii) GO Metrolinx

Another particularly large segment where GO Transit is expanding their service to Milton and the west of Toronto in a project called the Georgetown South Service Expansion and will include a rail link to Pearson Airport to be completed before the Pan Am Games. Due to this time constraint, THESL relocations need to be complete in 2012 (with one exception for Black Creek and Weston) to allow GO Transit sufficient time to expand the rail lines.

- Part II, Section 2.2 provides detailed information on the GO Metrolinx relocation jobs.

(b) Ministry of Transportation / City of Toronto

The *Public Service Works on Highways Act* (the Act) defines the obligations of companies with facilities in road allowances (Operating Corporation) and those that have responsibility to operate and maintain road allowances (Road Authority) during the course of construction (See Appendix A for a copy of the Act). When a Road Authority has a project within the road right of way, the Act obligates Operating Corporations, such as THESL, to relocate its facilities, located within the public road right of way, in cooperation with the Road Authority.

Within the City of Toronto, a Road Authority refers to the City of Toronto or the Ontario Ministry of Transportation, as applicable. A typical relocation project for a Road Authority could involve relocation of THESL infrastructure due to a City initiated road widening. The new road alignment would result in THESL poles being located within the proposed road alignment, thus THESL must relocate its existing infrastructure to avoid conflict with the road widening.

The Act provides a mechanism for negotiating the apportionment of labour costs of relocations required by Road Authorities as between the Road Authority and the Operating Corporation. Absent an agreement, the Act includes a default provision that labour costs will be apportioned equally as between the Road Authority and the Operating Corporation. Except for those labour costs, the Act provides that all other costs of the work shall be borne by the Operating Corporation. Finally, the Act provides for a mechanism to appeal unfair or unjust cost allocations to the Ontario Municipal Board for a final determination.

Under these provisions, THESL is able to negotiate such that it is responsible for 50% of the labour costs, 50% of the equipment costs, and 100% of material costs on relocation projects.

Typical relocation project cost breakdowns show that 40% to 60% of the project costs are labour and equipment costs. Generally the amount paid by the requesting Road Authority is between 20%-30% of the total project cost, based on the cost sharing outlined in the Act and a typical project cost breakdown. For the jobs described below in this document, THESL estimates that about 25% of the total job cost will be recoverable from the Road Authority, which is consistent with past experience. After the detailed design for the jobs are completed, the final recoverable amount is be determined and settled.

For projects that are initiated by a Road Authority, but are not explicitly covered under the Act, such as streetscape improvement projects, a cost sharing agreement with the Road Authority is typically negotiated. Historically, the cost recovery amount has varied considerably. For the purposes of this filing, THESL has assumed the scenario with the lowest cost recoverable that is defined by the Act. However, if THESL receives a higher contribution that is forecasted herein, the customers will only pay the net cost.

- Part II, Section 2.3 provides detailed information on the MTO relocation jobs.
- Part II, Section 2.4 provides detailed information on the City of Toronto relocation jobs.

(c) Summary of all Externally-Initiated Plant Relocation and Expansion Jobs

The schedules for jobs described in this document, and listed below, are externally driven by the requesting authorities, and not by THESL. As a result, the work to be undertaken in each year depends on the specific requests received in that year and the funding being requested through the ICM module will be used to support the work to be undertaken in a given year. These jobs represent incremental capital spending that is above and beyond that anticipated when distribution asset rates were established.

The table that follows lists both relocation jobs that THESL must undertake and expansion jobs that THESL proposes would be prudent to complete in response to infrastructure activities of external agencies. It also presents the costs that THESL will incur for these jobs and any external funding that will be provided for them pursuant to the provisions of the Act or other applicable commercial terms.

ICM Project | Externally-Initiated Plant Relocations and Expansions

Table 1: Summary of Externally-Initiated Plant Relocation and Expansion Jobs and Cost Estimates

Job Estimate Number	Job Title	Year	THESL Cost Estimate ($M)	Agency	Estimated Agency Cost ($M)
22851	Queens Quay Rebuild Phase 1	2012	$4.07	Waterfront Toronto	$0.60
22853	Queens Quay Rebuild Phase 2	2012	$4.70	Waterfront Toronto	$0.60
22854	Queens Quay Rebuild Phase 3	2012	$2.82	Waterfront Toronto	$0.60
24729	Queens Quay Rebuild Phase 4	2013	$9.73	Waterfront Toronto	$2.70
24731	Queens Quay Rebuild Phase 5	2014	$6.98	Waterfront Toronto	$1.00
23196	Metrolinx West of Hwy 27	2012	$0.23	GO Transit	$0
24079	GTS Bridge –Hwy 27	2012	$0.14	GO Transit	$0
24895	Weston Tunnel	2012	$0.47	GO Transit	$0
24784	Martin Grove Bridge	2012	$0.12	GO Transit	$0
23497	Black Creek and Weston UG Reinstatement	2014	$0.09	GO Transit	$0
23018	GO Strachan UG Crossing Civil	2012	$0.26	GO Transit	$0
24929	GO Strachan UG Crossing Civil	2012	$0.13	GO Transit	$0

ICM Project | Externally-Initiated Plant Relocations and Expansions

Job Estimate Number	Job Title	Year	THESL Cost Estimate ($M)	Agency	Estimated Agency Cost ($M)
23759	Strachan Electrical Relocation Part 1	2012	$1.98	GO Transit	$0
20124	Strachan Electrical Relocation Part 2	2012	$1.73	GO Transit	$0
20125	Strachan Electrical Relocation Part 3	2012	$1.34	GO Transit	$0
20129	Strachan Electrical Relocation Part 4	2012	$0.92	GO Transit	$0
21862	Keele St and Hwy 401-PH2- Tunnelling Under Hwy 401	2012	$1.32	MTO	$0.37
23329	Eglinton Ramp Onto Hwy 427	2012	$0.19	MTO	$0.05
22170	Dunn Ave Directional Drilling	2012	$0.56	City of Toronto	$0.16
25276	Dundas Street Overhead to Underground Phase 1 - Design	2012	$0.64	City of Toronto	$0
25280	Dundas Street Overhead to Underground Phase 2	2013	$6.86	City of Toronto	$1.91
25277	Dundas Street Overhead to Underground Phase 3	2014	$6.27	City of Toronto	$1.74

Job Estimate Number	Job Title	Year	THESL Cost Estimate ($M)	Agency	Estimated Agency Cost ($M)
24615	North West PATH Addition Phase 1	2012	$1.27	City of Toronto	$0.35
24967	North West PATH Addition Phase 2	2012-2013	$1.08	City of Toronto	$0.30
24037	Front Street Streetscape Improvement	2012	$0.41	City of Toronto	$0.11
23527	Beecroft OH Reconfiguration	2012	$0.84	City of Toronto	$0.23
24963	Lawrence Avenue Relocation	2012	$0.12	City of Toronto	$0.03
	TOTAL		**$55.27**		**$10.75**

2. Why the Project is Needed Now

According to the Act*,* THESL is obligated to relocate its infrastructure if asked to do so by the requesting Road Authority. While the date by which this relocation must be accomplished is typically negotiated with the requesting Road Authority, the Act provides a nominal allowance of only sixty days notice. Time is generally a critical element of these externally initiated projects, and THESL must strive to align its work with the overall infrastructure project schedule of the third party.

Similarly, if THESL is to complete anticipated expansion work on its facilities because it is prudent to do so concurrently with the relocation requirements to maximize efficiency for ratepayers, this work must be done within the timeline mandated by the requesting agency. There is a time-limited window to accomplish this expansion and if this window is missed, the opportunity for THESL to complete necessary and needed expansions of its required infrastructure in a cost-effective and prudent manner is likely forgone.

As the THESL relocation projects in this document are externally driven by governmental and other agencies, the main impacts from a deferral of any relocation work would be felt by the requesting agencies. Currently the City is preparing to host the Pan Am Games (the Games) in the summer of 2015, and this is driving a number of expansion and streetscape improvement projects such as the Dundas West Overheard to Underground Conversion, the Front Street Streetscape Improvement, and the North West PATH Addition. If THESL does not receive the requested ICM funding and the relocations are not completed in a timely manner in conjunction with the City construction, the broader public infrastructure projects may be delayed, and possibly postpone the project completion until after the Games therefore leaving the City in a state of construction throughout the duration of the Games.

As an example of a project being constructed for the Pan Am Games, GO Transit is preparing a large expansion across the service line that travels past the airport, allowing the addition of an Air Rail Link from Pearson International Airport to Union Station in downtown Toronto. Deferring THESL relocations along the proposed rail expansion would delay individual sections of the project, which would put the overall project completion date at risk. The GO Transit expansion must be completed by the end of 2014 to allow for testing prior to the Pan Am Games. This means that THESL relocations for this project need to be completed by the end of 2012.

Deferring externally initiated relocations to a later date will also impact THESL negatively as a company. According to the Act, THESL is required to comply with relocation requests for facilities in roadway and could face legal and financial costs associated with failure to comply. The financial costs include delay costs incurred by the requesting agency, which can be passed on to a utility that fails to comply. In addition, THESL’s reputation as a cooperative distribution utility working in the best interest of the public could suffer. This could negatively impact THESL’s working relationship with the municipal departments that issue permits for its other construction activities.

3. Why the Proposed Project is the Preferred Alternative

In general, when relocations are required THESL replaces the pre-existing facilities on a like-for-like basis. This approach is in most instances the preferred alternative because it represents the minimum investment that allows THESL to continue providing safe and reliable electricity distribution service.

Sometimes the nature of the project is such that like-for-like replacement is not the most efficient, or desired, option. In some instances the requesting agency, responsible for roadway occupancy decisions, requires THESL to relocate and underground existing overhead assets as part of an entire urban plan. In these cases, THESL reviews it obligations and options in conjunction with its future plans before it undertakes to negotiate any plant relocation and/or undergrounding. The Central Waterfront Revitalization represents an example of this type of project. Here THESL proposes relocating its underground infrastructure to accommodate facilities that were previously overhead.

