Hydro Ottawa Limited
EB-2022-0234
Interrogatory Response
IRR HONI-3
ATTACHMENT C
ORIGINAL

# Distribution System Plan 2021-2025

# 1. DISTRIBUTION SYSTEM PLAN BACKGROUND

## *1.1. INTRODUCTION*

Hydro Ottawa's Distribution System Plan ("DSP") provides a detailed and comprehensive view of the utility's investment plans and supporting information for the 2021-2025 period. The DSP identifies the capital investments in Hydro Ottawa's distribution system and general plant assets which are required to maintain safe and reliable service to its customers in the City of Ottawa and Village of Casselman, with operations that remain responsive to their needs and requests, 24 hours a day, 365 days a year.

In step with Ontario Energy Board ("OEB") requirements, the DSP describes how capital investments will be prioritized, paced, and optimized, while minimizing rate impacts for customers and facilitating continuous improvement and productivity. The DSP is a core deliverable emerging from multiple internal and external planning processes related to capital investment, asset management, regional planning, customer engagement, and business strategy.

This plan is a continuation of Hydro Ottawa's 2016-2020 plan, which focused on the enhancement of system capacity to keep pace with growth and shifts in loads within the service territory and renewal of the aged and aging infrastructure at risk of failure. Key accomplishments have included extensive replacements and enhancements of core infrastructure, such as overhead power lines and underground cables; upgrades to fibre optic networks; acquisition of a new Supervisory Control and Data Acquisition System; and asset relocations and expansions to support major local infrastructure projects such as the City of Ottawa's Light Rail Transit and renewal of north-south arteries in the downtown core. These and other initiatives have translated into improved system reliability and performance, with the utility having consistently met or exceeded its reliability targets over the 2016-2018 timeframe. All told, Hydro Ottawa is on track to successfully complete its plan for 2016-2020, with adjustments for typical changes and evolving circumstances.

Notwithstanding this progress, however, renewing Hydro Ottawa's aged and aging infrastructure in deteriorating condition (i.e. stations, and underground and overhead systems) at an appropriate pace remains a priority for both near-term performance and long-term sustainability of the distribution system. Hydro Ottawa's service territory continues to be characterized by both a growing and a shifting customer base. In terms of growth, expanding suburban areas and load intensification in established communities are driving a need for investments to maintain reliability, increase supply capacity, and reduce the frequency and duration of outages.

At the same time, as customer priorities and needs evolve with the advancement of technology and innovation, they are triggering discernible shifts: in patterns of supply and demand, in preferences with regards to the availability of information on the services they receive, and in expectations for how quickly and effectively utilities can restore service when an outage occurs.

What's more, alongside shifts in customer behaviour and values, Hydro Ottawa is also contending with a different form of shifting – namely, variations in weather patterns associated with climate change. From historic flooding to tornadoes, Hydro Ottawa and its customers have experienced firsthand in recent years the growing frequency of severe weather events and their adverse impacts on the distribution grid. In turn, the utility is having to enhance adaptation and risk mitigation measures within the design, operation, and maintenance of its system, in order to help protect infrastructure, service delivery, health, and safety.

Taken together, all of these factors are injecting greater complexity into the system, underscoring the urgent imperative for renewal of aged systems, and emphasizing the need for continued investment in information technology, operational technology, and cyber security solutions.

Through its robust and multi-layered planning processes, Hydro Ottawa has sought to strike a balance between these pressures on the distribution system and the top priorities of customers: (i) keeping distribution rates low; (ii) maintaining reliability; and (iii) investing in new technology.

The DSP serves as a critical point of culmination for these processes and represents the minimum level of investment needed to ensure this balance is achieved – all while avoiding the accumulation of risk and declines in performance over the long-term.

Hydro Ottawa's DSP has been developed to align with the OEB's *Chapter 5 Filing Requirements for Electricity Distribution Rate Applications,* as updated on July 12, 2018 and addended on July 15, 2019 ("Filing Requirements") as well as with the *Handbook for Utility Rate Applications* issued by the OEB in 2016.

## *1.2. OVERVIEW OF DOCUMENTS*

The DSP consists of the following eight main sections:

**Section 1 – Distribution System Plan Background** provides background information relative to the contents of the document.

**Section 2 – Overview of the Distribution System** provides an overview of the assets and the context in which they are operated.

**Section 3 – Asset Management Strategy & Objectives** outlines Hydro Ottawa's Corporate Strategic Direction and the relationship between the Asset Management Objectives.

**Section 4 – Performance Measurements for Continuous Improvement** includes the qualitative assessments and quantitative metrics to monitor the quality of the planning process, the efficiency of implementing the plans, and the extent to which objectives are being met. In addition, it includes how the performance measurements affect the planning process and promote continuous improvement.

**Section 5 – Asset Management & Capital Expenditure Process** outlines Hydro Ottawa's Asset Management process, which is the systematic approach used to plan and optimize ongoing capital expenditures. It provides an understanding of how the Asset Management Process leads to the decisions that comprise the capital investment plan.

**Section 6 – Asset Lifecycle Optimization** describes how Hydro Ottawa uses its asset lifecycle optimization policies and practices to assess system renewal investments and make decisions on refurbishment versus replacement of assets. In addition, it summarizes Hydro Ottawa's approach to managing and mitigating asset risk.

**Section 7 – System Capacity Assessment** provides information on the capability of Hydro Ottawa's system to accommodate new load and Renewable Energy Generation ("REG") connections. This includes network constraints identified through the Regional Planning Process.

**Section 8 – Capital Expenditure Plan** outlines the planned investments for the next five years. Investments are derived from the Asset Management and Capital Expenditure planning processes and includes justifications of the investment decisions made.

The mapping of the sections within Hydro Ottawa's DSP to those identified in the Filing Requirements can be found in Appendix A of this Schedule.

### *1.3. KEY ELEMENTS OF THE DSP*

Hydro Ottawa's capital investment plan is influenced by several key drivers, challenges, and trends that are unfolding within its operational and business environment. Among the major pressures on the distribution system, which are addressed through this plan, are the following:

- **A Growing Community** – Growing electrical loads and system capacity constraints are driving the need to expand the capacity of the distribution system. This growth is driven by the development of residential subdivisions and business parks outside of the

Greenbelt and in historically rural lands, intensification in urban areas, and major local infrastructure projects such as Light Rail Transit and transit-oriented development.

- **Aging Distribution Assets** – A significant proportion of Hydro Ottawa's distribution system assets have reached or are approaching the end of their expected service life. For example, more than 20% of Hydro Ottawa's poles have exceeded their expected end-of-service life. These assets not only present an increasing failure risk, but also potential operational challenges resulting from obsolete and legacy equipment not meeting current standards or lacking replacement or repair components.

- **Climate Change and Adverse Weather** – The increased frequency of extreme weather has had significant impacts on Hydro Ottawa's operations and system – especially in 2018, when three major events within a six-month span caused considerable damage and heavily impacted spending on emergency replacement of assets. The effects of climate change are expected to be felt more acutely and frequently over the coming decades. For Hydro Ottawa, these impacts are reinforcing the continuation of existing adaptation measures that have already been implemented in response to past weather events, prompting review and implementation of new adaptations, and underscoring the need for investments to enable the renewal of aged overhead infrastructure.

**Figure 1.1 – Broken Poles Caused by Ice Storm (2018)**


- **Innovation** – The changing expectations of customers will require ongoing investment and innovation to provide them with the technologies and tools that will enable them to better understand, manage, and monitor their electricity consumption. Moreover, innovation in the planning and operation of the distribution system itself is needed in order to accommodate such trends as the growth of electric vehicles ("EVs") and customer-generated renewable electricity, and to respond to customer expectations for improved restoration times in the event of an outage. Enhanced automation in system operations and communications will be particularly critical objectives, in this regard.

- **Information Technology** – Hydro Ottawa must ensure its Information Technology ("IT") meets the needs of the business and its customers. Building upon the technology investments Hydro Ottawa made throughout 2016-2020, Hydro Ottawa plans to continue adopting innovative IT systems throughout 2021-2025 to solve business challenges, increase efficiencies, and enhance customer services. A central area of focus will be taking proactive steps to prevent cyber attacks that could impact the protection of customer information and distribution system reliability.

### *1.4. DSP PERIOD*

The DSP provides capital expenditure plans and supporting information for the 2021-2025 period, along with Historical and Bridge Year information for 2016-2018 and 2019-2020, respectively.

### *1.5. VINTAGE OF INFORMATION*

Since the distribution system is changing on a daily basis, all information and details provided have been updated as of December 31, 2018, unless otherwise stated, and should be considered as current.

### *1.6. OVERVIEW OF CUSTOMERS' PREFERENCES AND EXPECTATIONS*

Based on results from a variety of customer engagement activities, Hydro Ottawa customers indicate that reliability should be maintained or improved, at minimal or no increased cost. As a result, Hydro Ottawa has created a capital plan that paces investments in order to minimize rate impacts while maintaining a focus on continuous improvement, efficiency, and productivity.

At a local level, customers are engaged through consultation sessions during the design phase of major projects to address any concerns in regards to potential impact to their property or neighbourhoods. These concerns are addressed in the final design of the project which minimizes the impacts raised by the customers in a cost effective manner.

Further details regarding Hydro Ottawa's engagement with customers, and how their input has been incorporated into the DSP, are available in section 1.10.1.

## 1.7. SOURCES OF COST SAVINGS AND PLANNING COORDINATION

Throughout the plan period and in the course of executing its planned work, Hydro Ottawa will continue to evaluate its operational efficiencies and seek ways to minimize and avoid costs. While continuing to minimize overall risk to Hydro Ottawa's strategic objective of delivering value to its customers. Examples of these initiatives are highlighted below, further examples can be found in Hydro Ottawa's Capital and Operating and Maintenance plans.

**Coordinated Renewal –** As part of the execution of its Station Renewal, Underground Renewal, and Overhead Renewal programs, Hydro Ottawa coordinates system investments where multiple adjacent systems are at or near the end of service life. This approach offers efficiencies and reduced customer impacts from the construction work.

Building on the benefits of this coordination, Hydro Ottawa also seeks cost saving opportunities through collaborations with various working groups and other local utilities, and with future plans identified through the internal planning process.

**Non-Wires Alternatives –** In step with provincial policy on electricity conservation, Hydro Ottawa seeks to leverage opportunities to pursue alternatives to infrastructure solutions and avoid/defer capacity enhancements, where feasible. Through the 2021-2025 period, Hydro Ottawa will be deploying a portfolio of measures in the Kanata North area to enable deferral of an additional transmission-connected station originally identified as being required through the Integrated Regional Resource Plan process. The deferral of this significant capital investment will be enabled through a mix of distribution enhancement and conservation measures. Deferring construction of an additional transmission-connected station allows the utility to minimize rate increases over the 2021-2025 period.

**Enhanced Work Coordination** – Over the course of 2015-2016, Hydro Ottawa introduced Mobile Workforce Management ("MWM"). This tool has been deployed across multiple groups in Operations (Collections, Metering, Forestry, Service trucks, Civil Inspection, etc.). The main strengths of the MWM system reside in its core capabilities to schedule and dispatch field work, including re-shuffling assignments to manage changes introduced during the day (e.g. cancellations and new high-priority work), and to enable communications through a mobile application to exchange information about work assignments, basic routing, work progress, and crew location. These strengths have resulted in improved work processes and productivity.

As the current tool has reached end-of-life and is no longer supported by the vendor, Hydro Ottawa will be replacing it with the new system in service by 2021. Through the implementation of the upgraded software, Hydro Ottawa will be seeking the increased functionality required to bring additional operational workgroups on to the scheduling platform. Furthermore, Hydro Ottawa will be aiming to drive productivity by sourcing a tool with improved scheduling policies and algorithms for routing (for example, using real-time and predictive traffic), the ability to bundle assignments by location, the ability to maintain dependencies between jobs, the ability to forecast more realistic completion times, and the ability to manage preferred execution times by area or work types (along with a variety of other criteria).

**Planning Effectiveness –** Hydro Ottawa's overall prioritization and optimization of distribution system expenditures is expected to drive value, including cost savings, over the long-term.

Through the inspection, testing, and maintenance planning and project prioritization process, Hydro Ottawa has developed a plan that paces spending while meeting the reliability requirements of the distribution system.

Through the Asset Management process outlined in section 5.1, Hydro Ottawa identifies the annual investments required to manage the risks associated with reliability, customer impact, safety, and environment while improving service to customers and providing increasing value to the shareholder. As described in section 5.2 Capital Expenditure Process, business cases are created to evaluate project alternatives thereby ensuring the optimum cost/benefit solution is identified for implementation. Annual expenditures are then paced to ensure timing of investments is optimized so as to maximize alignment with the achievement of Hydro Ottawa's strategic objectives.

**Figure 1.2 – Planned Insulator Replacement on 27.6 kV Pole Line**

## 1.8. CHANGES IN THE DSP

Refinements to Hydro Ottawa's Asset Management process have been focused on increasing the quantity and quality of data, establishing and documenting asset management processes, optimizing project prioritization, and improving workflow efficiency. Described below are key changes to the utility's Asset Management process that have been implemented since Hydro Ottawa's last rebasing application.[1]

[1] Hydro Ottawa Limited, *2016-2020 Custom Incentive-Rate Setting Distribution Rate Application*, EB-2015-0004 (April 29, 2015).

**ISO 55001 Certification**

As stated in Hydro Ottawa's *2016-2020 Strategic Direction,* the utility is committed to becoming a "leading partner in a smart energy future" and to continue creating value "for our shareholder, our customers and our community through excellence in the delivery of electricity and related services." In support of this vision and the utility's core mandate, Hydro Ottawa has committed to adopt the ISO 55001 Asset Management Standard as part of continual improvement in asset management.

The Asset Management System, which establishes an Asset Management framework, is used by the organization to direct, coordinate, and control asset management activities. It incorporates interrelated and interacting elements to establish an asset management policy, asset management objectives, and the overarching processes necessary to achieve those directives. The framework also strengthens the strategic asset decision-making processes by striving to do the following: balance the weighting of cost, risk and asset performance that meet or exceed service level expectations of customers; comply with the terms of applicable acts, licences and codes; improve asset value and resource efficiency; and minimize health, safety and environmental impacts.

As part of the ISO 55001 compliance initiative, Hydro Ottawa has formalized its asset management strategies in its Strategic Asset Management Plan ("SAMP"). The SAMP, found in Attachment 2-4-3(G) sets a clear and overarching framework for Hydro Ottawa's Asset Management System, documenting the strategies to achieve its asset management objectives and describes how these objectives support the corporate strategy. The SAMP guides the Asset Management Plans which have been developed for each major asset class. Each Asset Management Plan is a multi-year plan which includes specific activities, strategies, and timeframes required to achieve Hydro Ottawa's asset management objectives while describing what resources will be required for implementation.

**Budget Change Request Process**

Electronic change requests have been implemented in Copperleaf C55, Hydro Ottawa's investment optimization software. A change request is initiated if a project manager's budget forecast exceeds a threshold determined to have an impact on the overall sustainment budget. Once initiated, the change request must be approved by the appropriate level of authority depending on the amount of the variance. This process ensures that financial changes during project execution remain aligned with Hydro Ottawa's Asset Management Process.

**Asset Inspection Scope**

Hydro Ottawa continues to refine the statements and scopes of work that define specific inspection and testing activities used to collect data needed to assess the condition of its assets. This data is crucial to effectively identify assets that pose an increased level of risk to the continued reliability of Hydro Ottawa's distribution system. Specific improvements include:

- Alignment of inspection and testing activities to conform with data requirements for Hydro Ottawa's Asset Condition Assessment ("ACA") framework;
- Increased implementation of digital data capture forms to allow for accessibility and transferability between systems of the information; and
- Adoption of new inspection and testing programs for gas insulated pad-mounted switchgear and secondary pedestals.

**Geographic Information System Data Improvements**

Since Hydro Ottawa's previous rebasing application, continued effort has been made to improve the data available in the Geographic Information System ("GIS"), both in terms of quality and quantity.[2] Goals and benefits of these efforts include:

- Decrease in field visits required to identify or verify asset properties on-site, which improves labor efficiency;

[2] Hydro Ottawa Limited, *2016-2020 Custom Incentive Rate-Setting Distribution Rate Application*, EB 2015-0004 (April 29, 2015).