For the Central Waterfront Revitalization, THESL reviewed two options. The first option was simply to undertake the relocation necessary to underground its facilities without constructing additional civil infrastructure to accommodate THESL requirements. The second, and preferred, option was to create civil infrastructure sufficient to accommodate both the relocation and THESL's future demand and system requirements.

The second option is the preferred approach for four reasons. First, the revitalization is intended to encourage future growth in this area, which will necessarily increase electrical load. The existing civil infrastructure currently installed in the area is over 60 years old and also will be insufficient to serve this increase of electrical load in the near future. It will be less expensive to construct new civil infrastructure to support this load growth at the time the work is undertaken to accommodate enhancements being done on Queens Quay.

Second, Queens Quay Boulevard is a vital utility corridor that is required to serve THESL requirements. The location of this corridor aligns with the location of the proposed Bremner Station and THESL's long term plans for system reliability and load support. The installation of new civil infrastructure along Queens Quay allows for the interconnection and contingency mitigation between downtown stations.

Third, as part of the planning for the revitalization, the Central Waterfront will be designed to meet the long-term needs of all impacted utilities (i.e., telecommunications, natural gas, sewer, and water in addition to electricity). This approach is taken to eliminate the need to re-excavate the project area for a long period of time. If THESL does not actively promote and defend its long term system plans and requirements during the early stages of the coordinated planning process, utility corridors within the road right of way will very likely become completely occupied by other parties and leave no opportunity for THESL's future expansion along Queens Quay. This would force THESL to use an alternate route, such as Lakeshore Boulevard, which would be more costly, where space is not guaranteed to be available and which would create further obstacles and challenges such as alignment constraints, feasibility and a significant increase in cost.

Lastly, the City of Toronto will impose a five-year moratorium on road cuts in the area once the revitalization is completed, which would prevent THESL from installing the additional civil infrastructure.[1] This could lead to THESL having to install more costly and less optimally located facilities to connect the emerging load.

[1] Such moratoriums are part of the *Municipal Consent Requirements for the Installation of Plant Within City of Toronto Streets*, which states:

> To ensure the long-term sustainability of the City's infrastructure, the General Manager enforces a moratorium on all newly improved streets. The moratorium ensures that the integrity of the pavement structure is protected and also serves to minimise the disruptions and inconvenience to the public resulting from repeated construction activity.

II DETAILED PROJECT INFORMATION

1. Work Related to the Central Waterfront Revitalization

1.1. Overview

As part of the Central Waterfront revitalization plan (consisting of reduced single lane traffic, refurbished Light Rail Transit Line, and a new pedestrian promenade with a double row of trees alongside the Martin Goodman Trail), Waterfront Toronto has requested that THESL remove sections of its electrical plant from Queens Quay Boulevard. For THESL to comply with the request, sections of underground assets on the north side of Queens Quay Boulevard, along with portions of existing overhead assets are to be removed or relocated in new underground conduits to accommodate new construction for the Central Waterfront revitalization.

Figure 1 – Project Boundaries

Figure 1 shows the Project Boundaries of the revitalization along with the new TTC transit plans. As a part of the project, Waterfront Toronto intends to realign and relocate several of the existing road and utility right of ways. Relocations includes telecommunications, natural gas, sewer, and water as well as accommodations for TTC street car line installations, the Martin Goodman Trail and tree planting strategies (see Appendix B for Waterfront enhancement section plans and utility impacts). Waterfront Toronto intends to ensure that all utility corridors are occupied and accounted for in this revitalization as strict restrictions in addition to any road moratoriums will be in effect following the completion of the work. As a result, if THESL does not take the opportunity to rebuild and likely expand its infrastructure in conjunction with relocation, all utility corridors and right of ways will be occupied and accounted for by other utilities with very limited possibility of installing additional plant on Queens Quay Boulevard in the future.

Consequently, THESL is proposing to increase the construction of new ducts and cable chambers beyond those that would be required solely for relocation. This increased capacity will accommodate future development and also minimize the disruptions and inconvenience to the public resulting from repeated construction activity. Once the revitalization is complete, it is unlikely that THESL will be given approval to improve infrastructure that would require road cutting or trenching within this area within the moratorium period.

The decision for THESL to expand its existing infrastructure on Queens Quay Boulevard is primarily due to the fact there has been a future need identified and driven by the anticipated load increase in the Central Waterfront and East Bayside areas. Additional supporting factors include creating a corridor to allow for the interconnection of downtown stations for contingency mitigation and system reliability. The east-west corridor that is available on Queens Quay Boulevard must be efficiently utilized for these requirements as described above as well as the connection to Bremner Station which will be discussed further below. As shown in Figure 2, Waterfront Toronto has proposed and forecasted several development sites along Queens Quay Boulevard over the next ten years.

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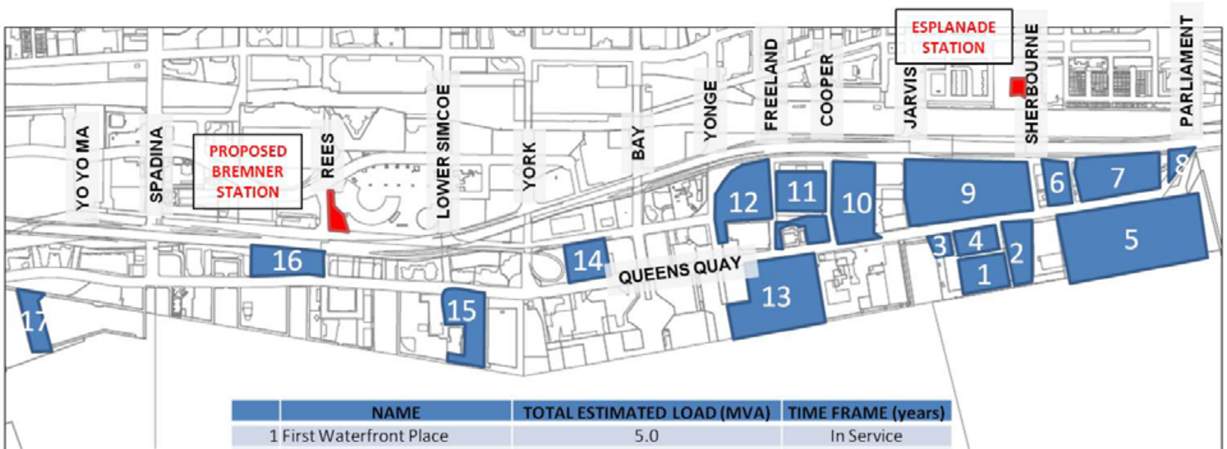


	NAME	TOTAL ESTIMATED LOAD (MVA)	TIME FRAME (years)
1	First Waterfront Place	5.0	In Service
2	George Brown College	5.9	In Service
3	Block 1	1.0	1-5
4	Block 2	3.5	1-5
5	Bayside Site	10.7	1-10
6	Parkside Site	3.7	1-5
7	Quayside Site	5.2	1-20
8	Haupert Site	2.6	1-20
9	EBF Privately Owned Site	11.4	1-10
10	Cooper St Site	8.9	TBD
11	LCBO Site	4.4	1-10
12	Ossimngton Site	9.9	1-10
13	MT27 Site	3.0	1-5
14	83 Harbour Site	6.8	TBD
15	York Quay Site	2.2	TBD
16	Rees St Parking Site	4.4	TBD
17	HFC Spadina Site	0.7	TBD

Figure 2 – Development Sites along Queens Quay Boulevard

Figure 3 shows the existing feeders in the area bounded by Jarvis Street and Parliament Street, where the initial growth is projected to occur. The most accessible feeders in the area are currently supplied from Esplanade Station and are installed in civil infrastructure on north-south routes along Jarvis Street, Sherbourne Street and Parliament Street.

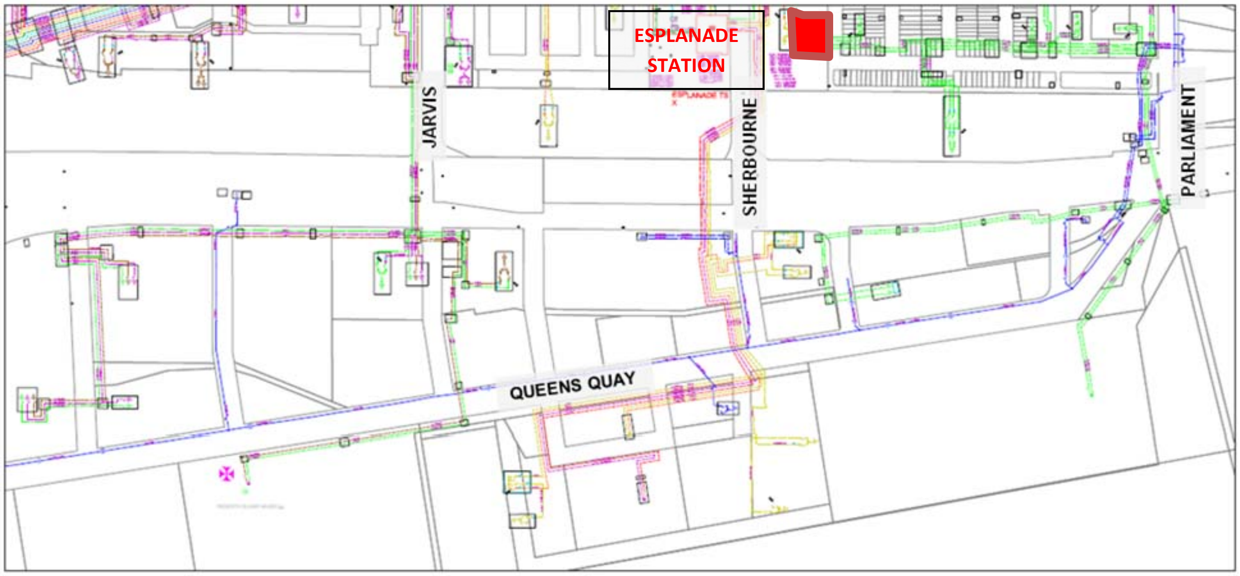


Figure 3 – Existing Feeders in Area of Growth

Figure 4 shows the projected load forecast over the next five years for all proposed development sites identified in Figure 2 along Queens Quay Boulevard. In addition, Figure 5 shows the effect on THESL's current published load forecast for Esplanade Station, if all projected loads expected over the next five years are connected there.