- Increasing availability of asset condition data for risk based asset condition modelling;
- Elimination of overlaps between planned programs of inspection and ad-hoc requests, reducing the frequency an asset is inspected within a given inspection period;
- Easier identification of system needs and prioritization of investments; and
- Improved ability to use automated tools for engineering analysis.

**Digital and Paperless Processes**

In 2018, Hydro Ottawa implemented the use of Bluebeam® Revu®, design review software, to increase efficiency in drawing feedback and approval processes. Rather than printing and mailing drawings, the software allows drawings to be shared online thereby decreasing the time required to complete the design approval process. Efficiencies gained through this digital process have been further bolstered with the integration of other technologies such as the ike-gps. This tool allows for the collection of poleline data seamlessly, efficiently and consistently from the field, and ultimately enables design and engineering analyses which accurately reflect field conditions.

**Capital Program Restructure**

Since its previous rebasing application, Hydro Ottawa has restructured its capital budget to better align with the definitions set out in the Filing Requirements.[3] Appendix C of this Schedule shows a comparison between the two structures.

At the Capital Program level, the main changes are as follows:

- The Metering Program was moved to System Service, since the main driver of gaining the ability to remotely disconnect and reconnect the meter better aligns with the System Efficiency driver under System Service Investment category.

[3] Hydro Ottawa Limited, *2016-2020 Custom Incentive Rate-Setting Distribution Rate Application*, EB-2015-0004 (April 29, 2015).

- The Distribution Assets Program was divided into two programs (Overhead Distribution Assets Renewal and Underground Distribution Assets Renewal) to facilitate spending tracking for each asset category type.
- The Station Enhancements program was moved to System Service, since the projects created under this program better align with drivers under System Service.
- The Station Capacity Program was renamed to Capacity Upgrades Program in order to include both Station Capacity Upgrades and a new Budget Program called Distribution Capacity Upgrades, which was created in 2018.
- The Plant Failure Program was renamed to Corrective Renewal.

At the Budget Program Level, the main changes are as follows:

- The Distribution Plant Failure and Station Plant Failure Programs have been restructured into two new programs – Emergency Renewal and Critical Renewal. These two programs will reallocate work into a common classification of failed equipment (typically, but not necessarily, resulting in an outage) and those that may still be providing service, but no longer meet their designed requirements be it for safety, environmental, or reliability reasons.
- As of 2018, no new projects have been allocated to the Line Extensions Program. Instead, line extensions that are built to increase capacity are allocated to the Distribution Capacity Upgrades Program. Line extensions that are built to improve reliability are allocated to the Distribution System Reliability Program.

## *1.9. ASPECTS CONTINGENT ON ONGOING AND FUTURE ACTIVITIES*

**Regional Planning**

The last Integrated Regional Resource Plan ("IRRP") cycle for the Ottawa area was completed in 2015 and the Regional Infrastructure Plan ("RIP") in 2016. Through the 2016 RIP, Hydro Ottawa has a number of station projects identified in the forecast period whose costs are dependent on the outcome of Hydro One Networks Inc.'s ("HONI") evaluation and estimating process – i.e. Connection and Cost Recovery Agreements ("CCRA"). Please refer to sections 8.4 and 8.5 of the Capital Expenditure Plan for more details on the forecasted expenditures.

Hydro Ottawa is currently engaged in the latest IRRP cycle for the Ottawa area, the results of which are not yet final. A number of regional and bulk system needs are currently being studied to determine optimal solutions. This cycle is expected to be completed in the first quarter of 2020. Hydro Ottawa's five-year investment plan incorporates required projects to address the near-term and medium-term regional needs identified below. These investments will remain subject to change through the finalization of the IRRP and subsequent RIP processes.

The near-term and medium-term needs identified in the 2019 IRRP scoping assessment are as follows:

1) Supply capacity for South Nepean region
2) Additional capacity in the Kanata North region
3) Additional capacity in the Leitrim/Russell region
4) Additional 230kV/115kV transformer capacity at Merivale TS
5) Additional supply capacity for circuit L2M
6) Bilberry Creek TS end of life station refurbishment/retirement
7) M30A and M31A 230kV circuits overload
8) Restoration Needs at:
    a. Circuits M4G & M5G
    b. Circuits D5A & B5D
    c. Breaker Failure at South March SS L6L7
9) Downtown Cables at end of life

### *1.10. COORDINATION WITH THIRD PARTIES*

Hydro Ottawa understands that planning and coordinating investments in isolation will only lead to inefficiencies, increase project costs, and negatively affect customer service. Thus, Hydro

Ottawa recognizes that coordinating and incorporating input from third parties is an essential aspect of its investment planning process.

### 1.10.1. Customer Consultations

Hydro Ottawa leverages a mix of ongoing and specific engagements with its customers to ensure that customer preferences and expectations are fully understood, and to ensure these are integrated into the utility's activities and plans. For a comprehensive summary of the tools, activities, and interactions which comprise the utility's toolkit for customer engagement, please see Exhibit 1-2-1: Customer Engagement Overview. In addition, information from the surveys that are regularly administered by Hydro Ottawa to gauge customer satisfaction and expectations is, likewise, included in section 4.1.1 of this Schedule.

Through the development of the DSP, customer engagement activities have been leveraged to direct the development of capital plans and to validate their components.

**Community Open Houses**

Engaging the customer on major projects is an important part of the project execution process. Hydro Ottawa regularly hosts Community Open Houses for major projects with the purpose of informing the public and obtaining feedback on how the project should proceed.

Promoting customer engagement has facilitated project improvements including the installation of natural and aesthetic barriers, adjustment to equipment locations to minimize property impacts, and project specific noise mitigation strategies, including the use of noise barriers or adjustments to the work schedule.

Hydro Ottawa plans to continue to hold Community Open Houses for major projects identified in this plan.

**Customer Consultation on 2021-2025 Rate Application**

In early 2019, Hydro Ottawa engaged Innovative Research Group ("Innovative Research"), a national consulting firm with expertise in public opinion research and experience in energy policy to collaboratively design, test, and implement a strategy for engaging customers on its 2021-2025 rate application proposals.

An iterative, two-phase customer engagement process was undertaken, with the following five key principles adopted in order to maximize effectiveness of the process:

- Ensure all Hydro Ottawa customers have an opportunity to be heard
- Ensure a representative sample of customers engaged
- Create an open, voluntary process to allow any customer the opportunity to provide comment
- Focus on the key outcomes and customer preferences
- Inform customers about the distribution system and electricity industry

***Phase I***

Phase I of the Customer Engagement process surveyed Hydro Ottawa's residential and small business customers. The purpose of this survey was to gather feedback and insights on priorities, preferences and needs from low-volume customers. The information collected through this survey helped Hydro Ottawa's planners and engineers inform the design of its DSP and Business Plan, which were shared in draft with customers in Phase II.

Among each customer type, Innovative Research conducted parallel telephone and online surveys through Phase I. This methodology enabled Innovative Research to establish baselines and develop weights that allowed Hydro Ottawa to move to an online methodology for its low-volume customer engagement program for Phase II.

This initial customer engagement yielded the following findings:

- The clear majority of residential and small business customers are satisfied with the current service they receive;

- Despite being the top priorities, customers do not simply expect Hydro Ottawa to focus exclusively on price and reliability; and

- Among competing priorities, price, reliability, and investing in new technology are the top three priorities for both residential and small business customers.

***Phase II***

Phase II provided additional insight about customers' needs and preferences prior to the completion of the business plan. The purpose of Phase II was threefold:

- To confirm customer needs, preferences, and priorities identified in Phase I;

- To solicit customer feedback on the content of Hydro Ottawa's proposed plans and the subsequent rate impact, including customer preferences toward particular capital programs where trade-offs on pacing existed; and

- To solicit customer feedback on Hydro Ottawa's planning development process, including the customer engagement process.

The Phase II approach involved an online workbook, available in English and French that gathered input from any interested residential, small business, or mid-market customers.

Customers were provided specific information about Hydro Ottawa's planning process, how it solicited feedback from customers, and information about Hydro Ottawa's cost benchmarking performance. The results of the Phase I engagement were summarized and customers were again asked to rank priorities to evaluate if the needs and preferences that informed the business plan had changed. Program-specific information, including activities, outcomes, and bill impacts were shared in respect of trade-offs where customer input was sought. In addition, customers participating in the online workbook were shown the estimated net bill impact of their trade-off choices and allowed to change their responses if desired.

In addition to the workbook, Focus Groups and Workshops were held to further solicit feedback. For the Low-volume customers, Hydro Ottawa held consultation sessions with general service and residential customers, who were recruited from a randomly generated list provided by the utility. A workshop was held with the mid-market, general service greater than 50 kW customers in Ottawa. Customers were randomly selected and screened.

There were 17,210 residential and 307 small business respondents to the survey. The majority of respondents, when considering investment areas individually, supported increased investment in overhead renewal, underground renewal and reliability investments. However, when asked for their views in regards to the draft plan 48% of residential and 47% of small business identified that "Hydro Ottawa should maintain the forecasted annual increase to deliver a program which delivers on the stated priorities." A further 35% of residential and 29% of small businesses expressed support for further improvements in service, even if this entailed further rate increases.

Mid-market participants who attended expressed concern over the current rate increases being proposed, and were open to potential decreases in service reliability if it would reduce the forecasted increases in the bill. This feedback has emphasized the importance of a balanced plan – with a continued focus on efficiencies and a strategy to maximize the impact of investments to match residential customer expectations, without further increasing rate pressures on business customers.

### 1.10.2. Regional Planning Process

The IRRP is developed by a working group, comprised of the Independent Electricity System Operator ("IESO"), transmitter, and local distribution companies ("LDCs") which work together to develop a plan that integrates a variety of resource options to address the electricity needs of the region. The Ottawa Region working group holds several meetings throughout the year to discuss progress on the study, and consists of the IESO, Hydro Ottawa, HONI and Hydro One Distribution. The IRRP process develops and analyzes forecasts of demand growth for a 20-year time frame, determines supply adequacy in accordance with the Ontario Resource and Transmission Assessment Criteria, and develops integrated solutions to address any needs that are identified. Potential solutions may include the following: conservation, demand management, distributed generation, large scale generation, transmission, and distribution. Hydro Ottawa has provided IESO with an updated long term load forecast for Hydro Ottawa regions, which is provided in Appendix E. The forecast outlines several transmission and distribution stations that will exceed their capacity limitations within the near, medium, and long-term. Hydro Ottawa also contributes to the IRRP by identifying feasibility limitations within the planning area that may not be known to the working group (i.e. Greenbelt, rivers, highways, etc.). The IRRP is designed to address emerging needs of the regional utilities, and to identify cost-effective and viable solutions.

The first IRRP for the Ottawa area began in 2011, with the IESO leading the process. The IRRP was finalized in April 2015, with the RIP issued shortly thereafter in December 2015. In April 2016, the IESO issued a hand off letter to HONI and Hydro Ottawa, thereby initiating development work on near and mid-term transmission solutions to meet the identified needs.

The latest IRRP for the Ottawa area, planned for completion in the first quarter of 2020, is in the final stage for evaluation of solutions to identified needs. The IESO, Hydro Ottawa and HONI recently discussed forecasted growth across Hydro Ottawa's service territory, focusing on Kanata North and South-East Gloucester. These areas have served as the IRRP focus due to existing capacity constraints on both Hydro Ottawa and HONI's systems, which are set to increase as a result of future planned residential and commercial developments.

Please see section 1.9 above for additional information on the near-term and medium-term needs identified in the 2019 IRRP scoping assessment.

### 1.10.3. Other Utility & Stakeholder Coordination

**City of Ottawa's Renewable Energy Strategy – Energy Evolution**

In 2015, the City of Ottawa initiated the development of a formal renewable energy strategy, designated as "Energy Evolution."[4] Energy Evolution is aimed at managing energy consumption, promoting the use of renewable energy, and advancing local economic development opportunities in Ottawa. The strategy has specific deliverables for the short, medium, and long-term (2020, 2031, and 2050 respectively). These deliverables are intended to align with the City's official target to reduce greenhouse gas ("GHG") emissions by 80% below 2012 levels by 2050.

City Council approved Phase 1 of Energy Evolution in December 2017. Phase 1 focuses primarily on renewable energy generation opportunities and includes a three-year action plan with over 30 initiatives that are targeted for completion in partnership with community stakeholders.

In conjunction with its approval of Phase 1, City Council formally directed the initiation of plans for Phase 2, with a focus on reducing energy use in the building and transportation sectors. A final strategy and action plan for Phase 2 is scheduled to be presented to City Council for approval in the first quarter of 2020.

Hydro Ottawa has been actively engaged in the Energy Evolution initiative since its inception and has taken the strategy's goals into consideration in the development of the DSP. Where appropriate, the DSP highlights planned actions and expenditures that are complementary to

[4] https://ottawa.ca/en/living-ottawa/environment/climate-change-and-energy/energy-evolution.

Energy Evolution's objectives. For example, the expansion of station capacity can support increased accommodation of renewable energy projects through such measures as the installation of transformers which are designed to enable reverse-flow capabilities.

**City of Ottawa Development Application Circulations**

The City of Ottawa's process to circulate development applications allows Hydro Ottawa to provide comments regarding upcoming developments and plan distribution system upgrades as required. The City of Ottawa notifies utilities and the public of different types of applications:

- Site Plan Control
- Zoning By-Law Amendment
- Official Plan Amendment
- Demolition Control
- Plan of Condominium
- Plan of Subdivision
- Community Design Plans
- Road Closure
- Heritage Applications to be considered by Council

During the comment period, Hydro Ottawa provides comments to inform developers on the processes required to protect its distribution infrastructure and guarantee a safe job site. Additionally, development applications provide information with regards to future growth, including its location, size and timeline for completion. In order to accommodate the anticipated load growth, estimates obtained via the development application process permit Hydro Ottawa to proactively plan for any required distribution upgrades and to coordinate any transmission upgrades with HONI and the IESO.

**City of Ottawa Utility Coordinating Committee**

The Utility Coordinating Committee ("UCC") provides a forum for communication between invited utilities and the City of Ottawa in order to ensure safe and efficient management of the infrastructure within road allowances and other rights-of-way. Every fall, Hydro Ottawa provides the road authority with its proposed major works plan for the following year to maximize efficiency through improved construction scheduling coordination, damage prevention initiatives, and development of standards. The primary functions of the committee are the following:

- Jointly plan construction activities
- Set technical standards
- Protect plant
- Provide a quick communication network
- Maintain a central registry
- Resolve disputes
- Assist the road authority with proposed utility installation permit processes

The committee members are: City of Ottawa, Hydro Ottawa, HONI, Heavy Construction Association, Enbridge Gas Distribution, Birch Hill Telecom, Bell Canada, Rogers Cable Communications, Telus Communications, and Allstream.

**Ottawa Light Rail Transit**

The first stage of the Ottawa Light Rail Transit ("LRT") system became operational in September 2019, and construction of Stage 2 of the Ottawa LRT system will also commence in 2019. The Stage 2 project will extend the electrically-powered Ottawa LRT Confederation Line and diesel-powered Trillium Line further across the city.

As the licensed distributor servicing the majority of the proposed LRT expansions, Hydro Ottawa has been actively engaged in the project. The utility's role includes developing an electrical servicing strategy for future stations and for consideration of Hydro Ottawa plant relocations that may be required where conflicts exist. The utility collaborates with the City and project contractors on relocation plans, ensuring that both Hydro Ottawa and the City's requirements are met.

The impacts and planning considerations of LRT construction have been incorporated into the development of the DSP, where appropriate. For example, the station capacity required to support the constructed and forecasted LRT loads have been included in the utility's system capacity planning.

**CEATI Distribution Programs**

The Centre for Energy Advancement through Technological Innovation ("CEATI") provides technology solutions to electrical utility participants who collaborate to advance the industry. Advancements are made by networking, sharing information, industry benchmarking and cost-sharing on asset technical projects. Hydro Ottawa participates in several CEATI programs such as Protection & Control, Distribution Line Asset Management, and Station Equipment Asset Management. Cost sharing with other power distribution utilities to solve technical issues allows Hydro Ottawa to enhance the system and provide higher levels of reliability at minimal cost. Program specific conferences occur on an annual or biannual basis depending on the program.

### 1.10.4. Energy Resource Facility Generation Investment Coordination

As per the Filing Requirements, the IESO Comment Letter outlines the IESO's assessments of an electricity distributor's Energy Resource Facility ("ERF") Investments Plan, including:

- Whether the distributor has consulted with the IESO, or participated in planning meetings with the IESO;
- The potential need for coordination with other distributors and/or transmitters or others on implementing elements of the ERF investments; and
- Whether the ERF investments proposed in the DSP are consistent with any RIP.