	NAME	TOTAL ESTIMATED LOAD (MVA)	TIME FRAME	2011	2012	2013	2014	2015	2016	2017
1	First Waterfront Place	5.0	In Service	0.50	0.50	1.00	2.00	1.00		
2	George Brown College	5.9	In Service		0.59	0.59	1.18	2.36	1.18	
3	Block 1	1.0	1-5		0.10	0.10	0.20	0.40	0.20	
4	Block 2	3.5	1-5		0.35	0.35	0.70	1.40	0.70	
5	Bayside Site	10.7	1-10		0.54	0.54	0.54	0.54	1.07	1.07
6	Parkside Site	3.7	1-5		0.37	0.37	0.74	1.48	0.74	
7	Quayside Site	5.2	1-20		0.05	0.05	0.05	0.10	0.26	0.26
8	Haupert Site	2.6	1-20		0.03	0.03	0.03	0.05	0.13	0.13
9	EBF Privately Owned Site	11.4	1-10		0.57	0.57	0.57	0.57	1.14	1.14
10	Cooper St Site	8.9	TBD	-	-	-	-	-	-	-
11	LCBO Site	4.4	1-10		0.22	0.22	0.22	0.22	0.44	0.44
12	Ossimngton Site	9.9	1-10		0.50	0.50	0.50	0.50	0.99	0.99
13	MT27 Site	3.0	1-5		0.30	0.30	0.60	1.20	0.60	
14	83 Harbour Site	6.8	TBD	-	-	-	-	-	-	-
15	York Quay Site	2.2	TBD	-	-	-	-	-	-	-
16	Rees St Parking Site	4.4	TBD	-	-	-	-	-	-	-
17	HFC Spadina Site	0.7	TBD	-	-	-	-	-	-	-
	TOTAL PROJECTED NEW LOAD				3.61	3.61	5.32	8.82	7.45	4.03

Figure 4 – Load Forecast for Development Sites along Queens Quay Boulevard

	2011	2012	2013	2014	2015	2016	2017
LOAD FORECAST FOR A1-2X BUS	59.00	60.00	63.00	65.00	66.00	68.00	69.00
NEW LOAD FROM DEVELOPMENT SITES	0.00	3.61	3.61	5.32	8.82	7.45	4.03
FORECASTED LOAD PLUS NEW LOAD	59.00	63.60	66.60	70.30	74.80	75.50	73.00
BUS CAPACITY OF A1-2X	69.00						

Figure 5 – Load Forecast for Esplanade Station (all values in MVA)[2]

Figure 5 demonstrates that if all projected new load were to be connected to Esplanade Station using existing infrastructure, by year 2014 the existing bus would exceed the station rated capacity of 69MVA. The overload values are highlighted in red.

[2] Note that in both Figures 4 and 5, the demand contributed by First Waterfront Place is not included in the total projected new load as it is already included in the current load forecast for A1-2X Bus in Figure 5.

As a result of the projected overloading on bus A1-2X, THESL will be required to service the projected load via another adjacent station. As shown in Figure 2, the proposed Bremner Station is in close proximity and the growth will be centered along Queens Quay Boulevard making the right of way the most logical and efficient route to serve the new load. The existing designs for the civil infrastructure egress from Bremner Station have also identified Rees Street south to Queens Quay Boulevard as an ideal egress point. Rebuilt and expanded civil infrastructure along the Queens Quay corridor would allow THESL to have a large and secure west-east route for feeders originating from Bremner Station.

Figure 6 shows the existing THESL civil infrastructure at Queens Quay Boulevard and Rees Street. This intersection is one of the main civil egress points for Bremner Station. Currently only a 3W3H duct bank (three ducts wide, three duct high, total of nine ducts) running west-east exists at this intersection. In addition, the existing chambers shown are all Type 5 chambers (2.5 metres x 4.0 metres) that were built in 1954, making the existing infrastructure over 60 years of age. Four feeders originating from Windsor Station, two circuits of secondary services, telecom cables and the system neutral currently occupy eight of the nine ducts this duct bank. Therefore, there is essentially no civil duct capacity for new feeders originating at Bremner TS.

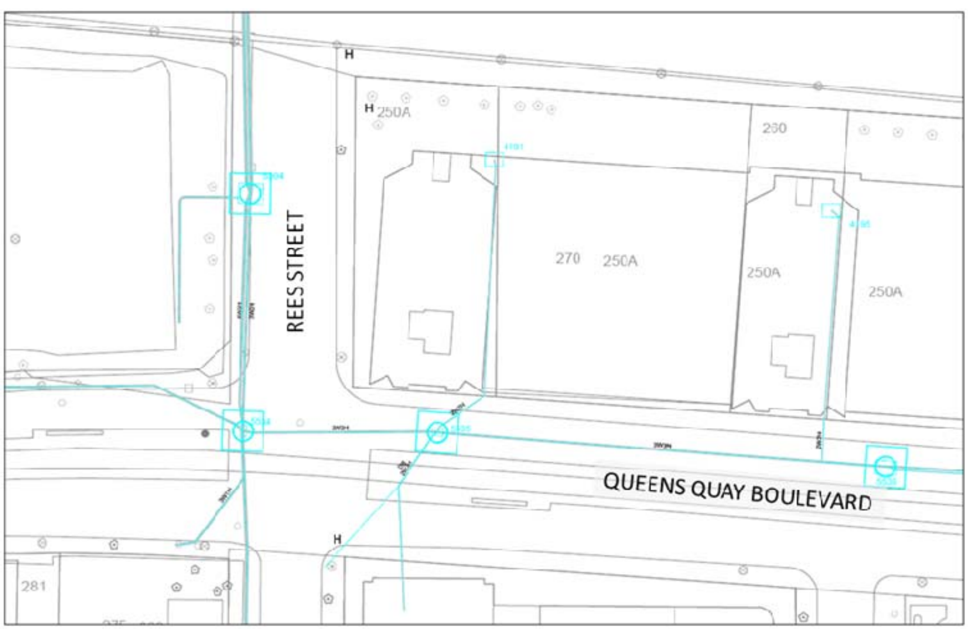


Figure 6 – Existing Civil Infrastructure at Queens Quay Boulevard and Rees Street

If only the required infrastructure for relocation is built at the present time, THESL will be limited by the existing civil infrastructure along Queens Quay Boulevard. This civil infrastructure, as detailed in Figure 6, is undersized and insufficient to accommodate existing circuits plus the additional feeders required to serve the loads anticipated along Queens Quay Boulevard shown in Figure 2.

The restrictions and possible lack of space along the new revitalized Queens Quay Boulevard from Yo Yo Ma Lane to Parliament Street would prevent THESL from utilizing that route unless new ducts and chambers are added as part of the Queens Quay refurbishment. Otherwise, additional capital funds will have to be spent in future years for THESL to install the necessary new civil infrastructure for new feeders to supply customers via Bremner TS.

This new civil infrastructure would, in turn, require new trenching along major routes such as York Street and Lakeshore Boulevard in order to access the high growth areas. This work would be significantly more costly because while the distance to be covered along Lakeshore is similar to that for Queens Quay Boulevard, additional work would be required on York Street. Moreover, Lakeshore is a higher traffic route resulting in more complex construction and maintenance restrictions. Overall, the long term costs associated with this approach are significantly higher than the costs associated with installing the necessary facilities as part of the expansion along Queens Quay Boulevard.

1.2. Business Case Evaluation (BCE) Results

The total cost for THESL to perform the relocations as requested by Waterfront Toronto and increase the duct capacity and civil infrastructure for future requirements is estimated at $33.80M. This estimate can be divided into two portions. Portion 1, to be funded one hundred percent by Waterfront Toronto, is estimated at $5.50M and includes the civil and electrical plant relocation based on preliminary design during project development and alignments proposed by Waterfront Toronto. Portion 2, required by THESL estimated at $28.30M and includes the expansion to a 32-duct 3.2 kilometre duct bank along Queens Quay Boulevard from Yo Yo Ma Lane to Parliament Street, approximately 55 cable chambers, all associated structure stabilization and all required road crossings.

Alternatively, the total cost involved for THESL to perform only the relocations required, and then in future years construct new infrastructure to meet demand is an estimated $43.30M. Similar to the scenario described above, this estimate includes a $5.50M portion to be fully paid for by Waterfront Toronto for the proposed civil and electrical relocation. In addition, it also includes an estimated $37.80M THESL portion for a 24-duct 3.2 kilometre duct bank along Lakeshore Boulevard from Yo Yo Ma Lane to Parliament Street, approximately 45 cable chambers, all associated structure stabilization and all required road crossings, plus the rebuild of approximately 150 metres and 300 metres of civil infrastructure on York Street and Parliament Street respectively for distribution customer servicing.

The projected savings of an estimated $9.50M arise because of the cost savings from not executing construction on Lakeshore Boulevard as well as the elimination of new facilities on York Street and Parliament Street. Compared to Queens' Quay, Lakeshore Boulevard is a main roadway with work restrictions that would result in escalated costs and complex construction requirements. In addition, by performing its civil infrastructure activities in alignment with external parties' required work, potential customer disruptions can be minimized.

The requested funds for the THESL expansion in both scenarios are initially driven from third parties as a result of their relocation activities which are performed at their expense. THESL, in turn, must respond to these third-party investments performing immediate expansion of THESL-owned infrastructure located in these same locations to address future growth considerations. If THESL does not take immediate action to address these assets, due to restrictions that are placed by the third parties (such as Waterfront Toronto) following the execution of their projects, THESL risks being unable to address the immediate load growth concerns and future source of supply for customers.