The IESO Comment Letter will be appended to Hydro Ottawa's DSP once the IRRP is completed.

### 1.11. GRID MODERNIZATION

Hydro Ottawa's approach to grid modernization is centered on the customer. Modernization is one of the ways the utility ensures that its system and services continue to meet the evolving needs and preferences of customers, and that Hydro Ottawa delivers on its commitment, as described in the *2016-2020 Strategic Direction*, to becoming a "leading partner in a smart energy future." In addition, results from the customer consultation that was undertaken to inform the utility's 2021-2025 rate application showed that investing in new technology is one of the top three priorities for both residential and small business customers.

With this customer focus, the utility's approach to grid modernization is focused on enhancing the customers' ability to produce, store, and export energy onto the grid, exploring new transaction interfaces with customers, deploying monitoring and control to improve reliability while gaining operational efficiencies, and growing electrical demand from EVs. Concurrently, this approach also seeks to ensure that the grid is resilient and able to withstand growing cyber security and adverse weather stressors.

Table 1.1 below maps the alignment of Hydro Ottawa's grid modernization activities to Ontario's Long Term Energy Plan ("LTEP").

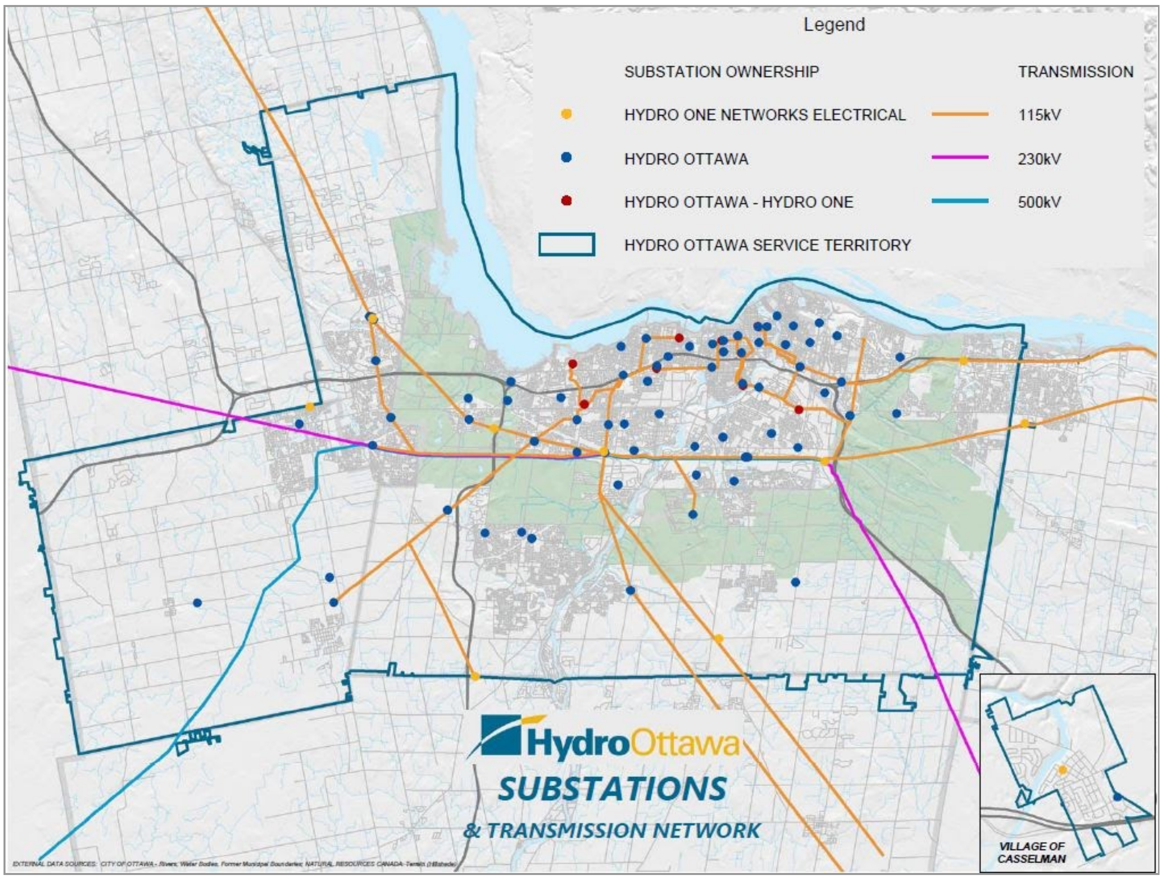
### Table 1.1 – Hydro Ottawa Response to Key LTEP Initiatives

| Key LTEP Initiatives | Hydro Ottawa Response and Proposed 2021-2025 Initiatives |
|---|---|
| Ensuring Flexible Transmission Energy System | Hydro Ottawa actively participates in the Regional Planning process and supports the flexible energy system as it relates to transmission. Please see section 1.10.2 |
| Electrification of Transportation - Innovating the Future | Hydro Ottawa Investments are focused on determining and preparing for the impact of large scale penetration of EVs. Please see section 8.1.6.4 |
| Grid Modernization-Innovating the Future | Hydro Ottawa grid modernization plans are focused on improving Distribution Automation, and operational technology to increase dynamic operation of the grid, and progress to a self-healing grid. Please See section 8.3.4.6-8.3.4.10<br><br>Hydro Ottawa through its Smart Grid projects such as MiGen is investing to explore tools and market models that support transactive future marketplace, to support the system and customers needs. See section 8.4.3.6 |
| Distributed Energy Resources - Innovating the Future | Hydro Ottawa is focusing on advancing the capability to connect DER, in the course of its other renewal and modernization activities, and building platforms to support control and monitoring of DERs connected to the Distribution System. See section 8.1.6.2 |
| Enhancing Reliability - Improving Value and Performance for Customers | Hydro Ottawa's System Renewal and System Service investments are targeted to maintain and enhance reliability performance, overall, and for identified areas that are experiencing below average reliability performance. See section 8.4.3.5. |
| Cybersecurity - Improving Value and Performance for Customers | Hydro Ottawa has integrated Cybersecurity into its information Technology and Operation Technology procurement, and is taking a proactive approach to fully secure against cyber threats. Please see Attachment 2-4-3(E): Material Investments |
| Strengthening the Commitment to Energy Conservation and Efficiency | Hydro Ottawa considers the existing and future Conservation and Demand Program for all capacity and renewal projects. See section 5.3. |
| Responding to Extreme Weather Events | Hydro Ottawa is investing in resiliency initiatives to mitigate the impacts of adverse weather. See section 8.1.6.3 |
| Supporting Regional Solutions and Infrastructure | Hydro Ottawa is engaged in regional planning, and has incorporated capital investments reflective and responsive to regional planning activities that impact its service area. Please see section 8.1.6.1 |

## 2. OVERVIEW OF DISTRIBUTION SYSTEM

This section provides an overview of the features of Hydro Ottawa's distribution service area, including regional factors, such as weather and high-level asset demographics. A map depicting Hydro Ottawa's service territory is shown in Figure 2.1.

**Figure 2.1 – Hydro Ottawa Service Territory**

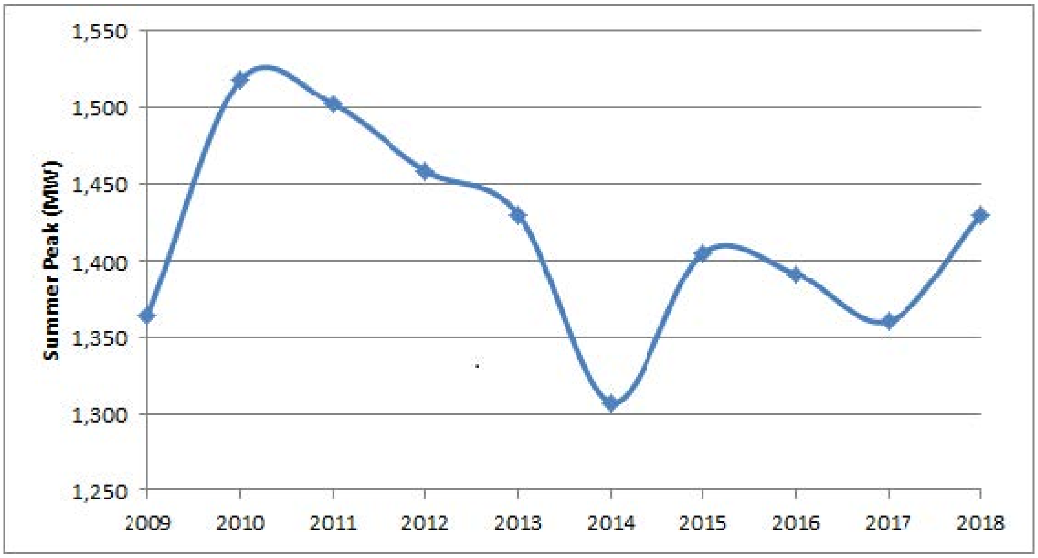



### 2.1. FEATURES OF THE DISTRIBUTION SERVICE AREA

Hydro Ottawa was formed in November 2000, following the amalgamation of five municipally-owned electric utilities (Gloucester Hydro, Goulbourn Hydro, Kanata Hydro, Nepean Hydro and Ottawa Hydro) from the former region of Ottawa-Carleton and the restructuring of the Ontario electricity sector as a result of the *Electricity Act, 1998*. In 2002, Casselman Hydro was acquired by Hydro Ottawa and joined the amalgamated utility. The amalgamation of the six distinct utilities resulted in an overall diverse system, with multiple service voltages comprising assets stemming from a variety of procurement and construction standards. Since amalgamation, Hydro Ottawa has focused on consolidating the systems and standards with common processes.

As of the end of 2019, Hydro Ottawa distributes electricity to approximately 340,000 metered customers within the City of Ottawa and the Village of Casselman. The service area covers 1,116 square kilometers and is supplied by an even mix of overhead and underground distribution lines. In 2018, Hydro Ottawa purchased a total of 7,446 gigawatt hours of electricity from the provincial grid to supply to customers. The Hydro Ottawa system peaks in the summer at a level that has remained relatively constant (maximum of 1,518 MW in 2010 and minimum of 1,308 MW in 2014) over the past decade. While population growth continues to increase, reductions from conservation programs, improvements in appliance efficiencies, and the installation of ERFs have offset the demand requirements of intensification. As the City grows, former rural areas fed by long distribution lines are becoming urban centres. This has created a new dynamic of customer requirements for higher reliability. Figure 2.2 depicts the net system summer peak (i.e. including embedded generation) over the last 10-year period.

**Figure 2.2 – Net System Summer Peak (2009-2018)**




Distribution expansion within Hydro Ottawa's service territory is impacted by both natural and constructed barriers including the Rideau River, the Greenbelt, and 400-Series highways, which limit distribution connectivity in some areas of the system. As a result, system planning must consider these barriers when identifying routing for distribution circuitry and evaluating capacity options.

Large segments of the system were constructed in the 1960s, 1970s, and 1980s, with a typical expected service life for these assets on the order of 50 years. Consequently, a considerable proportion of the system has exceeded or is approaching its anticipated end of life. These aging assets pose an increasing failure potential, and without corrective actions, will impact the utility's ability to maintain system reliability and minimize unplanned renewal cost in the future.

Overall, the City of Ottawa continues to grow in population and developed lands. The Ottawa-Gatineau population has consistently grown by 22,000 (1.5%) residents annually since 2015 (see Table 2.1 below). On the Ottawa side, this development is primarily focused in five regions: the Downtown Core, Nepean & Riverside South, South Kanata & Stittsville, the Village of Richmond, and Orleans. This growth is being seen through the development of new mixed commercial/residential communities, intensification of existing communities, and major projects like the Ottawa LRT system. The location of major growth areas is shown in Figure 2.3.

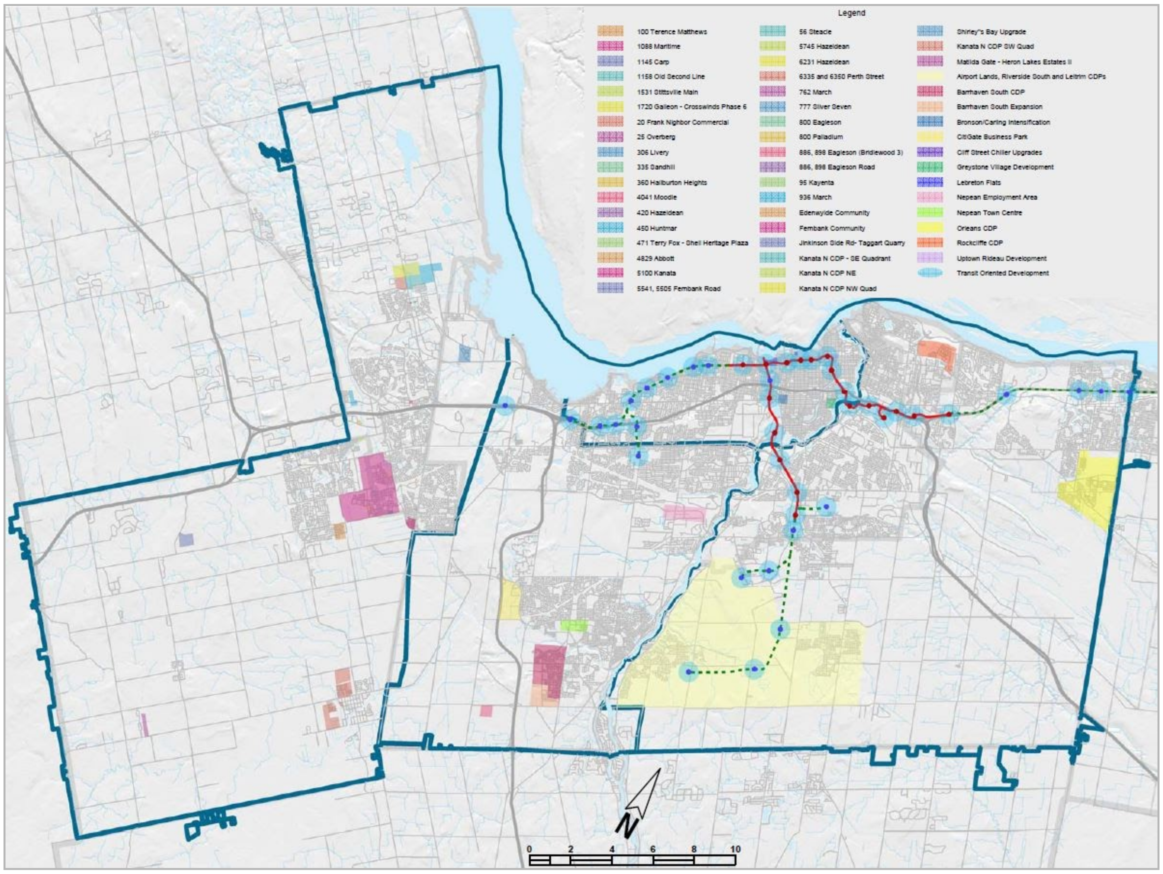
**Table 2.1 – Ottawa-Gatineau Population and GDP Growth**

| | | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|---|---|---|
| **Population** | ($'000s) | $1,336 | $1,360 | $1,388 | $1,409 | $1,429 | $1,447 | $1,466 |
| | *(%)* | *1.12%* | *1.79%* | *2.03%* | *1.55%* | *1.39%* | *1.30%* | *1.27%* |
| **GDP** | ($'000,000s) | $65,041 | $66,629 | $68,806 | $69,994 | $71,515 | $72,892 | $74,351 |
| | *(%)* | *1.86%* | *2.44%* | *3.27%* | *1.73%* | *2.17%* | *1.93%* | *2.00%* |

*Source: Conference Board of Canada. Figures are from Q4 in the year cited.

HydroOttawa

**Figure 2.3 – Primary Areas of Growth in Hydro Ottawa's Service Territory**




## 2.2. SYSTEM CONFIGURATION

Hydro Ottawa's distribution system has diverse characteristics, which have endured since the amalgamation of the six former municipal utilities. The system has six different distribution operating voltages that are constructed in a mix of overhead and underground systems. The majority of the underground infrastructure is located in the downtown and suburban areas.