All costs identified above for both scenarios include work required for relocation as requested by Waterfront Toronto and work associated to additional expansion required by THESL. Only the incremental capital required by THESL is being justified in this Business Case and does not include the portion of relocation work to be one hundred percent funded by Waterfront Toronto.

Given that THESL must undertake the relocation and expansion work on Queens Quay Boulevard, installing sufficient duct capacity to meet future needs is the most prudent approach for ratepayers. In addition, it will result in strategically located facilities that are optimally integrated with the planned Bremner TS. It will also minimize construction disruption for the neighbourhood area. In contrast, if future needs are not addressed, THESL will have insufficient ducts and associated facilities to supply new customers along Queens Quay Boulevard and will be forced to construct more expensive facilities in undesirable locations that will not support or strengthen THESL's distribution system.

1.3. Detailed Descriptions of Specific Central Waterfront Revitalization Jobs

Table 2: Waterfront Revitalization Jobs and Cost Estimates (2012-2014)

Estimate Number	Job Title	THESL Cost Estimate ($M)
22851	Queens Quay Rebuild Phase 1 (2012)	$4.07
22853	Queens Quay Rebuild Phase 2 (2012)	$4.70
22854	Queens Quay Rebuild Phase 3 (2012)	$2.82
24729	Queens Quay Rebuild Phase 4 (2013)	$9.73
24731	Queens Quay Rebuild Phase 5 (2014)	$6.98
	TOTAL	**$28.30**

The scope of work for this entire expansion project includes constructing a new 32-duct 3.2 kilometre duct bank along the south side of Queens Quay Boulevard from Yo Yo Ma Lane to Parliament Street. The duct bank to be constructed will be designed as two 4x4 duct banks with associated cable chambers required for splicing and jointing. Approximately 55 cable chambers and structure stabilization material, such as Helix Anchors and piles for cable chamber installation, will be required as a part of this project.

For the section of work between York Street and Yonge Street, there will be additional design and construction complexities associated due to the underground streetcar tunnel access to Union Station that exists along Queens Quay Boulevard between York Street and Bay Street. The cost of the preliminary design includes funds required for directional drilling, tunnelling as well as structure stabilization in order to mitigate the impacts to TTC structures and assets.

In addition, a number of road crossings at each major intersection (Spadina Street, Rees Street, Lower Simcoe Street and York Street) and several smaller intersections (Cooper Street, Jarvis Street, Lower Sherbourne Street and Bonnycastle Street) as well at customer locations will also be constructed as a part of the scope of work. THESL's costs for this expansion project is projected to be $28.30M.

Figure 7 through 9 show the proposed new 3.2 kilometre trench and duct bank layout outlined in red along with proposed double chamber locations.

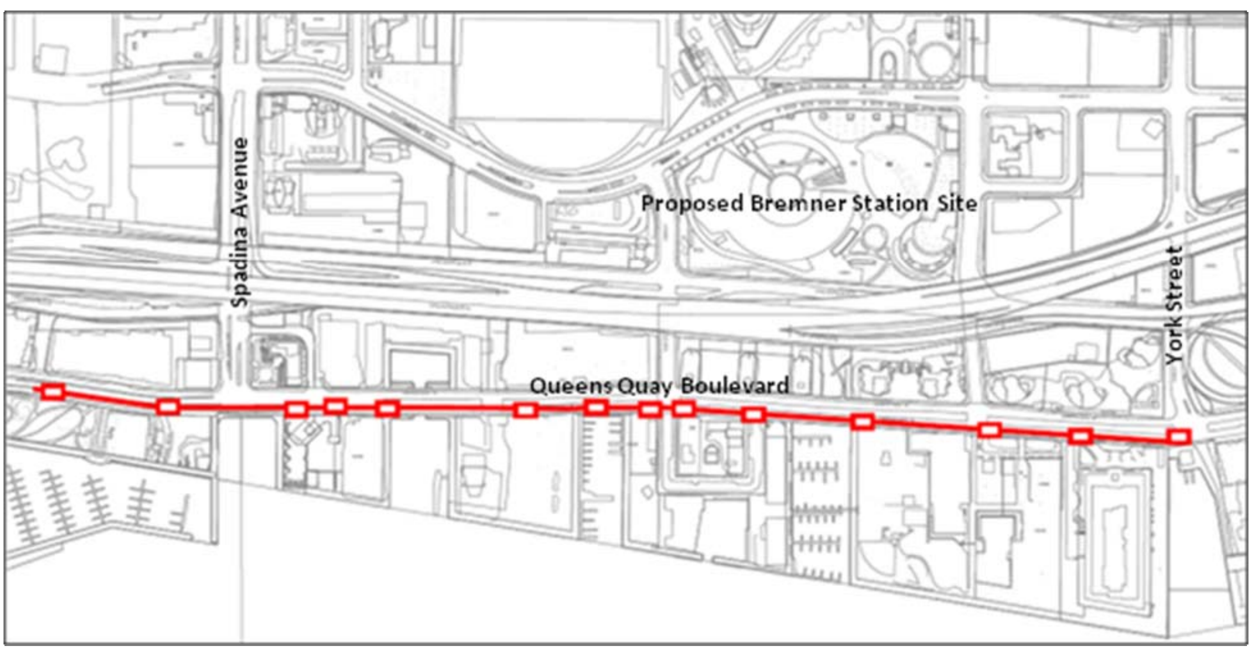


Figure 7 –Proposed Area of Work from Yo Yo Ma Lane to York Street

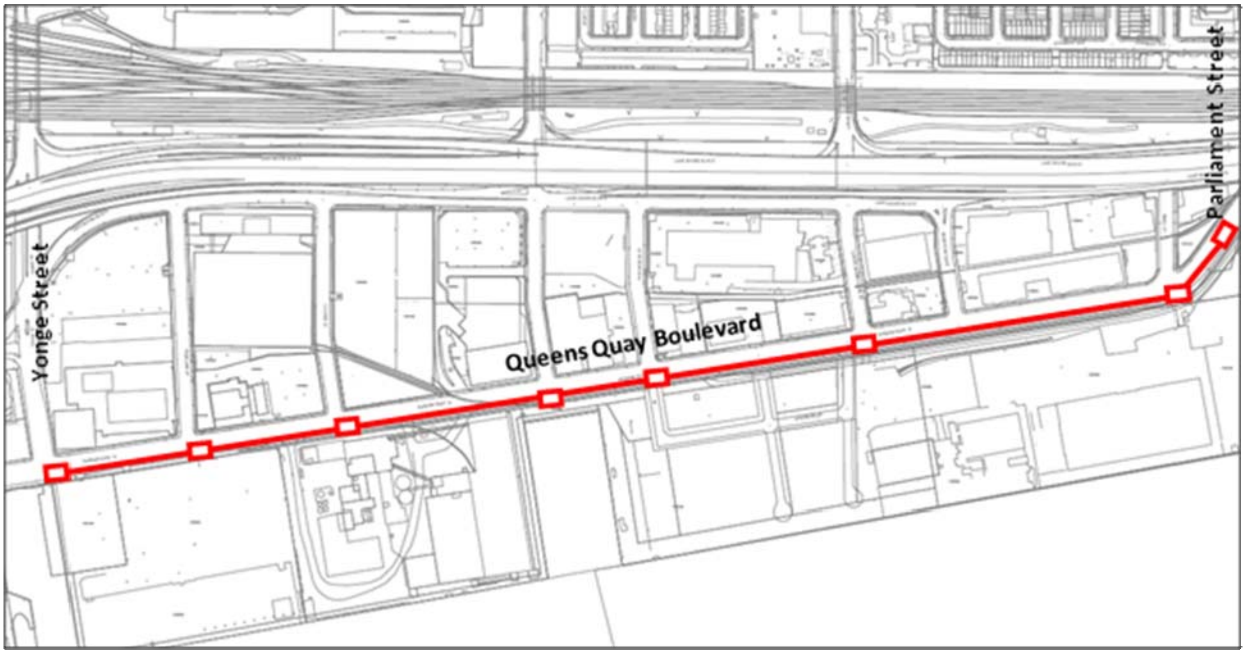


Figure 8 – Proposed Area of Work from Yonge Street to Parliament Street

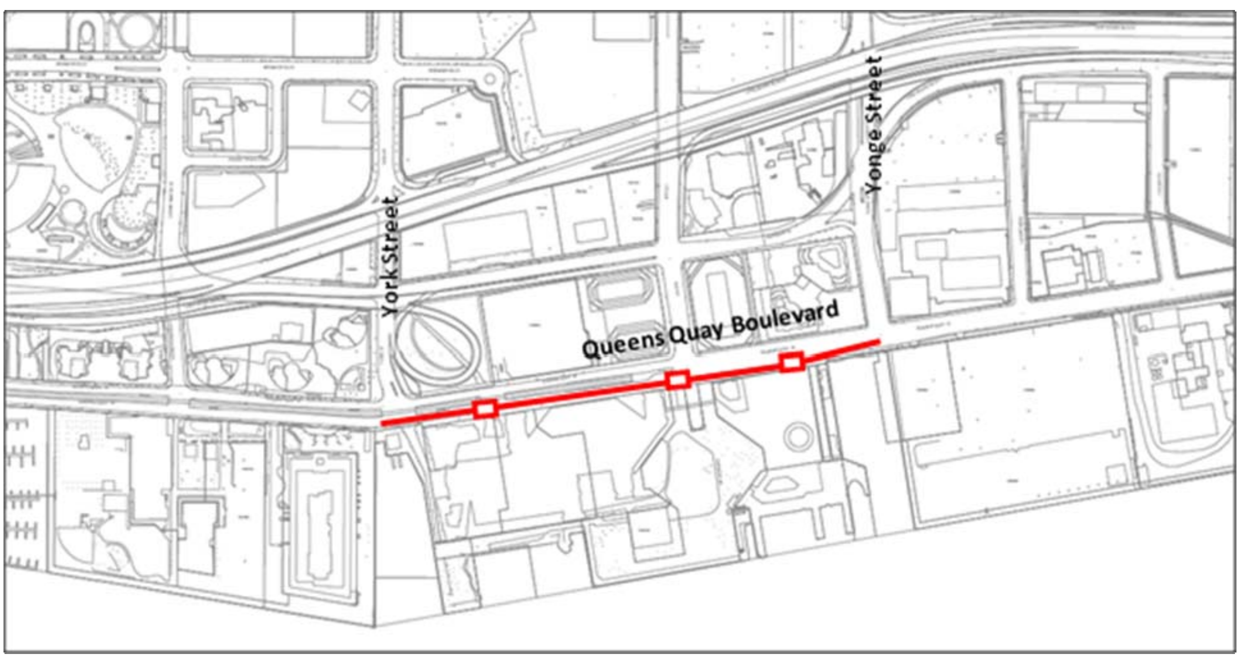


Figure 9 – Proposed Area of Work from York Street to Yonge Street

Construction is anticipated to start in the second quarter of 2012. This has been requested by Waterfront Toronto in order to align with its construction timelines which is slated to begin in spring 2012.