The stations supplying the service area are a mix of Hydro Ottawa-owned and HONI-owned stations and transformers. Formerly, HONI owned all transmission-connected transformers supplying Hydro Ottawa-owned breakers at the low voltage side to distribute electricity throughout the service area. The current practice for newly built transmission-connected stations is for Hydro Ottawa to construct and own all equipment.

Table 2.2 below shows the length of overhead and underground lines in Hydro Ottawa's distribution system.

**Table 2.2 – Length of Underground & Overhead Lines**

| Orientation | Total Length (km) | Total Length (%) |
|---|---|---|
| Underground | 3,022 | 52.4% |
| Overhead | 2,745 | 47.6% |
| **TOTAL** | **5,767** | **100%** |

Table 2.3 below shows the number of circuits and length of overhead and underground cables per voltage level in Hydro Ottawa's distribution system.

**Table 2.3 – Number & Length of Circuits by Voltage Level**

<table>
<tr><th>Voltage Level</th><th>Number of Circuits</th><th>Total Overhead (km)</th><th>Total Underground (km)</th></tr>
<tr><td>4.16 kV</td><td>280</td><td>620</td><td>278</td></tr>
<tr><td>8.32 kV</td><td>115</td><td>687</td><td>507</td></tr>
<tr><td>12.43 kV</td><td>6</td><td rowspan="2">459</td><td rowspan="2">918</td></tr>
<tr><td>13.2 kV</td><td>314</td></tr>
<tr><td>27.6 kV</td><td>51</td><td>785</td><td>1,312</td></tr>
<tr><td>44 kV</td><td>17</td><td>194</td><td>7</td></tr>
<tr><td>TOTAL</td><td>783</td><td>2,745</td><td>3,022</td></tr>
</table>

Table 2.4 below shows the number of transformer stations in Hydro Ottawa's service territory per voltage level.

**Table 2.4 – Number of Transformer Stations**

| Secondary Voltage Level | # of Stations | # of Transformers Owned by Hydro Ottawa | # of Transformers Owned by HONI |
|---|---|---|---|
| 4.16 kV | 35 | 97 | 0 |
| 8.32 kV | 24 | 42 | 2 |
| 12.43 kV | 2 | 3 | 0 |
| 13.2 kV | 12 | 2 | 23 |
| 27.6 kV | 15 | 23 | 6 |
| 44 kV | 3 | 0 | 6 |
| **TOTAL** | **91** | **167** | **37** |

## 2.3. AREA CONSIDERATION

The following examples outline some of the issues and concerns that are taken into consideration when planning the distribution system in Ottawa.

### 2.3.1. Physical and Administrative Barriers

Hydro Ottawa's service territory sits at the convergence of three major rivers: the Ottawa River, the Gatineau River and the Rideau River. The Ottawa River functions as the northern border of Hydro Ottawa's service territory, beyond being the province of Quebec. Hydro Ottawa is otherwise completely surrounded by HONI's service territory. The Rideau River and Rideau Canal, which by-passes unnavigable sections of the Rideau River, wind through the service area. Around the main urban area of the City of Ottawa is an extensive Greenbelt comprised of mostly forest, farmland and marshland. Outside of the Greenbelt, there are a number of rapidly growing suburban communities. Constructed barriers such as divided highways (417, 416 and 174) further subdivide the territory.

As the Nation's Capital, there are a number of federal lands in Hydro Ottawa's service territory which are managed by different government agencies. These federal lands can present an administrative barrier, which drive technical and administrative challenges in the construction and maintenance of distribution interconnections. These conditions can often result in increased cost and time required to create or augment new distribution interconnections within the service territory.

### 2.3.2. Soil Conditions

The Ottawa area soil conditions generally fall within two categories: till soils with loam to sandy loam texture, and clay soils. There are also extensive bogs within the region consisting of pockets of moist to wet soils. These conditions call for increased civil infrastructure (piling) beneath the civil footings to ensure the stability of structures, specifically within stations. The piling necessitates further excavation, resources, material and design, and therefore higher costs. Due to the shallow bedrock there can be increases in costs associated with boring or excavating (e.g. with the installation of poles, ducts, or piling to support civil structures). In the west area of the City, there are regions of exposed sedimentary bedrock.

### 2.3.3. Seismic Zone

Ottawa sits within Zone 4 for Seismic Acceleration (0.16-0.23g) and Zone 2 for Seismic Velocity (0.0-0.11m/s). Ottawa falls within the Western Quebec seismic zone which sees on average one earthquake every five days.[1] This condition requires civil footings and foundations to be designed and constructed to withstand these higher seismic levels. Larger foundations and footings require more reinforcing steel (rebar), larger excavations, and more concrete, contributing to increases in capital expenditures.

The seismic zone also requires that additional steel cross bracing is designed and installed on all structures. The additional bracing results in larger design, fabrication, and installation costs than that of a zone of lower seismic activity.

## *2.4. CURRENT AND FUTURE CLIMATE*

In comparison to other major Ontario cities (with the exception of Sudbury), Ottawa is characterized by having generally lower wind speeds and colder winters with higher snowfall.

[1] Natural Resources Canada, *Earthquake Zones in Eastern Canada:* http://www.seismescanada.rncan.gc.ca/zones/eastcan-en.php#WQSZ.

Hydro Ottawa strives to complete capital work year-round. However, work must be scheduled to accommodate the winter months in which there are more challenges to overcome in the field (e.g. snow removal) before work can commence.

The data presented in the following charts represent the Climate Normals from 1981-2010 for major cities in the province, as recorded by the Government of Canada.

**Figure 2.4 – Daily Maximum Temperature**

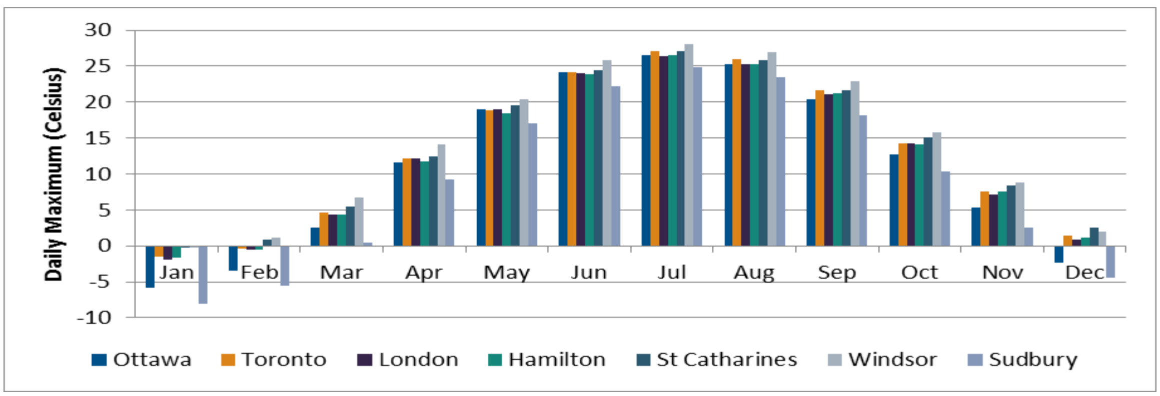
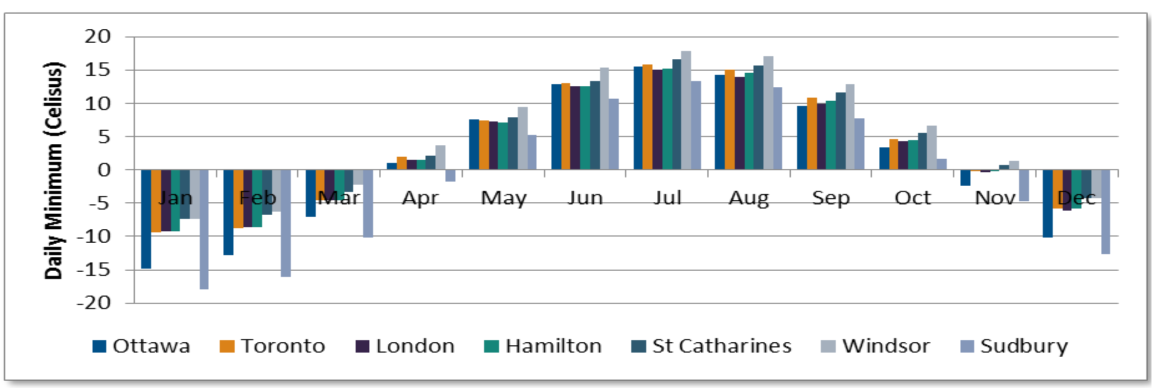
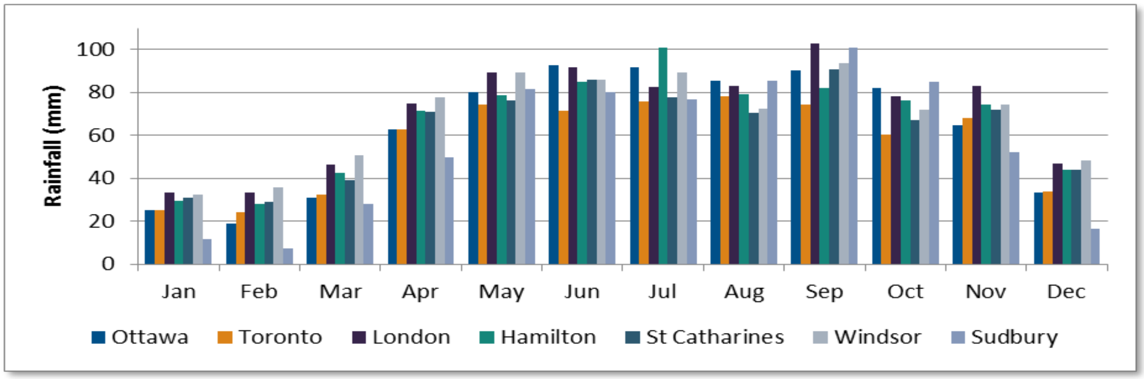


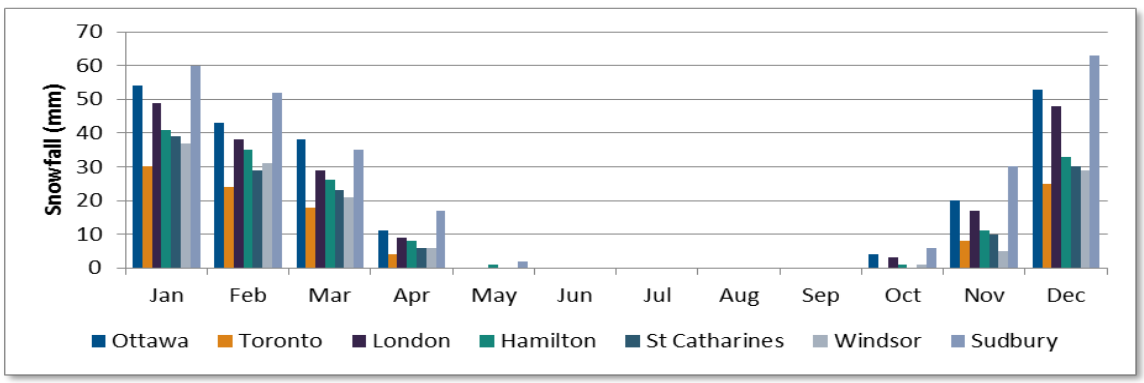

**Figure 2.5 – Daily Minimum Temperature**



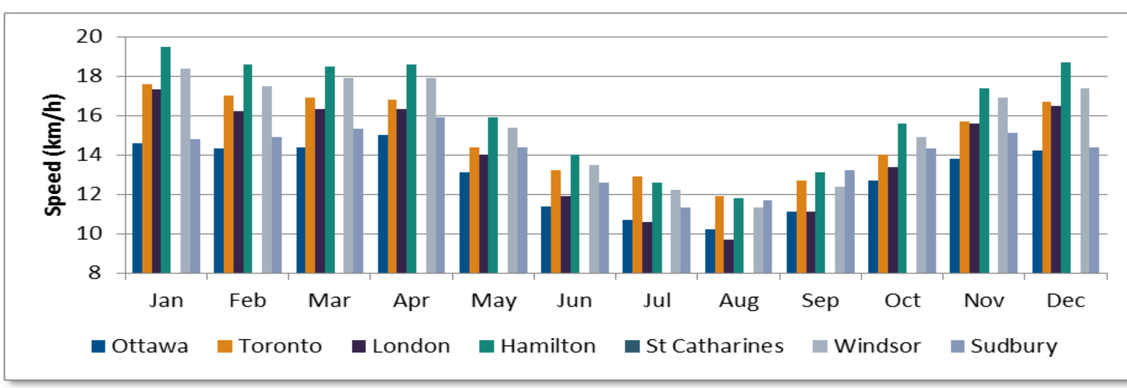
## Figure 2.6 – Rainfall




## Figure 2.7 – Snowfall




## Figure 2.8 – Wind Speed



**Temperature Profile**

The Ottawa region temperature profile requires that equipment operate under a temperature range of -40 to +40 degrees Celsius. Various pieces of equipment, such as those containing inert gasses, require extra heaters to ensure reliable operation at the lower end of this temperature range. The requirement of additional heaters on equipment typically results in design modifications and the procurement of non-standard equipment.

**Ice Accumulation & Snow Loading**

Due to the amount of snowfall and ice accumulation experienced in Ottawa, civil structures (structural steel) must be able to withstand a significant amount of snow and ice build-up without impacting structural integrity. This requires that the specific alloys chosen must be of high quality and thus increases the cost of fabrication. Hydro Ottawa follows Canadian Standards Association ("CSA") and American Society for Testing and Materials ("ASTM") standards in order to ensure that structures are able to withstand winter conditions.

Substations are classified as "post-disaster buildings" as defined by the Ontario Building Code. The Ontario Building Code Supplement SB-1 lists the weather design criteria for buildings and structures, including snow load.

Another impact of the harsh winters is an increased use of road salt which can lead to premature rusting of equipment located along the road right of way. The salt spray from roadways increases the need to repaint and repair rusted underground and overhead equipment. Salt contamination on porcelain insulators can lead to pole fires and flashovers. Insulator washing is necessary to mitigate the risk of these failure modes.

### 2.4.1. Future Climate Projections

Weather patterns in the region are changing as a result of climate change and will ultimately result in Hydro Ottawa needing to adjust operations and infrastructure. Projections of the 2050s climate parameters in this section were prepared by Risk Science International for Hydro Ottawa as part of a Climate Vulnerability and Risk Assessment that was commissioned by the utility (see Attachment 2-4-3(H): Distribution System Climate Risk and Vulnerability Assessment). These forecasts are based on a “business as usual” climate scenario, which the Intergovernmental Panel on Climate Change (“IPCC”) refers to as the Representative Concentration Pathway (“RCP”) 8.5. Based on this scenario, it is assumed that global carbon emissions will continue to rise until 2100. Current estimates of GHG emissions are still close to following the RCP 8.5 path and thus this is considered to be conservative but realistic at this time. Details of Hydro Ottawa’s climate adaptation plans can be found in section 8.1.6.3.

**Temperature**

The climate models project that certain areas within Southern Ontario could have summers that are 2-3°C warmer by the mid-century and potentially 4-5°C warmer by as early as 2071. The warming of the climate system is also leading to important changes in temperature extremes. For example, at the Ottawa Airport, the average annual number of days with a maximum temperature of 30°C or greater has increased from 13.4 days to 15 days over the 1981-2010 time period. Similarly, an increase in the frequency and duration of heat waves has also been observed in the region and is expected to increase in the future.

Other warming trends expected for the region under current emissions rates include:

- An increase in the number of days per year where the temperature reaches above 25ºC an average of 99 times per year up from 62-63 times per year as a baseline)
- An increase in the number of days per year where the temperature reaches above 30ºC (an average of 42 times per year up from 14-15 times per year as a baseline)
- A decrease in the number of days per year at or colder than -35ºC (an average probability of 3% of occurrence per year declining to 0.1% chance of probability).
- The annual number of freeze-thaw cycles is projected to decrease under climate change, from a baseline (1981-2010) mean of ~76 cycles per year to 59-60 cycles per year by the 2050’s. While the number of freeze-thaw cycles is projected to decrease in many months under climate change, increases are projected for the months of

December, January, and February, during which freeze-thaw cycles can be particularly damaging.

**Figure 2.9 – Pole Replacement Following 2018 Ice Storm**

## Precipitation

The Ottawa region has experienced an overall increase in annual precipitation, with total precipitation increasing 25.9 mm at the Ottawa Airport during the 1981-2010 time period. Future climate projections indicate an increase in precipitation for all seasons in the coming decades.