2. Externally Driven Relocation Jobs

2.1. Introduction

This initiative covers relocations requested by The City of Toronto, the MTO and GO Transit, to allow their infrastructure projects to proceed on schedule. The THESL facilities impacted by these projects are replaced on a case by case basis to ensure that current system capability and capacity are maintained. At each project location, the needs and requirements from the requesting agency are reviewed and compared with THESL's needs and requirements to determine what relocation options are available, optimizing constraints such as cost, schedule and system risk to achieve the objective of eliminating the project conflict. These include various relocation routes as well as the possibility of supporting and protecting THESL facilities in place as opposed to a relocation project.

In the sections below, THESL describes the jobs that it proposes be undertaken and associated capital spending to accomplish the relocation work necessitated by GO Transit, Ministry of Transportation and the City of Toronto projects. The amount of THESL's proposed capital spending and the agency's contribution, if any, are shown in the Table below. In sum, THESL's total capital spending on these jobs is projected at $26.97M with an additional $5.25M being spent by the initiating agencies through cost sharing arrangements.

Table 3: Summary of Externally Initiated Relocation Projects (all jobs)

Agency	THESL Cost Estimate ($M)	Estimated Agency Cost ($M)
GO Transit	$7.41	$0.00*
Ministry of Transportation	$1.51	$0.42
City of Toronto	$18.05	$4.83
TOTALS	$26.97	$5.25

* Crossing agreements between utility companies and railway corporations typically indicate that the utility is required to pay 100% of relocation costs when requested to move by the railway corporation.

2.2. GO Transit and Metrolinx Relocation Jobs

GO Transit is expanding their service to Milton and the west of Toronto in a project called the Georgetown South Service Expansion and will include a rail link to Pearson Airport to be completed before the Pan Am Games. Due to this time constraint, THESL relocations need to be complete in 2012 (with one exception for Black Creek and Weston) to allow GO Transit sufficient time to expand the rail lines.

There are six main areas of relocations associated with the Georgetown South Service Expansion where THESL has been requested to do work. These are:

- (i) West of Hwy 27 (2012)
- (ii) GTS Bridge –Hwy 27 (2012)
- (iii) Weston Tunnel (2012)
- (iv) Martin Grove Bridge (2012)
- (v) Black Creek and Weston Rd-UG Reinstatement (2014)
- (vi) Strachan Avenue Relocation (2012)

The largest of these jobs, the relocation at Strachan Avenue, is divided up into six individual jobs for a total of 11 jobs.

GO Transit Initiated Relocation Jobs

Table 4: Summary of GO Transit and Metrolinx Relocation Jobs and Costs (2012-2014)

Job Estimate Number	Job Title	Job Year	THESL Cost Estimate ($M)	Agency	Estimated Agency Cost*
23196	Metrolinx West of Hwy 27	2012	$0.23	GO Transit	$0
24079	GTS Bridge –Hwy 27	2012	$0.14	GO Transit	$0
24895	Weston Tunnel	2012	$0.47	GO Transit	$0
24784	Martin Grove Bridge	2012	$0.12	GO Transit	$0
23497	Black Creek and Weston UG Reinstatement	2014	$0.09	GO Transit	$0
23018	GO Strachan UG Crossing Civil	2012	$0.26	GO Transit	$0
24929	GO Strachan UG Crossing Civil	2012	$0.13	GO Transit	$0
23759	Strachan Electrical Relocation Part 1	2012	$1.98	GO Transit	$0
20124	Strachan Electrical Relocation Part 2	2012	$1.73	GO Transit	$0
20125	Strachan Electrical Relocation Part 3	2012	$1.34	GO Transit	$0
20129	Strachan Electrical Relocation Part 4	2012	$0.92	GO Transit	$0
	TOTALS		**$7.41**		**$0**

* Crossing agreements between utility companies and railway corporations typically indicate that the utility is required to pay 100% of relocation costs when requested to move by the railway corporation.

2.2.1. West of Highway 27 (2012):

This job is intended to resolve the conflict between THESL's overhead primary lateral lines extending west from Highway 27 along the north right of way parallel with the GO Transit railway.

2.2.2. GTS Bridge Highway 27 (2012):

This job is to clear the work zone in order to accommodate the GO rail bridge expansion at Highway 27. The existing aerial hydro line will need to be temporarily relocated as a result of a potential conflict with pile-driving equipment during construction.

2.2.3. Weston Tunnel (2012):

The Weston Tunnel project is from Lawrence Avenue to Church Street, where GO Transit is lowering the tracks to create a tunnel effect through the area. GO Transit requested that utilities remove their infrastructure that crosses the tracks at these locations. This was not possible for THESL, so a compromised solution was reached. The John Street crossing is being removed, and the Lawrence Avenue crossing is being expanded to accommodate the load from the former John Street Crossing. There is no THESL infrastructure at King Street and on Church Street, so GO Transit agreed to allow THESL infrastructure to cross, provided that 60 foot poles were installed to allow clearance between the wires and the work zone.

2.2.4. Martin Grove Bridge (2012):

This job is to clear the work zone in order to accommodate the GO Transit rail bridge expansion at Martin Grove Road. The existing aerial hydro line will need to be temporarily relocated as a result of conflict with pile-driving equipment during construction.

2.2.5. Black Creek and Weston Road – UG Reinstatement (2014):

GO Transit is upgrading the bridge crossing at Black Creek Drive, and THESL has infrastructure crossing under the existing bridge north of Weston Road and east of Black Creek Drive. GO Transit has requested that THESL remove the duct bank temporarily while they are constructing the foundation of the new rail bridge. Upon completion of the GO Transit bridge work, THESL intends to rebuild the duct bank crossing the rail right of way. This is expected to allow the distribution system to return to a normal state, as various feeder loading routes are being altered to allow the duct bank to be removed.

2.2.6. Strachan Avenue Relocation (2012):

Strachan Avenue is a main supply artery for THESL to serve several commercial and residential customers in the Liberty Village and Trinity-Bellwoods areas from Strachan Station, with a total of 60 ducts crossing under the railway at Strachan Avenue. These ducts are separated into three separate duct runs along Strachan Avenue, a 24 duct structure on the east side and two 18 duct structures on the west side. Within these ducts there are five 4kV feeders and sixteen 13.8kV feeders, for a total of 21 feeders crossing under the railway.

These ducts and feeders need to be relocated to accommodate GO Transit lowering the grade of the current tracks by five meters. THESL proposes to relocate the feeders along Western Battery Road and tunnelling under the tracks to Douro Street. Due to the extent of the civil and electrical work involved with this relocation, it was divided into the following six projects; GO Strachan UG Crossing Civil, GO Strachan Crossing Feeder Relocate – Civil, Strachan Electrical Relocations Part 1(Relocate Feeders Serving Dafoe MS), Strachan Electrical Relocations Part 2 (Relocate B11T/B9T/B2T/B3T/B6T), Strachan Electrical Relocations Part 3 (Relocate A22T/A49T/A53T), and Strachan Electrical Relocations Part 4 (Relocate A25T/A27T/A29T/A31T.)

The first two jobs are to install new civil infrastructure in order to relocate the required feeders. This involves the construction of a new one kilometre 24-duct concrete encased duct bank with associated cable chambers. In addition, it also includes the installation of a new tunnel crossing approximately 500 metres west of the existing rail crossing at Strachan Avenue.

The four electrical jobs are expected to utilize the new civil infrastructure as described above to divert and relocate the existing feeders crossing the tracks at Strachan Avenue. These jobs involve the pulling and installation of new cable, splicing and re-connecting to the existing cable and any associated load transfers required.

ICM Project | Externally-Initiated Plant Relocations and Expansions

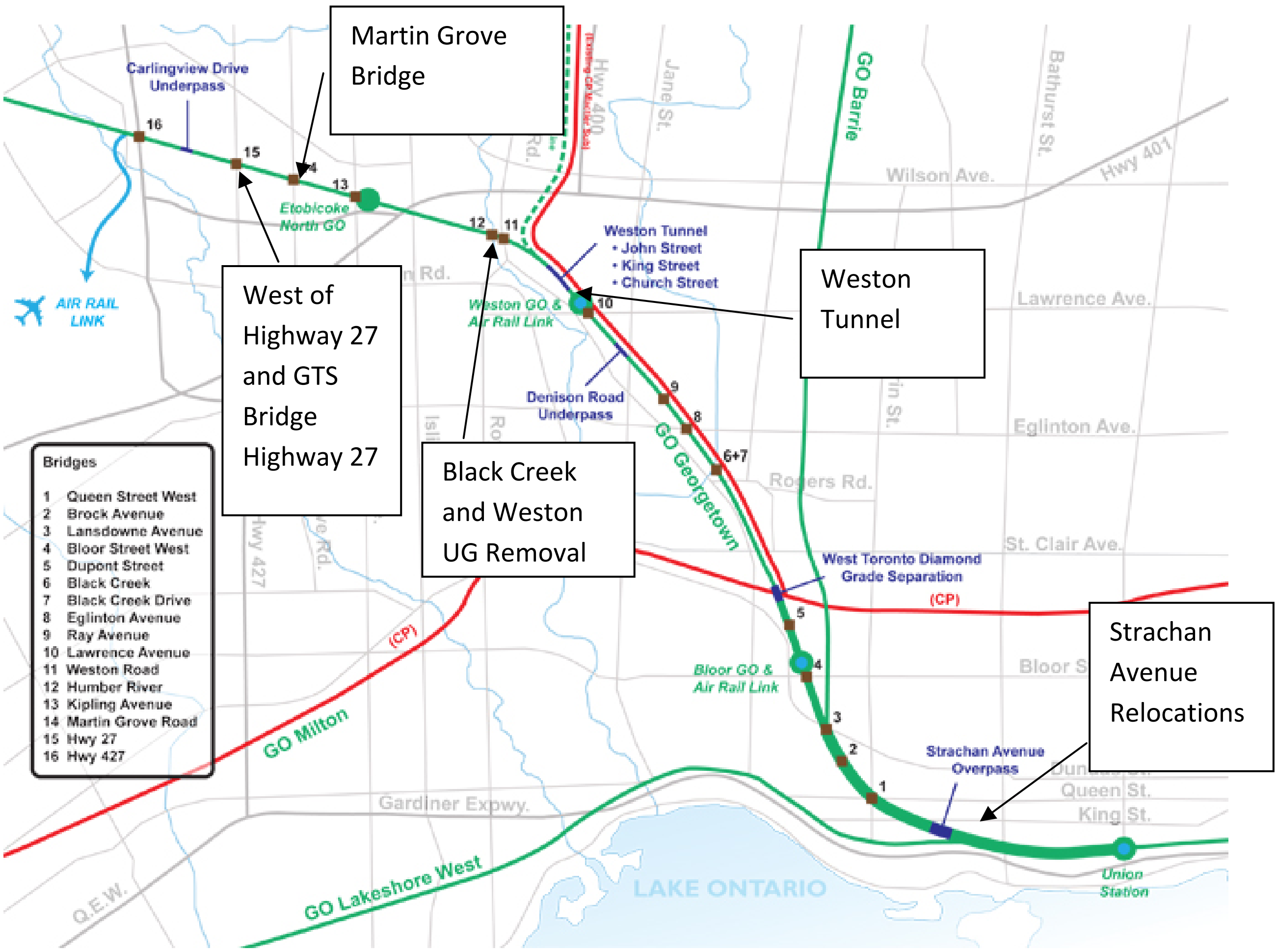


Figure 10: GO Transit Georgetown South Service Expansion Projects

2.3. Ministry of Transportation Relocation Jobs

The Ministry of Transportation is undertaking a number of infrastructure jobs to rehabilitate bridges, highway overpasses and highways in the City of Toronto. Some of these projects require THESL to relocate its facilities according the jobs listed in the following table and described below.

MTO Initiated Relocation Jobs

Table 5: Summary of MTO Relocation Jobs and Costs (2012)

Job Estimate Number	Job Title	Job Year	THESL Cost Estimate($M)	Agency	Estimated Agency Cost ($M)
21862	Keele St and Hwy 401- PH2- Tunnelling Under Hwy 401	2012	$1.32	MTO	$0.37
23329	Eglinton Ramp Onto Hwy 427	2012	$0.19	MTO	$0.05
	TOTALS		**$1.51**		**$0.42**

The map below shows the locations of the MTO infrastructure projects and the associated THESL jobs to relocate facilities.

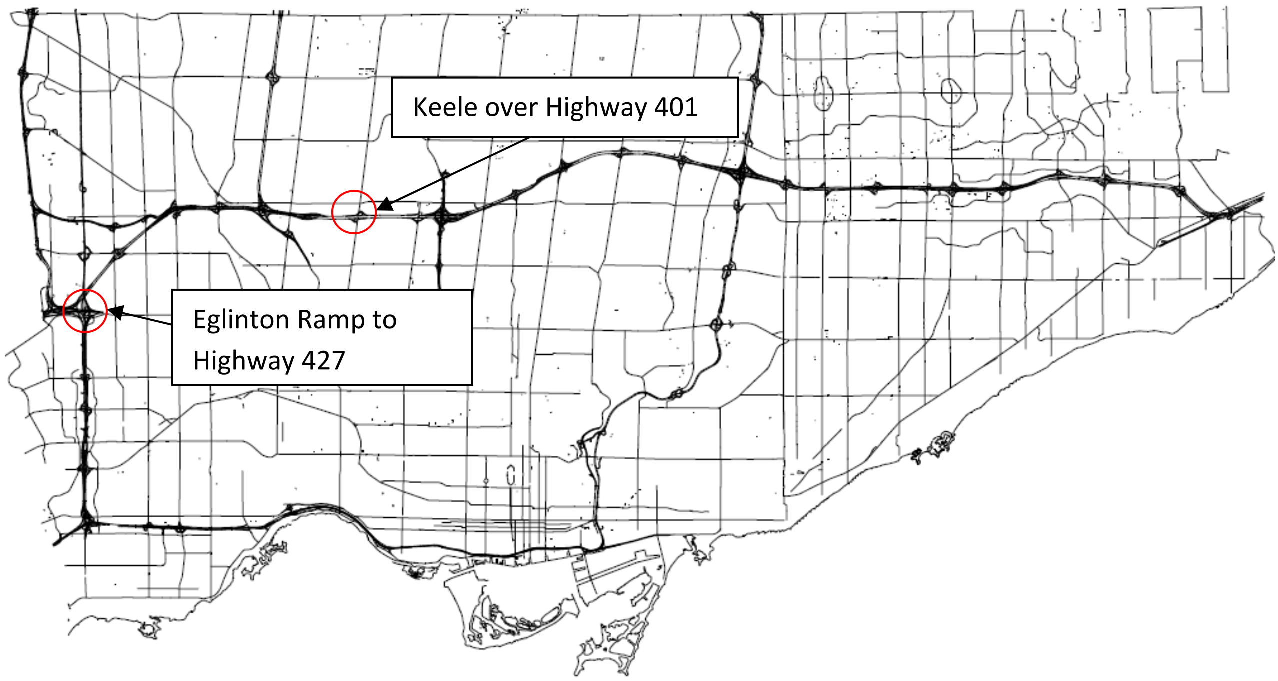


Figure 11: MTO Jobs

2.3.1. Keele Street Bridge Phase 2, Tunnelling Under Hwy 401

This job is where the MTO is rehabilitating the Keele Street Bridge over Highway 401. MTO requires that utilities are not permitted within the bridge structure so THESL is relocating under Highway 401. To accomplish this, there is a tunnel being constructed under Highway 401, large enough to accommodate nine 100mm ducts. The tunnel is approximately 200m east of the Keele Street Bridge. The tunnel design conforms to MTO requirements as stipulated within the *Guidelines for Foundation Engineering – Tunnelling Specialty for Corridor Encroachment Permit Application* document.

2.3.2. Eglinton Ramp onto Hwy 427

This job is where Highway 427 crosses over Eglinton Avenue on an overpass. The MTO is building a ramp to Highway 427 southbound, intended to be used by buses.

In order to accommodate a new access ramp to Highway 427 as proposed by the MTO, THESL has been requested to lower existing conduit structures and one cable chamber where the new ramp will be located on Eglinton Avenue in order to maintain the minimum clearance requirement of 800 mm as required by THESL standard 31-0300 (refer to Appendix C).

2.4. City of Toronto Relocation Jobs

The City of Toronto is undertaking a number of infrastructure projects to rehabilitate bridges, streets and public pathways in the City of Toronto. Some of these projects require THESL to relocate its facilities according the jobs listed in the following table and described below.

Table 6: Summary of City of Toronto Relocation Jobs and Costs (2012-2014)

Job Estimate Number	Job Title	Job Year	THESL Cost Estimate ($M)	Agency	Estimated Agency Cost ($M)
22170	Dunn Ave Directional Drilling	2012	$0.56	City of Toronto	$0.16
25276	Dundas Street Overhead to Underground Phase 1 - Design	2012	$0.64	City of Toronto	$0
25280	Dundas Street Overhead to Underground Phase 2	2013	$6.86	City of Toronto	$1.91
25277	Dundas Street Overhead to Underground Phase 3	2014	$6.27	City of Toronto	$1.74

ICM Project | **Externally-Initiated Plant Relocations and Expansions**

Job Estimate Number	Job Title	Job Year	THESL Cost Estimate ($M)	Agency	Estimated Agency Cost ($M)
24615	North West PATH Addition Phase 1	2012	$1.27	City of Toronto	$0.35
24967	North West PATH Addition Phase 2	2012-2013	$1.08	City of Toronto	$0.30
24037	Front Street Streetscape Improvement	2012	$0.41	City of Toronto	$0.11
24963	Lawrence and Allen Pole Relocation	2012	$0.12	City of Toronto	$0.03
23527	Beecroft OH Reconfiguration	2012	$0.84	City of Toronto	$0.23
			$18.05		**$4.83**