More importantly, the short duration-high intensity ("SDHI") rainfall event – i.e. a rainfall threshold of 50 mm in 1 hour – is expected to increase in annual probability from 1% today to 4.5% by 2050. SDHI events are more likely to result in flooding as stormwater infrastructure is overwhelmed by the sheer volume of water being deposited.

Over the next few decades, a slight decline in precipitation is expected during the summer months and an increase in precipitation during the winter and spring seasons. This means drier summers and wetter winters, and when rain or snow does fall, it is likely to be more variable and shorter, meaning intense rainfall or snow events are likely to be more common by the end of the century. The decline in winter precipitation means that declines in snowfall as a result of climate change are expected. More ice storms and freezing rain are also anticipated, as temperatures fluctuate around zero degrees. While the frequency of these events is projected to increase under climate change, large magnitude events will continue to be relatively rare.

**Wind**

The frequency of straight-line wind events with wind gusts that are greater than 60 km/hour are projected to increase from 14-15 times per year to 16 times per year by the 2050s. High straight-line wind gust events where the winds exceed 80 km/hour are projected to remain steady with approximately one to two instances per year. Damaging straight-line wind events, in the form of microbursts, can result in more damage than tornadoes as the winds can be stronger and affect a much larger area than a tornado. These events tend to occur during lightning storms.

**Tornadoes**

It is conservatively estimated that the annual probability of an Enhanced Fujita ("EF") scale category 1 or greater tornado impacting Hydro Ottawa's service territory could increase from 14.6% to 18.2% by the 2050s. Although the probability of a tornado event occurring remains low over the next century, a tornado can result in considerable damage to infrastructure.

**Lightning**

Estimates of increases in lightning frequency for the region indicate that lightning activity could be expected to increase by about 12% (per degree Celsius of warming), with about a 50% rise over the 21st century. It is projected that flash density in the region will increase in annual frequency from 1.1% to 1.5% by 2050. Furthermore, the length of the higher frequency lightning season is also expected to increase with warming under climate change.

**Fog**

Fog in the winter months promotes aerosolizing of salts (e.g. road salt) which can result in corrosion to Hydro Ottawa's infrastructure and cause pole fires and flashovers. During the 1981-2010 baseline, winter fog has been observed an average of 49 days per year and with a decreasing frequency over the 30-year period. During this baseline, there is an annual probability of 37% for a winter with 50 or more fog days. Days with winter fog are likely to increase under climate change as winter temperatures warm, increasing moisture availability and promoting more evaporation in the region.

# 3. ASSET MANAGEMENT STRATEGY & OBJECTIVES

## *3.1. CORPORATE STRATEGIC OBJECTIVES*

Hydro Ottawa's *2016-2020 Strategic Direction* sets the organization's overarching objectives, which, in turn, drive the Asset Management Process and planning practices. This framework provides context for Hydro Ottawa's Strategic Asset Management Plan ("SAMP") and DSP, and is referenced throughout both documents.

One of the central challenges facing Hydro Ottawa and other utilities is the need to invest heavily in the replacement and modernization of aging and deteriorating infrastructure without putting upward pressure on customer rates, which continue to rise due to increased electricity commodity prices. In this context, achieving efficient and effective operations has never been more important to the utility. Hydro Ottawa must continually find ways to work smarter and more efficiently – and the utility is doing just that.

**Strategy**

The essence of Hydro Ottawa's business is to put the customer at the centre of everything we do. Reorienting our activities around the customer was the primary goal of our *2016-2020 Strategic Direction*, and customer centrality continues to drive our business strategy. The utility believes that a sharp focus on the value we provide to our customers will generate positive results in all areas of performance – financial strength and business growth, operational efficiency and effectiveness, and contributions to the well-being of the community.

A core premise of the *2016-2020 Strategic Direction* is that the electricity service model is in the midst of significant transformation – taking on a more decentralized, customer-centric, technologically-advanced, and environmentally-sustainable form. The transition to a more customer-driven and customer-centric model of electricity will present opportunities for energy providers that are able to innovate, and challenges for those that fail to adapt. Hydro Ottawa's strategy for responding to this emerging landscape involves the following core elements:

- Taking customer experience to the next level;
- Continuing to achieve strategic growth;
- Ensuring access to capital for growth;
- Making sure the utility has the right skill sets and organizational capacity to deliver on existing and new business lines;
- Continuing to enhance operational performance, including productivity and safety;
- Continuing to build public confidence and trust; and
- Being ready to embrace change and disruption in the industry.

Hydro Ottawa's aim is to be the trusted energy advisor for our customers – large and small – and our community. As the energy needs and options of our customers and our community evolve, and as signature projects and developments proceed, Hydro Ottawa will play a leading role in helping the City to transition to a smart energy future.

The utility will also continue to grow shareholder value, maintaining a focus on strategic business growth within core areas of strength.

Taken as a whole, Hydro Ottawa believes this strategy for the utility's future presents a balanced program for solid performance, adaptation to a changing business environment, and sustainable and profitable business growth.

**Mission**

To create long-term value for our shareholder, benefitting our customers and the communities we serve.

Hydro Ottawa is both a community asset and an investment for our shareholder, the City of Ottawa. As a community asset, our purpose is to provide efficient and reliable services and a first-class customer experience to our customers, and to continue to be a strong strategic partner with the City, helping to deliver on its economic development and environmental agendas. As an investment, our purpose is to provide stable, reliable and growing returns, and to increase shareholder value both in the short- and long-term.

**Vision**

Hydro Ottawa – *a leading partner in a smart energy future*

**Guiding Principles**

Hydro Ottawa is committed to creating long-term value in a manner that will withstand the test of public scrutiny and inspire confidence and trust. To that end, the utility strives to achieve excellent operating and financial results while abiding by professional standards of conduct. Hydro Ottawa is guided not only by legal obligations, but also by best governance and business practices, and standards established by independent agencies. These expectations provide the foundation for our commitment to all of our stakeholders, and are reflected in our organizational values, our Code of Business Conduct, and our operating policies and procedures.

**Organizational Values**

Hydro Ottawa is committed to an organizational environment that fosters and demonstrates ethical business conduct at all levels and reflects our shared values of teamwork, integrity, excellence and service. Every employee must lead by example in this endeavour.

**Commitment to our Stakeholders**

Hydro Ottawa takes into account the interests of all our stakeholders including employees, customers, suppliers, our shareholders, and the communities and environment in which we operate.

- **Employees** – The quality of our workforce is our strength and we will strive to hire and retain the best-qualified people available and maximize their opportunities for success. Hydro Ottawa is committed to maintaining a safe, secure and healthy work environment enriched by diversity and characterized by open communication, trust, and fair treatment.

- **Customers** – Our continued success depends on the quality of our customer interactions, and we are committed to delivering value across the entire customer experience. We are honest and fair in our relationships with our customers, and provide reliable, responsive and innovative products and services in compliance with legislated rights and standards for access, safety, health and environmental protection.

- **Suppliers & Contractors** – We are honest and fair in our relationships with our suppliers and contractors and purchase equipment, supplies and services on the basis of merit, with a preference for local procurement. We pay suppliers and contractors in accordance with agreed terms, encourage them to adopt responsible business practices, and require them to adhere to our health, safety and environment standards when working for Hydro Ottawa.

- **Community & the Environment** – We are committed to being a responsible corporate citizen and will contribute to making the communities in which we operate better places to live and do business. We are sensitive to the community's needs, and dedicated to protecting and preserving the environment where we operate.

- **Shareholder & Other Suppliers of Finance** – We are financially accountable to our shareholders and to the institutions that underwrite our operations, and communicate to them all matters material to our organization. We protect our shareholder's investment, and manage risks effectively. We communicate to our shareholder all matters that are material to an understanding of our corporate governance.

**Four Key Areas of Focus (Corporate Strategic Objectives)**

Hydro Ottawa's success in the past has been achieved by focusing on four critical areas of performance – the utility's four Key Areas of Focus.

**Figure 3.1 – Corporate Strategic Objectives**


In each of these areas, Hydro Ottawa has set one overarching objective:

- **Customer Value**: We will deliver value across the entire customer experience by providing reliable, responsive and innovative services at competitive rates;

- **Financial Strength**: We will create sustainable growth in our business and our earnings by improving productivity and pursuing business growth opportunities that leverage our strengths – our core capabilities, our assets and our people;

- **Organizational Effectiveness**: We will achieve performance excellence by cultivating a culture of innovation and continuous improvement; and

- **Corporate Citizenship:** We will contribute to the well-being of the community by acting at all times as a responsible and engaged corporate citizen.

## 3.2. ASSET MANAGEMENT OBJECTIVES

Hydro Ottawa has structured its asset management processes for Distribution Assets to align with best practices described in the ISO 55001 Asset Management Standard. A cross-functional team from the organization has developed and supports the implementation of the plan to meet Hydro Ottawa's five Asset Management Objectives, which are outlined in Table 3.1.

**Table 3.1 – Asset Management Objectives**

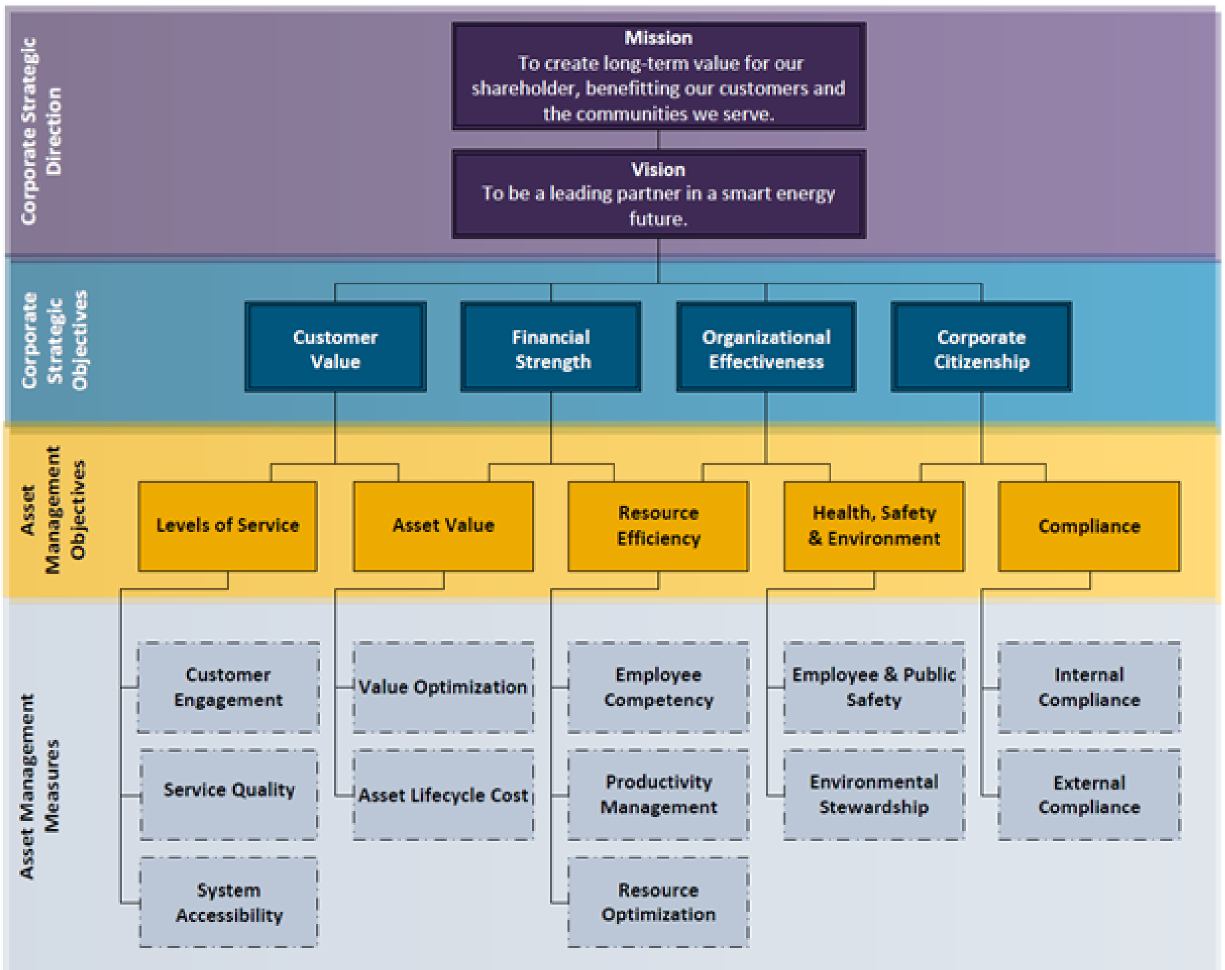
| Asset Management Objective | Description |
|---|---|
| Levels of Service | To maintain and enhance leading performance of the distribution system through improving electrical service and alignment with customers' expectations |
| Asset Value | To maximize the realization of value from distribution system assets over their entire lifecycle through managing risks and opportunities |
| Resource Efficiency | To maximize economic efficiency by minimizing costs associated with maintaining and operating the distribution system |
| Health, Safety & Environment | To minimize employee and public health and safety risks and environmental risks from distribution system activities |
| Compliance | To maintain compliance with all internal and external requirements while managing the distribution system |

The Asset Management Objectives have been identified as drivers in the success of the Corporate Strategic Objectives. The successful delivery of these objectives is implemented through Hydro Ottawa's Asset Management System, Asset Management Process, and the utility's portfolio of capital, operational, and maintenance projects.

The success of the Asset Management Objectives is expressed in terms of Asset Management Measures. These are specific goals which are directly impacted by the work carried out under the Asset Management Process. The evaluations of the Asset Management Measures are used to prioritize projects as described in the process outlined in section 5 Asset Management & Capital Expenditure Process.

The alignment and interplay between the Corporate Strategic Direction and Objectives through to the Asset Management Objectives and Measures is shown in Figure 3.2.

**Figure 3.2 – Corporate Strategic Direction & Asset Management Objectives**



# 4. PERFORMANCE MEASUREMENT FOR CONTINUOUS IMPROVEMENT

Hydro Ottawa monitors and tracks performance measurements to identify risks and opportunities for continuous improvement.

This section will cover the following:

- Distribution System Planning Process Key Performance Indicators
- Unit Cost Metrics
- Historical Reliability Performance Analysis
- Historical Performance Impact on DSP
- Realized Efficiencies Due to Smart Meters

## *4.1. SYSTEM PLANNING PROCESS KEY PERFORMANCE INDICATORS*

Hydro Ottawa uses Key Performance Indicators ("KPIs") to measure and support continuous improvement in Customer Oriented Performance, Cost Efficiency & Effectiveness, Asset Performance and System Operations Performance. These KPIs are quantitative measures and align with Hydro Ottawa's Asset Management Objectives, and by extension, with Hydro Ottawa's Corporate Strategic Objectives. These measures are used to monitor the effectiveness of Hydro Ottawa's planning processes, efficiencies in carrying out work, as well as identifying shortfalls and areas for continuous improvement.

Table 4.1 below summarizes the KPIs by Category, Asset Management Objective, and Sub-Category, and the corresponding section where the detailed description and historical performance can be found.

### Table 4.1 – System Planning Process Key Performance Indicators by Category

| Category | Asset Management Objective | Sub-Category | KPIs |
|---|---|---|---|
| **4.1.1 Customer Oriented Performance** | Levels of Service | 4.1.1.1 Customer Engagement | a. Customer Satisfaction<br>b. Staff Knowledge<br>c. Staff Courtesy<br>d. First Call Resolution<br>e. Residential & Small Commercial Satisfaction<br>f. Commercial Satisfaction<br>g. Staff Helpfulness<br>h. Value for Money<br>i. Customer Loyalty |
| | | 4.1.1.2 System Reliability | j. System Average Interruption Frequency Index (SAIFI)<br>k. System Average Interruption Duration Index (SAIDI)<br>l. Customer Average Interruption Duration Index (CAIDI)<br>m. Feeders Experiencing Multiple Sustained Interruptions (FEMI) |
| | | 4.1.1.3 System Power Quality | n. System Average Root Mean Square Variation Frequency Index (SARFI) |
| **4.1.2 Cost Efficiency & Effectiveness** | Compliance | 4.1.2.1 Cost Efficiency | o. Cost Efficiency |
| | Resource Efficiency | 4.1.2.2 Labour Utilization | p. Productive Time<br>q. Labour Allocation |
| **4.1.3 Asset Performance** | Asset Value | 4.1.3.1 Defective Equipment Contribution to SAIFI | r. System Average Interruption Frequency Index – Defective Equipment ($SAIFI_{DE}$) |
| | Health, Safety & Environment | 4.1.3.2 Public Safety Concerns | s. Public Safety Concerns (PSC) |
| | | 4.1.3.3 Oil Spilled | t. Litres Annual Oil Spilled<br>u. Cost of Annual Oil Remediation |
| **4.1.4 System Operations Performance** | Levels of Service | 4.1.4.1 Stations Capacity | v. Stations Exceeding Planning Capacity<br>w. Stations Approaching Rated Capacity |
| | | 4.1.4.2 Feeder Capacity | x. Feeders Exceeding Planning Capacity<br>y. Feeders Approaching Rated Capacity |
| | | 4.1.4.3 System Losses | o Losses |

The following sections describe the KPIs used by Hydro Ottawa to monitor the quality of the planning process and the efficiency with which the plans are implemented and the extent to which the planning objectives have been met.

### 4.1.1. Customer Oriented Performance

Hydro Ottawa's KPIs surrounding Customer Oriented Performance align with the asset management objective for Levels of Service, which is to "maintain and enhance leading performance of the distribution system through improving electrical service and alignment with customers' expectations." Specifically, Hydro Ottawa continuously seeks feedback from customers on their satisfaction with the services provided by the utility. The customer satisfaction levels are greatly impacted by the distribution system's service reliability which is integral to all work undertaken as part of system planning. Hydro Ottawa continually assesses system reliability, and where gaps are found, implements appropriate actions to address the issues.

#### *4.1.1.1. Customer Engagement*

Customer value is at the core of Hydro Ottawa's Corporate Strategic Objectives and asset management objectives, and customers are engaged continuously to ensure their feedback is appropriately incorporated into planning of the distribution system. Annually, the utility engages customers with two surveys: a Touch Logic Survey and a Customer Satisfaction Survey (referred to as the SIMUL Survey). The results of these surveys provide Hydro Ottawa with KPIs used to identify areas of improvement and benchmark the utility's accomplishments against results of other utilities.

**Touch Logic Survey**

The Touch Logic survey is an automated survey sent to customers who have previously called the customer hotline. There are four KPIs evaluated for this survey (see Table 4.2), each measured as a percentage of customers who indicated they were neutral or satisfied with their service.

- Customer Satisfaction – the customer's overall level of satisfaction with the call;
- Staff Knowledge – the customer's assessment of the knowledge of the call centre staff;
- Staff Courtesy – the customer's assessment of the courtesy of the call centre staff; and
- First Call Resolution – the ability of the staff to deal with the customer's issue.

**Table 4.2 – Touch Logic Survey Results**

| KPI | Target | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|
| Customer Satisfaction | **90%** | 88% | 90% | 89% | 87% | 78% |
| Staff Knowledge | **90%** | 92% | 92% | 93% | 90% | 90% |
| Staff Courtesy | **90%** | 93% | 93% | 94% | 92% | 91% |
| First Call Resolution | **85%** | 84% | 85% | 85% | 84% | 86% |

The number of Touch Logic survey questions changed from six to four in late 2018 to better reflect the call centre performance. The questions previously used were too ambiguous and did not properly reflect customer satisfaction.

Hydro Ottawa uses the results from this survey to help assess customers' level of satisfaction with their interaction with Hydro Ottawa's call centre. In 2019, Hydro Ottawa will begin conducting email and web chat surveys to further improve this process.

**SIMUL Survey**

Hydro Ottawa's SIMUL survey captures customer service satisfaction numbers in five different categories:

- Residential and small commercial
- Commercial
- Staff Helpfulness – the helpfulness of staff who dealt with you
- Value for money
- Customer Loyalty – satisfied, would continue if given a choice, would recommend

Hydro Ottawa tracks the percentage that identify they are satisfied with the utility in each of these categories and sets a target to equal or better than the provincial average in each year (see Table 4.3).

**Table 4.3 – SIMUL Survey Results**

| KPI | | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|
| Pre-Survey Residential & Small Commercial (Target >90%) | Results | 83% | 87% | 81% | 90% | 94% |
| | Ontario Results | 83% | 86% | 81% | 85% | 91% |
| Pre-Survey Commercial (Target >90%) | Results | - | - | - | 90% | 94% |
| | Ontario Results | - | - | - | 90% | 93% |
| Staff Helpfulness (Target >80%) | Results | 73% | 75% | 81% | 74% | 65% |
| | Ontario Results | 65% | 67% | 69% | 66% | 64% |
| Value for Money (Target = 2% better than Ontario) | Results | 61% | 63% | 57% | 66% | 75% |
| | Ontario Results | 63% | 62% | 58% | 57% | 71% |
| Customer Loyalty - Satisfied (Target = 35%) | Results | 24% | 23% | 25% | 33% | 47% |
| | Ontario Results | 27% | 28% | 30% | 32% | 36% |

Feedback from these surveys is incorporated into Hydro Ottawa's planning process, and ultimately forms the basis of plans which address customer needs and service offerings. These results are compiled with the Voice of the Customer program to enable Hydro Ottawa to adapt processes and procedures in a timely manner in response to changing customer needs and expectations.

#### *4.1.1.2. System Reliability*

Hydro Ottawa tracks system reliability performance using four indicators: System Average Interruption Frequency Index ("SAIFI"), System Average Interruption Duration Index ("SAIDI"), Customer Average Interruption Duration Index ("CAIDI") and Feeders Experiencing Multiple Sustained Interruptions ("FEMI"). More detailed information regarding historical reliability performance can be found in section 4.3 - Historical Reliability Performance Analysis.

**System Average Interruption Frequency**

This index represents the average frequency of sustained interruptions per customer and is defined as follows:

$$SAIFI = \frac{Total\ number\ of\ customer\ interruptions}{Total\ number\ of\ customers\ served}$$

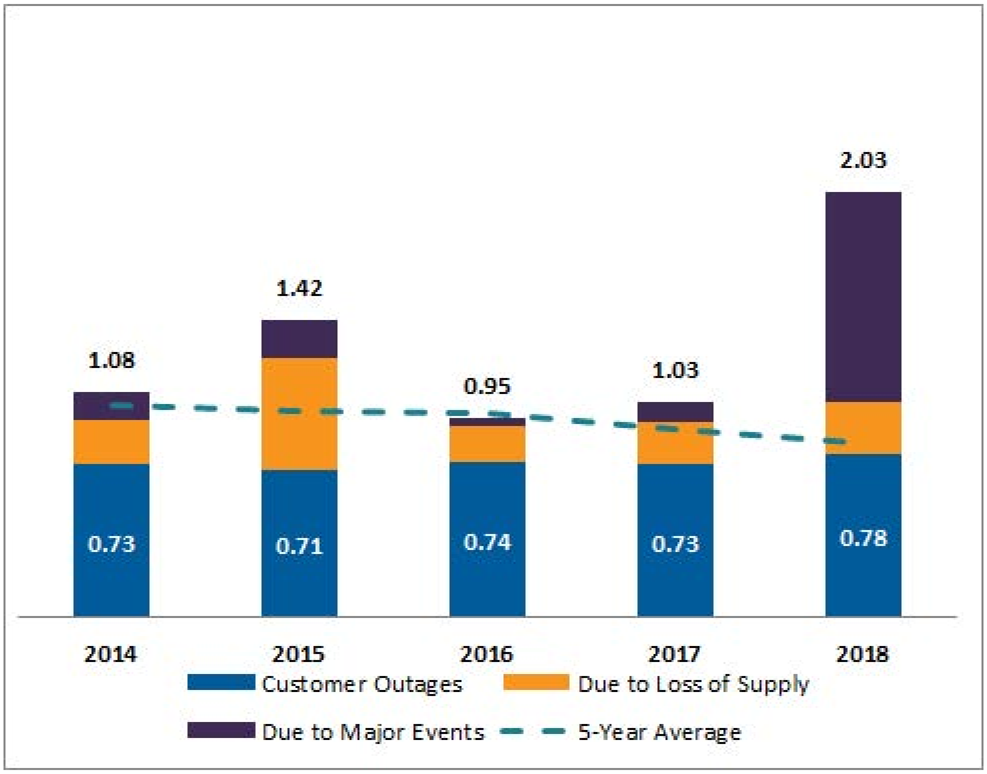
This index is reported both including and excluding Loss of Supply ("LoS") and Major Event Days ("MEDs").

Hydro Ottawa's target is to achieve or better the historical five-year average, excluding MEDs and LoS. This aligns with the OEB's distributor-specific target for reliability performance (see Table 4.4 and Figure 4.1).

**Table 4.4 – SAIFI Reliability Performance**

| Metric | | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|
| SAIFI | All Interruptions | 1.08 | 1.42 | 0.95 | 1.03 | 2.03 |
| | Excluding LoS | 0.86 | 0.75 | 0.78 | 0.83 | 1.19 |
| | Excluding LoS & MEDs | 0.73 | 0.71 | 0.74 | 0.73 | 0.78 |
| | 5-Year Historical Average | 1.02 | 0.99 | 0.98 | 0.90 | 0.83 |
| | Target Met | ● | ● | ● | ● | ● |

**Figure 4.1 – SAIFI Reliability Performance**




The reliability performance measure of SAIFI has been stable over the last five years (with LoS and MEDs excluded). The previous five years have all featured achievement of the target of the historical five-year average.[1]

Interruptions due to LoS and MEDs continue to have a large influence in maintaining a reliable system. Details of the historical MEDs can be found in section 4.3.2 - Major Events.

[1] For further details on how Hydro Ottawa's recent reliability performance compares favourably to other large electricity distributors in Ontario, please see Attachment 1-1-12(C): Electricity Utility Scorecard.

**System Average Interruption Duration Index**

This index represents the average interruption duration per customer and is defined as follows:

$$SAIDI = \frac{Total\ hours\ of\ customer\ interruptions}{Total\ number\ of\ customers\ served}$$

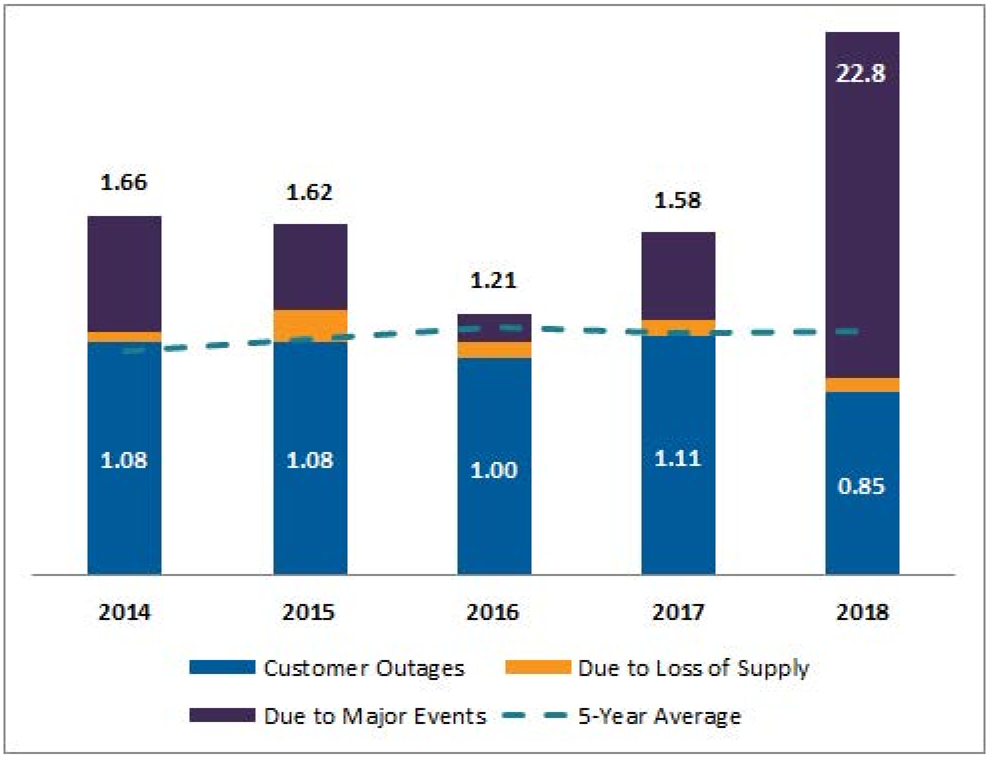
This index is reported both including and excluding LoS and MEDs.

Hydro Ottawa's target is to achieve or better the historical five-year average, excluding MEDs and LoS (see Table 4.5 and Figure 4.2). This aligns with the OEB's distributor-specific target for reliability performance.

**Table 4.5 – SAIDI Reliability Performance**

| Metric | | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|
| SAIDI | All Interruptions | 1.66 | 1.62 | 1.21 | 1.58 | 22.83 |
| | Excluding LoS | 1.59 | 1.15 | 1.13 | 1.51 | 3.54 |
| | Excluding LoS & MEDs | 1.08 | 1.08 | 1.00 | 1.11 | 0.85 |
| | 5-Year Historical Average | 1.04 | 1.09 | 1.15 | 1.12 | 1.13 |
| | Target Met | ● | ● | ● | ● | ● |

**Figure 4.2 – SAIDI Reliability Performance**




The reliability performance measure of SAIDI has been stable over the last five years (with Los and MEDs excluded), with particularly exceptional performance in 2018. The previous five years have all witnessed the achievement of the target of the historical five-year average, with the exception of 2014, where the SAIDI value excluding LoS and MEDs exceeded the five-year average by 0.04.

Interruptions due to MEDs continue to have a large influence in maintaining a reliable system. Details of the historical MEDs can be found in section 4.3.2 - Major Events.

**Customer Average Interruption Duration Index**

This index represents the average time required to restore power per sustained interruption and is defined as follows:

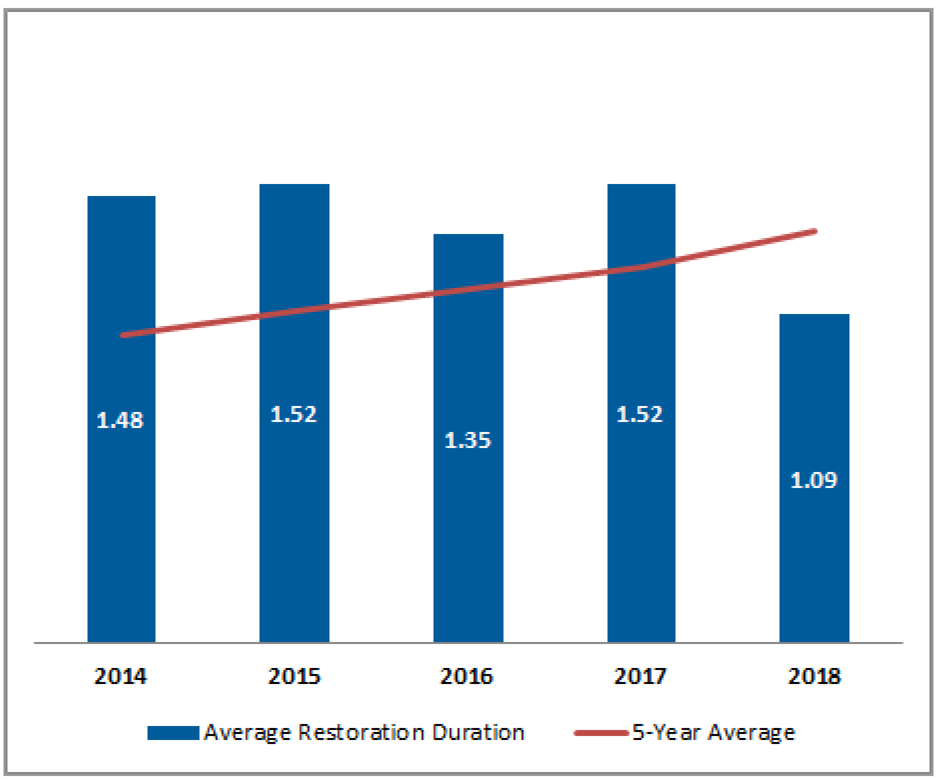
$$CAIDI = \frac{SAIDI}{SAIFI} = \frac{Total\ hours\ of\ customer\ interruptions}{Total\ number\ of\ customer\ interruptions}$$

This index is reported excluding LoS and MEDs (see Table 4.6 and Figure 4.3).