City of Toronto Initiated Relocation Jobs

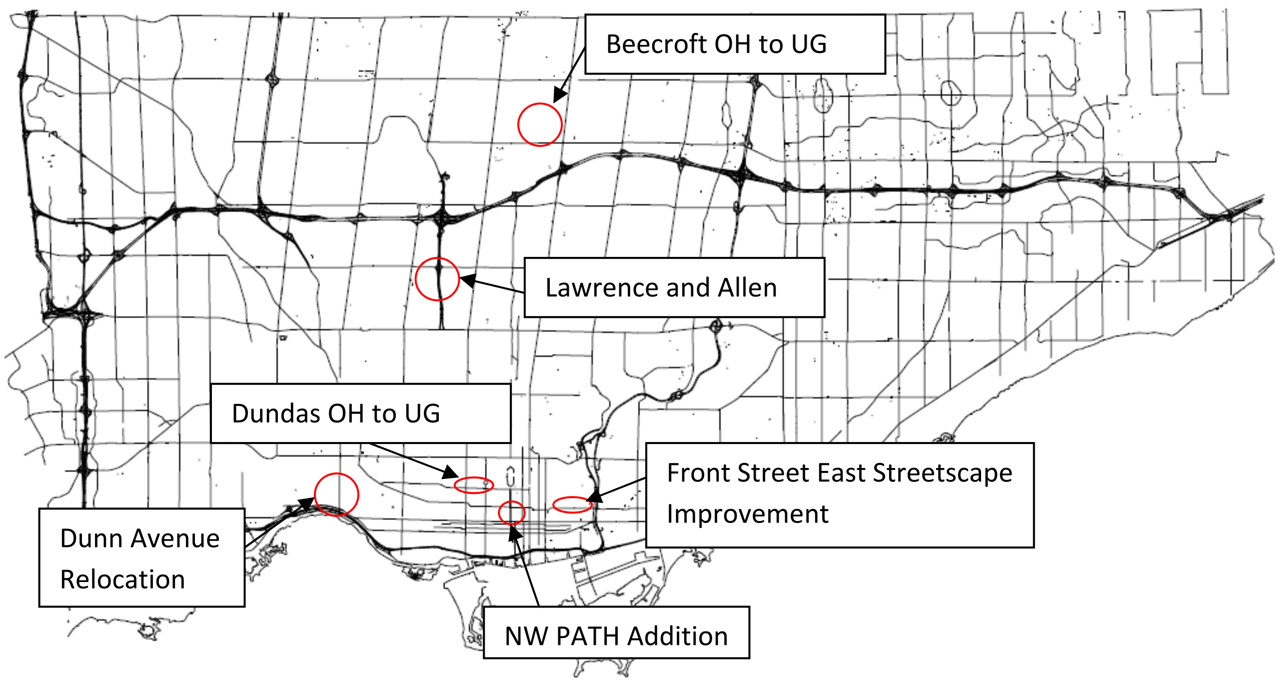


Figure 12 – City Projects

2.4.1. Dunn Avenue Bridge over the Gardiner Expressway (2012):

The City of Toronto was rehabilitating the bridge over Gardiner Expressway and requested that THESL relocate existing ducts that were buried in the sidewalk of the bridge. To accommodate this request THESL and the City of Toronto agreed to relocate the ducts in a new 90-metre long duct structure under the Gardiner Expressway. The circuit has been temporarily relocated overhead to accommodate the bridge rehabilitation. Once the relocation construction is finished, the feeders are expected to be transferred to the new permanent infrastructure located under the Gardiner Expressway. The job is required to be completed in 2012.

2.4.2. Dundas West Overhead To Underground Relocation Phases 1 to 3 (2012-2014):

This job is on Dundas Street West from Bathurst Street to University Avenue and it is part of City of Toronto revitalization capital program. The City of Toronto will be rebuilding a watermain and completing a sidewalk replacement along this stretch of road and have requested that THESL relocate its overhead infrastructure underground. THESL expects it will be required to install approximately 2,000 metres of civil duct, 40 cable chambers, ten transformer vaults, 2,000 metres of underground circuits and multiple underground service points. The job is required to start design in 2012.

2.4.3. North West Path Addition Phases 1 and 2 (2012-2013):

The North West PATH is a new underground extension to the City of Toronto underground PATH network from Union Station to Wellington Street via York Street. This expansion will provide additional capacity to accommodate the growing numbers of pedestrians accessing Union Station from the downtown core. The City of Toronto has requested that THESL relocates its infrastructure that is in conflict with proposed work from the intersection of York Street and Front Street to York Street and Wellington Street. Approximately 550m of duct and 13 cable chambers will have to be relocated, rebuilt or supported, for this project. North of the intersection at Front Street and York Street, much of the THESL infrastructure can be supported as opposed to relocated. Phase one of the project is required to be complete in 2012, while phase two is required to be completed in 2013.

2.4.4. Front Street East Streetscape Improvement (2012):

This project is to convert all THESL poles to decorative type poles on the south side on Front Street East between Sherbourne Street and Parliament Street. On this stretch of Front Street East, the majority of the poles are not the conventional direct buried poles, but rather these poles are mounted in a reinforced sidewalk bay, which add challenges to the relocation. The project also involves rerouting secondary conductors impacted by the project. The project is required to be completed in 2012.

2.4.5. Lawrence Avenue and Allen Road Pole Relocation (2012):

The City of Toronto is in the initial construction phases for the Lawrence-Allen Revitalization project. This plan involves redeveloping the area around Lawrence Avenue and Avenue Road. The first stage of this revitalization project is modifications to Lawrence Avenue, where an additional right turn lane is being added. Three THESL poles, and the associated underground services from the poles, require relocation to allow for the road expansion.

2.4.6. Beecroft Overhead to Underground Relocation (2012):

The City of Toronto expropriated land between Ellerslie Avenue and Hounslow Avenue to allow for the extension of Beecroft Road. The City requested that all THESL infrastructure be relocated from overhead to underground at locations where it crosses the extended Beecroft Road. This relocation includes civil construction and electrical work at three intersections – Churchill Avenue, Horsham Avenue and Hounslow Avenue.

APPENDIX A

Public Service Works on Highways Act, 1990

Ontario

ServiceOntario
e-Laws

Français

Public Service Works on Highways Act

R.S.O. 1990, CHAPTER P.49

Consolidation Period: From June 22, 2006 to the e-Laws currency date.

Last amendment: 2006, c.19, Sched.C, s.1 (1).

Definitions

1. In this Act,

"appliances or works" means poles, wires, conduits, transformers, pipes, pipe lines or any other works, structures or appliances placed on or under a highway by an operating corporation; ("appareils ou ouvrages")

"cost of labour" means,

(a) the actual wages paid to all workers up to and including the foremen for their time actually spent on the work and in travelling to and from the work, and the cost of food, lodging and transportation for such workers where necessary for the proper carrying out of the work,

(b) the cost to the operating corporation of contributions related to such wages in respect of workers' compensation, vacation pay, unemployment insurance, pension or insurance benefits and other similar benefits,

(c) the cost of using mechanical labour-saving equipment in the work,

(d) necessary transportation charges for equipment used in the work, and

(e) the cost of explosives; ("coût de la main-d'oeuvre")

"operating corporation" means a municipal corporation or commission or a company or individual operating or using a telephone or telegraph service, or transmitting, distributing or supplying electricity or artificial or natural gas for light, heat or power; ("exploitant")

"road authority" means the Ministry of Transportation, a municipal corporation, board, commission, or other body having control of the construction, improvement, alteration, maintenance and repair of a highway and responsible therefor. ("office de la voirie") R.S.O. 1990, c. P.49, s. 1; 1998, c. 15, Sched. E, s. 30.

Notice to operating corporation to take up works

2. (1) Where in the course of constructing, reconstructing, changing, altering or improving a highway it becomes necessary to take up, remove or change the location of appliances or works

placed on or under the highway by the operating corporation, the road authority may by notice in writing served personally or by registered mail require the operating corporation, without prejudice to their respective rights under section 3, so to do on or before the date specified in the notice. R.S.O. 1990, c. P.49, s. 2 (1).

Apportionment of costs of taking up

(2) The road authority and the operating corporation may agree upon the apportionment of the cost of labour employed in such taking up, removal or change, but, subject to section 3, in default of agreement such cost shall be apportioned equally between the road authority and the operating corporation, and all other costs of the work shall be borne by the operating corporation. R.S.O. 1990, c. P.49, s. 2 (2).

Minimum time interval

(3) The date specified in a notice under subsection (1) shall be as agreed upon by the road authority and the operating corporation, but in default of agreement shall be not less than sixty days after the date of the personal service or mailing of the notice. R.S.O. 1990, c. P.49, s. 2 (3).

Additional time

(4) An operating corporation may, upon such notice as a judge of the Superior Court of Justice directs, apply to the judge for an order altering to a later date the date specified in the notice given under subsection (1), and, if the judge finds that the physical or technical difficulties in complying with the notice require additional time, the judge may make such order as he or she considers appropriate. R.S.O. 1990, c. P.49, s. 2 (4); 2006, c. 19, Sched. C, s. 1 (1).