**Table 4.6 – CAIDI Reliability Performance**

| Metric | | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|
| CAIDI | Excluding LoS & MEDs | 1.48 | 1.52 | 1.35 | 1.52 | 1.09 |
| | 5-Year Historical Average | 1.02 | 1.10 | 1.17 | 1.24 | 1.36 |

**Figure 4.3 – CAIDI Reliability Performance**



Hydro Ottawa monitors the annual trend of CAIDI performance to evaluate potential concerns with restoration efforts. From 2014-2017, the CAIDI metric has been higher than the five-year average. Hydro Ottawa continues to target initiatives to reduce restoration times. In 2018, this is reflected in a significant reduction in the CAIDI metric.

**Figure 4.4 – Outage Caused by Tree Falling onto Overhead Line**

**Feeders Experiencing Multiple Sustained Interruptions**

The Feeders Experiencing Multiple Sustained Interruptions ("FEMI"$_n$) index represents the number of feeders experiencing sustained (greater than one minute) interruptions greater than or equal to value n; current reporting is done for n=10 – i.e. the count of feeders that have seen 10 or more sustained interruptions. Hydro Ottawa targets a $FEMI_{10}$ less than or equal to 10.

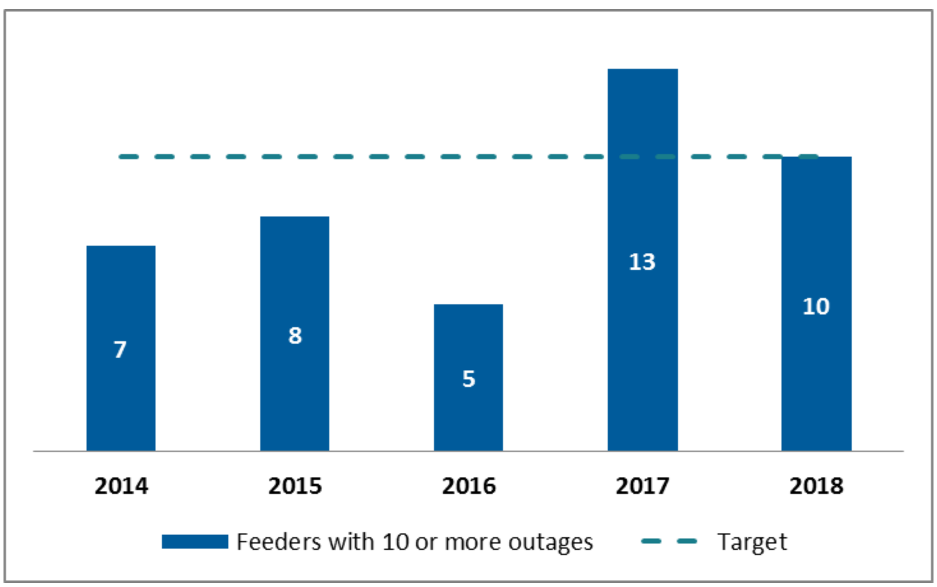
FEMI is used as a customer centric representation as it provides an indication as to which regions have seen reduced service quality. $FEMI_{10}$ is reported excluding Scheduled Outages, LoS, and MEDs.

Table 4.7 and Figure 4.5 show the historical system performance for FEMI.

**Table 4.7 – FEMI Reliability Performance**

| Metric | Target | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|
| **FEMI** | **10** | 7 | 8 | 5 | 13 | 10 |

**Figure 4.5 – FEMI Reliability Performance**




On average, Hydro Ottawa has been achieving its targets for FEMI. Hydro Ottawa tracks and evaluates feeders that affect the performance of the FEMI metric monthly at its Reliability Council, to identify projects to improve the reliability of these parts of the distribution system.

Hydro Ottawa will continue to evaluate the performance of feeders that appear in the FEMI metric to ensure customer reliability is maintained.

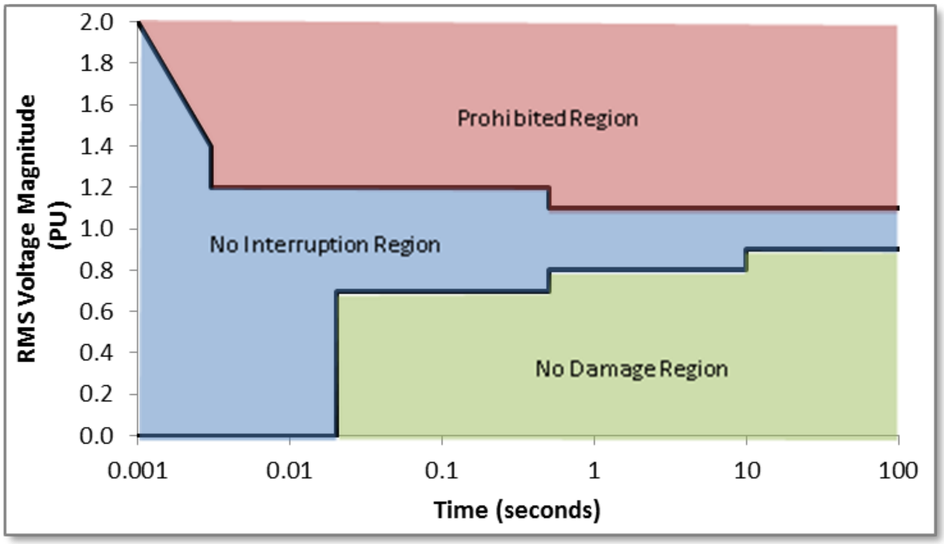
#### *4.1.1.3. System Power Quality*

Hydro Ottawa continuously monitors the quality of power supplied to its customers to ensure that it is meeting its required levels of service. This quality of power is based on industry standards for the delivery and use of power. With customer equipment becoming more sensitive to variations in the supplied power, monitoring the quality of this power has become an important factor in the levels of service provided.

**System Average RMS Variation Frequency Index**

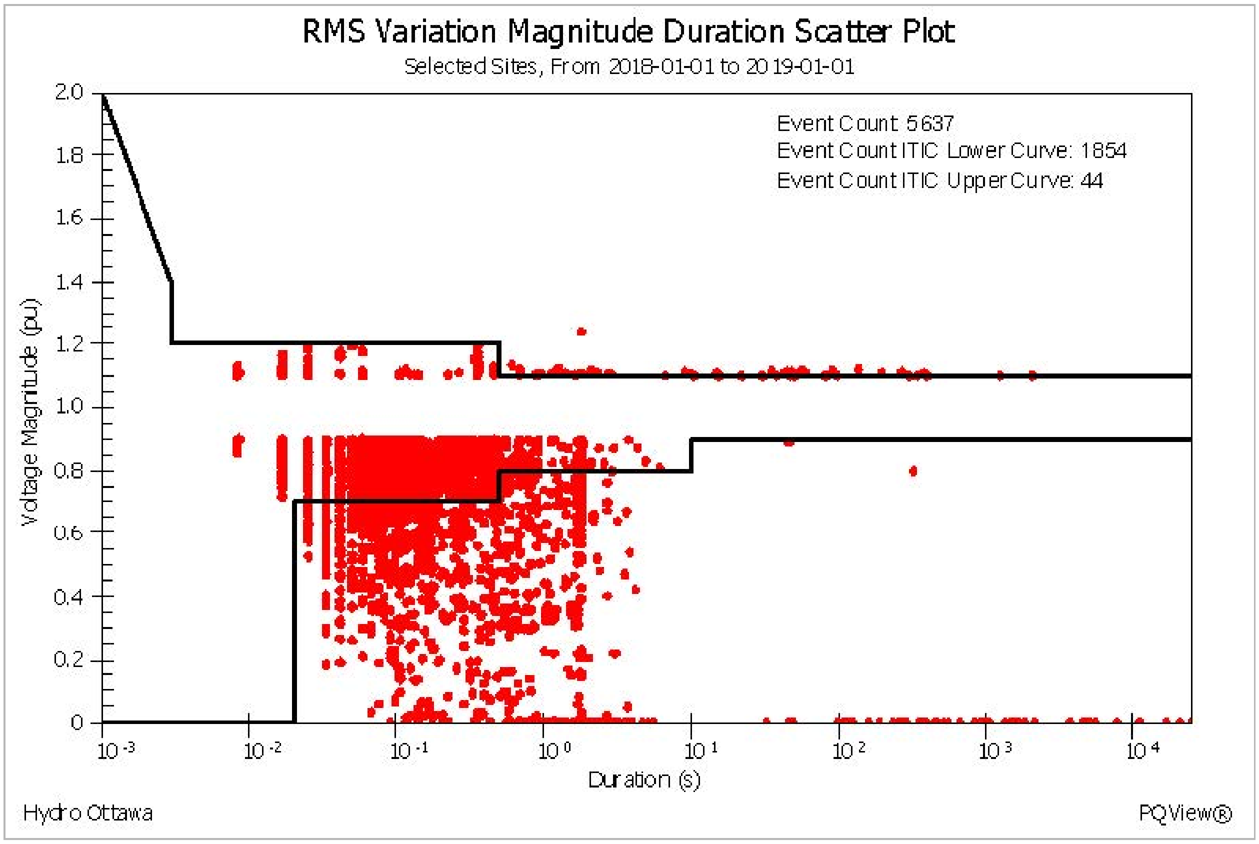
The System Average Root Mean Square ("RMS") Variation Frequency Index ("SARFI") is an indicator of system power quality which measures the average number of voltage sags or swells on the system. This index looks specifically at SARFI events that are caused by Hydro Ottawa or occur on the distribution system (i.e. excluding events originating from the transmission system or other third parties). Poor voltage is considered to be outside ±6% of the system nominal voltage and it is Hydro Ottawa's objective to maintain voltage within these tolerances and below the prohibited region of the Information Technology Industry Council ("ITIC") curve, as shown in Figure 4.6. The target is to identify areas of concern and implement corrective measures as soon as possible.

**Figure 4.6 – Information Technology Industry Council Curve**




As indicated in Figure 4.7, there were 5,637 events recorded in 2018. Of these, 44 fell within the prohibited region. Of the 44 prohibited events, five were due to events on Hydro Ottawa's system. There were no known customer impacts from these short duration RMS events. Hydro Ottawa continues to track and monitor SARFI events.

**Figure 4.7 – 2018 Power Quality Events ITIC Curve**




### 4.1.2. Cost Efficiency & Effectiveness

Annually, Hydro Ottawa determines the cost efficiency and labour utilization KPIs to report on the progress, efficiency, and effectiveness of its planning processes, as well as the efficiency of executing those plans. This helps to drive continuous improvement at the utility.

#### *4.1.2.1. Cost Efficiency*

On an annual basis, Hydro Ottawa uses cost efficiency as a means to monitor and report on the progress of carrying out the identified projects within the plans. This enables Hydro Ottawa to ensure the utility continues to deliver value to customers by demonstrating that it is effective in executing the capital projects deemed essential to the continued reliable operation of the distribution system.

**Cost Efficiency**

Cost efficiency is a measure of all planned capital projects, classified as either system renewal or system service investment categories, but excludes projects deemed as either system access or general plant and all emergency work. It is defined as the ratio of the amount of budget allocated for planned capital activities to the actual expenditures, per year. The formulation utilized appears below.

$$Cost\ Efficiency\ (\%) = \frac{Actual\ SS\ \&\ SR\ Expenditures}{Budgeted\ SS\ \&\ SR\ Expenditures} \times 100$$

Execution of planned capital projects are monitored through Hydro Ottawa's financial system. Deviations from the projected budget are administered via change request that is subject to approval on a case-by-case basis. Representatives from scheduling, construction, engineering, and design groups meet on a bi-weekly basis to prioritize and administer on-going and upcoming work. The target of the cost efficiency indicator is to achieve 100% completion of the annual planned work within the approved budget.

The yearly Cost Efficiency is shown in Table 4.8.

**Table 4.8 – Cost Efficiency**

| KPI | Target | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|
| Cost Efficiency | 100% | 94% | 94% | 94% | 95% | 113% |

Between the years 2014 and 2017, inclusive, the targeted value for this KPI was not achieved due to re-tasking of resources to address equipment failures. In 2018, the target was exceeded due to scope changes on large projects late in the year with insufficient time to adjust other projects and programs to align with the planned budget.

#### *4.1.2.2. Labour Utilization*

On an annual basis, Hydro Ottawa uses the labour utilization KPIs to monitor and report the progress, efficiency and effectiveness of carrying out plans, as well as identifying shortfalls as areas for continuous improvement. This measure enables the utility to demonstrate efficient use of its resources through good stewardship.

Hydro Ottawa monitors labour utilization performance using productive time and labour allocation KPIs.

**Productive Time**

The definition of productive time is the ratio of total regular hours charged to a work order (billable) and total regular hours available per year. The formulation used appears below.

$$\text{Productive Time} = \frac{\text{Percent of Billable Hours}}{\text{Total Regular Hours}}$$

This KPI is influenced by hours allocated for training, vacation, and sick time; further it does not account for work completed using overtime. Table 4.9 shows the trend of productive time for the last five years.

**Table 4.9 – Productive Time**

| KPI | Target | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|
| ProductiveTime | 74% | 71% | 74% | 74% | 73% | 72% |

The decrease in KPI observed in 2017 and 2018 is largely due to an increase in requests for extended sick leave for surgical procedures.

#### *4.1.2.3. Labour Allocation*

The definition of labour allocation is the ratio of the percentage of labour hours used to execute capital activities and the amount of total productive time (as defined above). The intent of this

KPI is to measure the proportion of time spent on capital activities, as per annual work plans, versus time used for OM&A activities. The formulation used appears below.

$$Labour\ Allocation = \frac{Percent\ of\ \ Labour\ Time\ on\ Capital\ Activities}{Total\ Productive\ Time}$$

Labour allocation can be affected by an increase in labour hours needed to perform operations and maintenance ("O&M") activities associated with supporting aging infrastructure, resulting in a reduction in available for capital projects. Table 4.10 shows how this KPI trends for the previous five years.

**Table 4.10 – Labour Allocation**

| KPI | Target | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|
| Labour Allocation | 61% | 60% | 61% | 62% | 60% | 58% |

The reduction observed in 2018, over 2017, results primarily from an increase in mutual aid responses undertaken in that year.

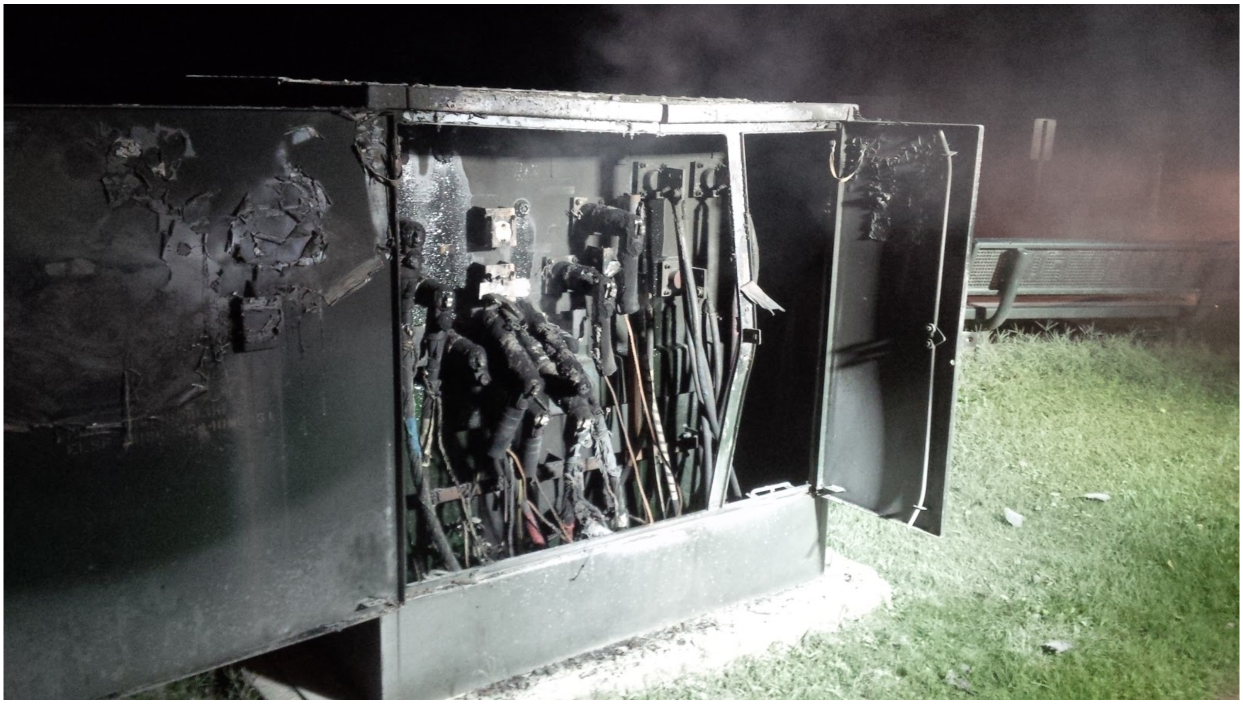
### 4.1.3. Asset Performance

Hydro Ottawa tracks asset performance through three metrics: defective equipment contribution to SAIFI, public safety concern notifications, and oil spilled incidents. Altogether, these metrics help Hydro Ottawa deliver on its asset management objectives. This section details these three metrics, and provides insight as to why these metrics are important tools used to mitigate risks in the distribution system.