Compensation

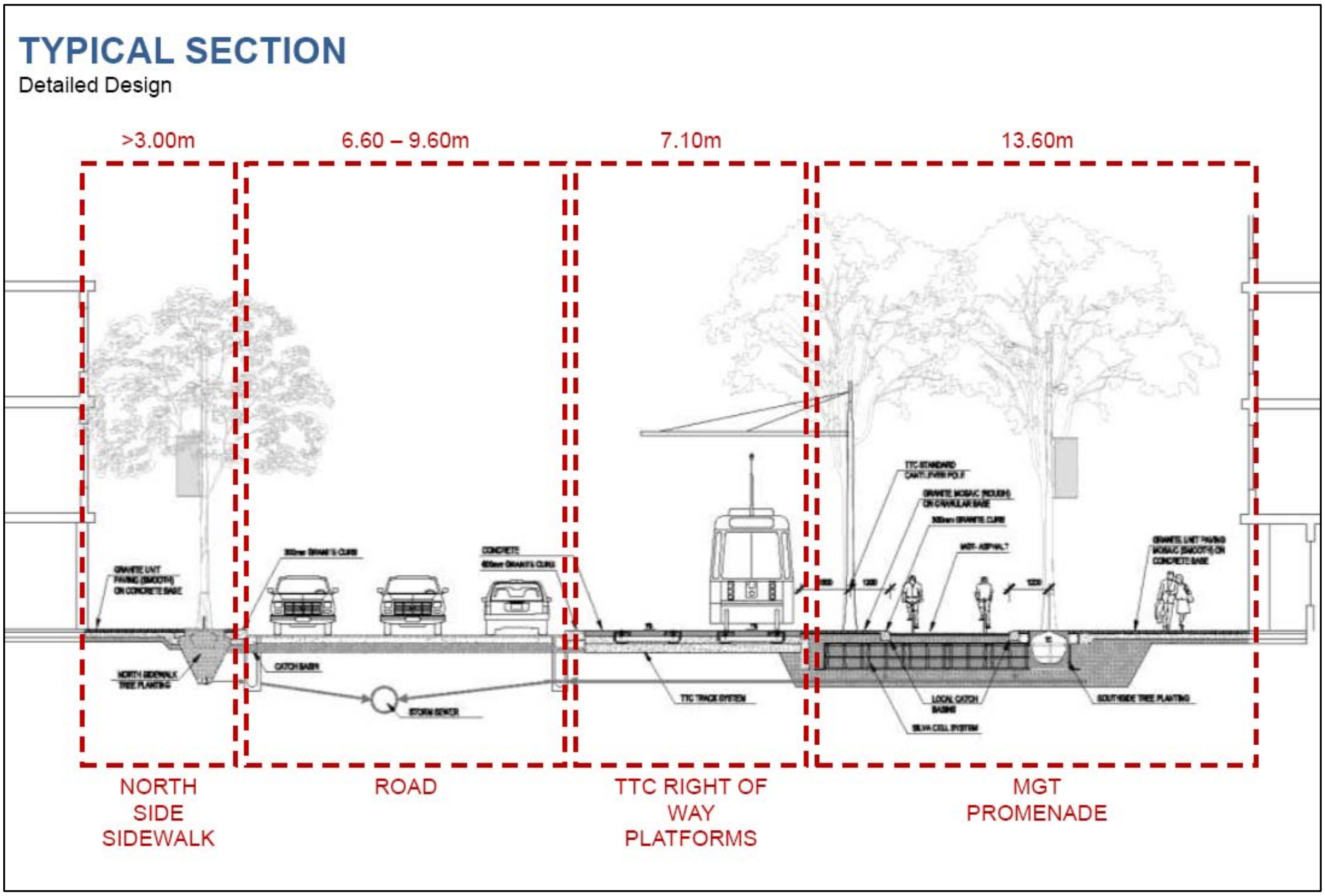
(5) Where a road authority incurs a loss or expense by reason of an operating corporation neglecting to take up, remove or change the location of appliances or works by the date specified in a notice given under subsection (1) or such date as altered by a judge under subsection (4), the operating corporation shall make due compensation to the road authority for such loss or expense, and a claim for compensation, if not agreed upon by the operating corporation and the road authority, shall be determined by the Ontario Municipal Board. R.S.O. 1990, c. P.49, s. 2 (5).

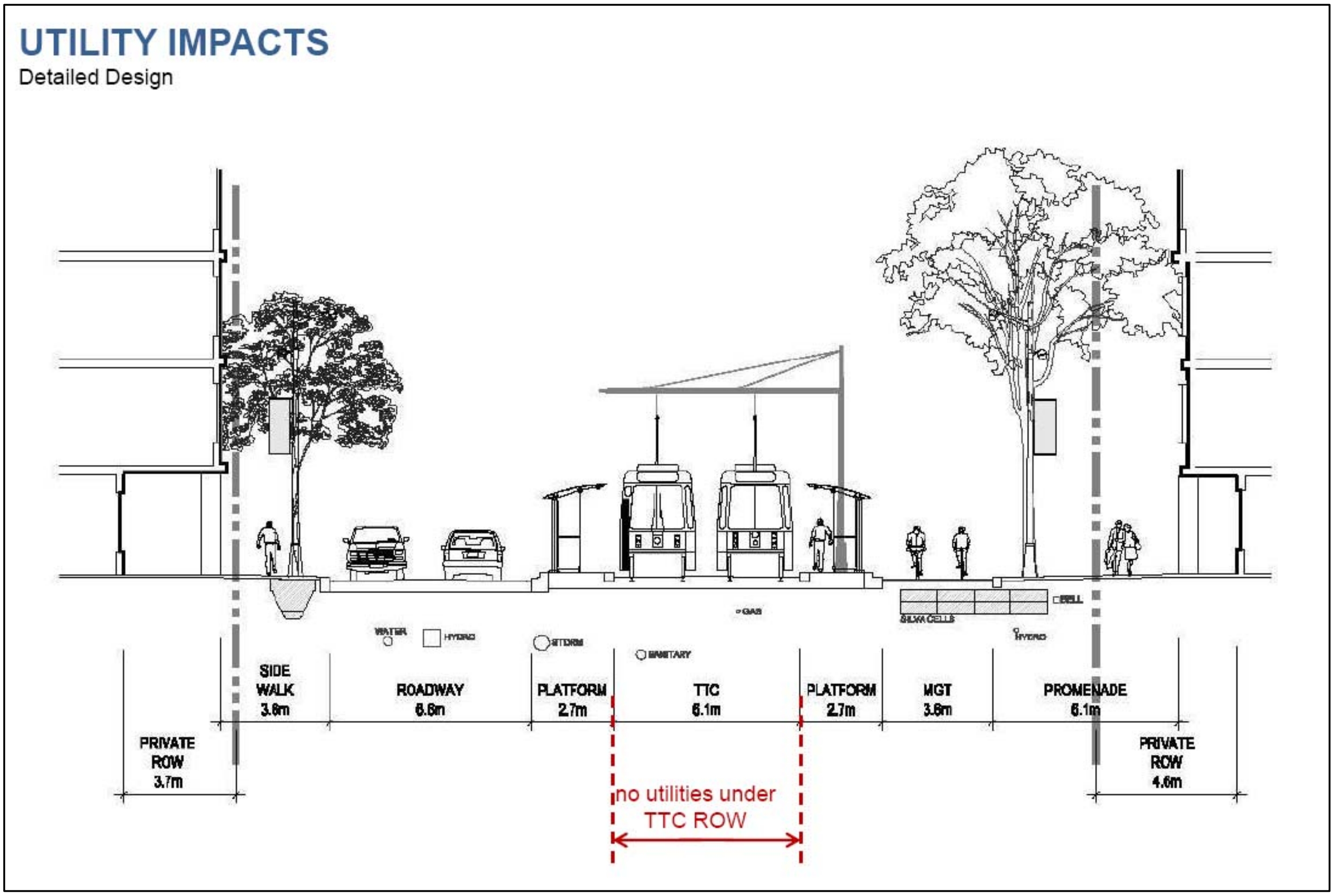
Apportionment of cost by Ontario Municipal Board

3. Where it is made to appear to the Ontario Municipal Board, upon application made to it, that the circumstances and conditions under which any of the appliances or works mentioned in section 2 have been placed on or under a highway, or that other special conditions render it unfair or unjust that the cost of taking up, removing or changing the location of the appliances or works should be apportioned and paid as provided in section 2, the Board, upon the application of the road authority or operating corporation, may apportion the cost of the taking up, removing or changing the works in such manner as appears to it to be equitable, and the decision of the Board is final and is not subject to appeal. R.S.O. 1990, c. P.49, s. 3.

1 **APPENDIX B**

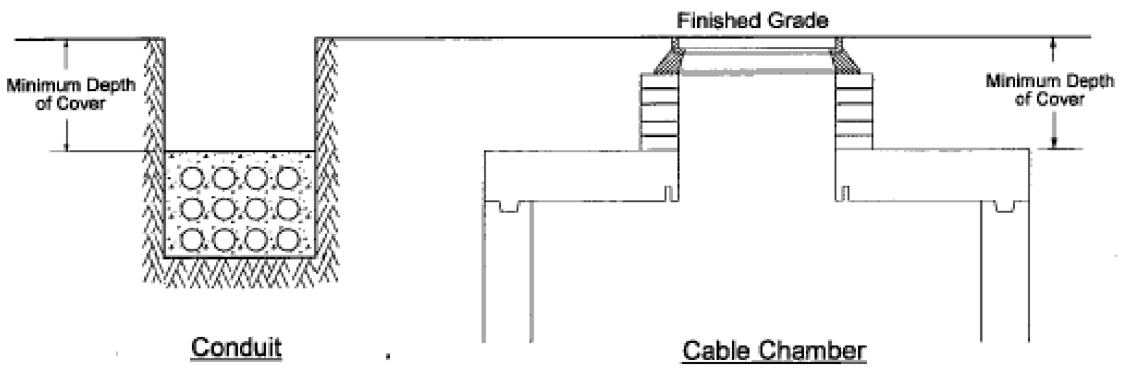
2 **Corridors and Right of Ways identified in Queens Quay design update, June 9th, 2009**




UTILITY IMPACTS
Detailed Design
WATER
HYDRO
STORM
SANITARY
GAS
SILVA CELLS
BELL
HYDRO
SIDE WALK 3.8m
ROADWAY 6.6m
PLATFORM 2.7m
TTC 6.1m
PLATFORM 2.7m
MGT 3.6m
PROMENADE 6.1m
PRIVATE ROW 3.7m
PRIVATE ROW 4.6m
no utilities under TTC ROW

APPENDIX C

THESL Standard Clearances



The "Minimum Depth of Cover" for THESL plant (conduits and cable chambers) will be as follows:

Type	Minimum Depth of Cover	Description
Major and Minor Arterial Roads	1.0m	Under the road, curb, the portion of the boulevard within 1.0m of the back of the curb, and the entire Right-of-Way within 30m of an intersection
Collector and Local Roads	1.0m	Under the road, curb, the portion of the boulevard within 1.0m of the back of the curb, and the entire Right-of-Way within 30m of an intersection with a Major or Minor Arterial road.
Uncurbed Roads	1.3m below the centerline of the road, or 0.6m below the lowest point of the adjacent ditch, whichever is deeper.	For the entire Right-of-Way, from street-line to street-line
Boulevards	0.8m	On all streets except for areas of boulevards as specified above

Notes:

1. The depths of cover are in accordance with the City's latest Municipal Consent Requirements document.
2. The depths of cover apply to all conduits irrespective of the type and method of installation.

DISTRIBUTION CONSTRUCTION STANDARD Civil Construction			MINIMUM DEPTH OF COVER FOR TORONTO HYDRO STRUCTURES				
toronto hydro	civil: [signature]	electrical:					
	original issue: Oct. 21, 2010	scale: N.T.S.	rev. 1	rev. 2	rev. 3	31-0300	1/1