#### *4.1.3.1. Defective Equipment Contribution to SAIFI*

The SAIFI metric is used by Hydro Ottawa to improve its levels of service, asset value, resource efficiency and compliance objectives. It allows Hydro Ottawa to identify assets that cause multiple outages and better focus its attention on issues directly affecting customers.

**Figure 4.8 – Catastrophic Failure of a Three-Phase Transformer**



This KPI tracks the contribution of defective equipment outages by asset class to the overall SAIFI (including MEDs) for 100 customers (SAIFI x 100). Hydro Ottawa's objective is to reduce the number of customer interruptions caused by defective equipment from year to year on a rolling basis. The yearly target is set by the average of the previous five years.

Each asset class contributes to the overall SAIFI reliability metric. Table 4.11 below details the contribution of each asset class to the SAIFI x 100.

**Table 4.11 – Defective Equipment SAIFI per 100 Customers**

| Asset – SAIFI x 100 | Target | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|
| Overhead System Assets | 10.13 | 12.73 | 7.89 | 6.70 | 13.69 | 9.58 |
| Station System Assets | 1.77 | 0.33 | 2.28 | 1.88 | 0.20 | 3.65 |
| Underground System Assets | 11.17 | 13.28 | 14.89 | 9.26 | 5.09 | 13.26 |

Customer interruptions due to Overhead System Assets and Underground System Assets have exhibited a relatively constant and decreasing trend, respectively, over the 2014-2018 period. Despite this positive trend, 2018 performance for Underground System Assets failed to meet the target. This was driven by aged XLPE cable failures in the Orleans area. Targeted cable renewal and expansion of the renewal program are required to ensure the positive trend is maintained.

Station System Assets performance failed to meet the target in 2018, and exhibits a slight overall increasing trend over the 2014 to 2018 window. These observations are not currently reflected in any current asset trends requiring specific interventions, as the 2018 performance was the result of a single, repairable transformer outage at Fallowfield station.

#### *4.1.3.2. Public Safety Concerns*

**Public Safety Concerns**

The public concerns metric is used by Hydro Ottawa to deliver on its health, safety, and environment objectives. This metric allows Hydro Ottawa to review public safety concerns on an annual basis and to identify any existing assets that may pose similar risks.

Table 4.12 shows the annual safety concerns recorded by Hydro Ottawa. The goal is to reduce this metric to zero. Hydro Ottawa works proactively to respond and undertake corrective action where required for all Public Safety Concerns received. There is no consistent trend or underlying cause for the Public Safety Concerns raised over the 2014-2018 window.

**Table 4.12 – Public Safety Concerns**

| KPI | Target | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|
| Public Safety Concerns | 0 | 8 | 2 | 1 | 1 | 2 |

#### *4.1.3.3. Oil Spilled*

**Litres of Annual Oil Spilled & Cost of Annual Oil Remediation**

The annual oil spilled metric is used by Hydro Ottawa to improve its health, safety, and environment objectives. It allows Hydro Ottawa to track the amount of oil spilled into the environment as well as the annual cost of oil remediation.

Table 4.11 shows the annual litres of oil spilled into the environment, as well as the remediation costs. The target is to have no oil spills and zero cleanup costs.

**Table 4.13 – Annual Oil Spills**

| KPI | Target | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|
| Oil Spilled (litres) | 0 | 958 | 1,133 | 824 | 1,119 | 1,475 |
| Oil Remediation ($'000s) | 0 | 695 | 609 | 799 | 733 | 1,083 |

Hydro Ottawa reports to the Ministry of the Environment, Conservation and Parks on the volume of oil spilled and the cost of remediation. Hydro Ottawa performs routine inspection programs on oil filled equipment and actively manages replacements to mitigate the environmental impact of oil spills.

### 4.1.4. System Operations Performance

Hydro Ottawa's KPIs surrounding System Operations Performance align with Asset Management Objectives for Levels of Service and Asset Value. Specifically, Hydro Ottawa monitors the operational performance of the system by tracking annual levels of station capacity, feeder capacity and system losses. This information is used to identify potential equipment upgrades ensuring that adequate capacity is available during normal system conditions and for reliable operation during system contingency in order to meet the levels of service expected by Hydro Ottawa's customers. In addition, these KPIs allow the identification of stations and feeders operating above or approaching its design ratings in order to implement the appropriate actions required to maximize the value of the distribution system assets throughout its lifecycle.

#### *4.1.4.1. Stations Capacity*

To improve System Accessibility, Stations Capacity KPIs are tracked to provide insight for larger medium- and long-term capacity needs, as well as smaller capacity deficits that may be solved through load transfers.

**Figure 4.9 – Station Transformer at Terry Fox MTS**

System Service projects are initiated to address issues and negative trends. Projects, in order of increasing complexity and cost, include extending distribution ties to other stations with available capacity, upgrading an existing station's planning capacity, or construction of a new station. The following KPIs quantify capacity risks through demand comparisons to a station's planning and equipment ratings and by determining if stranded load is possible during an N-1 contingency.

**Stations Exceeding Planning Capacity**

This KPI is defined by the percentage of stations with a summer peak operating above 100% of their planned capacity rating, as shown in the equation below.

$$Stations\ Exceeding\ Capacity\ (\%) = \frac{\#\ of\ Stations\ Exceeding\ Planning\ Capacity}{\#\ of\ Total\ Stations} \times 100\%$$

The planned capacity rating is defined as the sum of either the transformers' 10 day Limited Time Rating ("LTR") or the allowable top load rating if there is no published LTR for the remaining transformers following a single contingency loss of the largest element within the station (N-1 contingency). An N-1 contingency for a station is defined as the loss of the largest transformer within the station. For stations with a single supply and a single transformer, feeder ties from adjacent stations are used to provide contingency backup and the planning capacity rating is considered to be the rated capacity of the single unit (10 day LTR or allowable top load rating if there is no published LTR).

System capacity has not been added at the same rate as load growth in the City of Ottawa. This has resulted in 16% of the stations owned by Hydro Ottawa operating above their planning capacity rating set to ensure that adequate capacity is reserved for reliable operation during system contingency, as shown in Table 4.14 below.

**Table 4.14 – Stations Exceeding Planning Capacity**

| KPI | Target | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|
| SEPC % | ≤5% | 14% | 13% | 10% | 9% | 16% |
| Count | | 13 | 11 | 9 | 8 | 15 |

Hydro Ottawa has undertaken significant station expansion and upgrade projects which has demonstrated improvement in stations operating within their planning capacity ratings. In 2011, 24% of stations were operated beyond their planning capacity rating. This percentage has gradually declined to 9% in 2017. The proportion of stations exceeding their planning rating increased in 2018 to 16%. Further information on these stations can be found in section 7.1.1. There are near-term projects underway to address capacity limitations at seven of 15 stations exceeding planning ratings, which will return the SEPC % to a decreasing trend by 2020.

**Stations Approaching Rated Capacity**

This KPI is defined by the percentage of stations at or above 100% of the station rated capacity, as shown in the equation below.

$$Stations\ Approaching\ Capacity\ (\%) = \frac{\#\ of\ Stations\ Approaching\ Rated\ Capacity}{\#\ of\ Total\ Stations}$$

The rated capacity is defined as the sum of the top rating (10-day LTR or allowable flat rating should an LTR not be published) of all transformers within the station. If the loading on a transformer exceeds this limit it will cause accelerated loss of life.

Similar to the Stations Exceeding Planning Capacity index, the index for Stations Approaching Rated Capacity has improved over the last five years, as shown in Table 4.15. In 2014, two stations were being operated at or beyond rated capacity. This number has since been reduced to zero.

**Table 4.15 – Stations Approaching Rated Capacity**

| KPI | Target | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|
| **SARC %** | 0% | 2.2% | 1.1% | 1.1% | 0% | 0% |
| **Count** | | 2 | 1 | 1 | 0 | 0 |

### *4.1.4.2. Feeder Capacity*

Hydro Ottawa plans feeder capacity based upon coincident peak loading and single (N-1) contingency. Typically, feeders have contingency pairs so that for the loss of any one feeder the entire load can be recovered by its back-up, thereby reducing the number of switching operations (and time) for recovery of full load. With this arrangement the sum of the load on any one circuit and its back-up must be less than its 8-hour emergency rating. With this philosophy two key capacity ratings need to be considered: the numbers of feeders exceeding their planning capacity and the number of feeders approaching their rated capacity.

**Feeders Exceeding Planning Capacity**

This KPI is defined by the percentage of feeders with a summer peak operating above 100% of the planned capacity rating, as shown in the equation below.

$$Feeders\ Exceeding\ Capacity\ (\%) = \frac{\#\ of\ Feeders\ Exceeding\ Planning\ Capacity}{\#\ of\ Total\ Feeders} \times 100\%$$

The planned capacity rating for a feeder takes three factors into consideration:

- **Coordination with lo-set instantaneous protection:** Under normal pre-contingency operating conditions, a feeder cannot be loaded above a level that would result in the lo-set instantaneous protection preventing feeder restoration (see the description below for Cold Load Pick Up).

- **Feeder Cold Load Pick Up ability:** Outage analysis indicates that the cold-load and hot-load pick up phenomenon results in loading factors approximately twice pre-contingency feeder loading at 0.2 seconds (trip time setting for lo-set instantaneous protection). See Table 4.16 for cold load pick up factors.

- **Short term (8-hour) egress cable overload capabilities:** Under normal pre-contingency operating conditions, a feeder cannot be loaded above the nominal capacity rating of the egress cable. In addition, a feeder must be capable of backing up neighbouring feeder(s) in the event of failure of supply of the neighbouring feeder or other contingency conditions. For purposes of providing back-up ability, Hydro Ottawa assumes that a feeder will be required to operate in the abnormal configuration with post-contingency loading levels for up to eight hours.

**Table 4.16 – Cold Load Pick Up Factors**

| Voltage (kV) | Lo-set Inst. Pick Up (A) | Cold Load Factor | Feeder Load Limit (A) |
|---|---|---|---|
| 4.16 | 1000 | 2 | 300 |
| 8.32 | 1200 | 2 | 300 |
| 12.47 | 1100 | 2 | 350 |
| 13.2 | 1350 | 2.5 | 400 |
| 27.6 | 1275 | 2.5 | 350 |

**Table 4.17 – Cable Ratings**

| Voltage (kV) | Typical Egress Cable | Design Rating (A) | 8hr Rating (A) |
|---|---|---|---|
| 4.16 | 5kV 4/0 Cu PILC, buried in duct | 285 | 330 |
| 8.32 | 15kV, 500 MCM Cu XLPE, direct buried | 675 | 870 |
| 12.47 | 15kV, 500 MCM Cu XLPE, direct buried | 675 | 870 |
| 13.2 | 15kV 500 MCM Cu PILC, duct bank | 425 | 510 |
| 27.6 | 29kV, 750 MCM Al XLPE, duct bank | 450 | 620 |
| 27.6 | 29kV, 1000 MCM Al XLPE, duct bank | 500 | 685 |

Given the constraints outlined in Table 4.17, the rating limits presented in Table 4.18 below are used based on feeder egress cable type.

**Table 4.18 – Cable Planning Ratings**

| Voltage (kV) | Typical Egress Cable | 8-hour Loading Limit (A) | Cold Load Limit (A) | Planning Limit (A)* | Limiting Factor |
|---|---|---|---|---|---|
| 4.16 | 5kV, 4/0 Cu PILC | 330 | 300 | 300 | Coordination between Lo-set instantaneous protection and cold/hot load pick-up |
| 8.32 | 15kV, 500 MCM Cu XLPE | 870 | 300 | 300 | Coordination between Lo-set instantaneous protection and cold/hot load pick-up |
| 12.47 | 15kV, 500 MCM Cu XLPE | 870 | 350 | 350 | Coordination between Lo-set instantaneous protection and cold/hot load pick-up |
| 13.2 | 15kV 500 MCM Cu PILC | 510 | 400 | 255 | Ability to provide adequate back-up capability for neighbouring circuits |
| 27.6 | 29kV, 750 MCM Al XLPE | 620 | 400 | 310 | Ability to provide adequate back-up capability for neighbouring circuits |
| 27.6 | 29kV, 1000 MCM Al XLPE, | 685 | 400 | 340 | Ability to provide adequate back-up capability for neighbouring circuits |

*Planning Limits may change from above based on specific feeder configurations.

Feeders exceeding their planning ratings are within target (≤ 10%), as shown in Table 4.19. Careful review and planning is being undertaken to ensure adequate backup is maintained to allow for secure and reliable delivery of power for customers.

**Table 4.19 – Feeders Exceeding Planning Capacity**

| KPI | Target | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|
| **FEPC %** | ≤10% | 2.5% | 1.4% | 1.6% | 2.0% | 2.8% |
| **Count** | | 19 | 11 | 13 | 17 | 22 |

**Feeders Approaching Rated Capacity**

This KPI is defined by the percentage of feeders at or above 90% of the rated capacity.

$$Feeders\ Approaching\ Capacity\ (\%) = \frac{\#\ of\ Feeders \geq 90\%\ of\ Rated\ Capacity}{\#\ of\ Total\ Feeders} \times 100\%$$

The rated capacity is defined as the egress cable 8-hour loading limit. If the circuits are loaded above this limit for longer than eight hours it will cause overheating and accelerated loss of life.

From 2015-2017, there were no feeders operated above 90% of their rated capacity, as shown in Table 4.20. In 2018, one feeder from Fallowfield station operated at 95% of its rated capacity. Feeder capacity needs in this area will be addressed with the construction of the new Cambrian Municipal Transformer Station ("MTS").[2]

**Table 4.20 – Feeders Approaching Rated Capacity**

| KPI | Target | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|
| **FARC** | 0% | 0.1% | 0% | 0% | 0% | 0.1% |
| **Count** | | 1 | 0 | 0 | 0 | 1 |

### *4.1.4.3. System Losses*

Hydro Ottawa records and monitors annual system losses aiming to maintain losses within acceptable levels. An increasing trend in losses would trigger identification of investment needs to reduce losses in the system in order to meet set out levels of service.

**System Losses**

Distribution System losses are defined in the *Distribution System Code* as: "energy losses that result from the interaction of intrinsic characteristics of the distribution network such as electrical resistance with network voltages and current flows." Table 4.21 shows the historical performance over the last five years.

**Table 4.21 – System Losses**

| KPI | Target | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|
| **Losses %** | ≤ 4.00% | 2.71% | 3.32% | 3.04% | 2.97% | 3.20% |

[2] Cambrian MTS was previously named South Nepean MTS.

Losses remained below the target of 4%. Hydro Ottawa continues to work to reduce system losses through better system planning and by upgrading or replacement of equipment.

### 4.2. UNIT COST METRICS

The unit cost metrics identify the associated capital and O&M costs that Hydro Ottawa has incurred per customer, kilometers of line, and peak capacity, as prescribed in Appendix 5-A of the Chapter 5 Filing Requirements (see Attachment 2-4-3(C)). Table 4.22 lists the various unit costs and indicates that Hydro Ottawa's per unit costs in 2018 were above the five-year average.

**Table 4.22 – Unit Cost Metrics (as per Appendix 5-A)**

| Metric Category | Metric | 1-Year Cost (2018) | 5-Year Average (2014-2018) |
|---|---|---|---|
| Cost | Total Cost per Customer | $803 | $664 |
| | Total Cost per km of Line | $46,678 | $38,634 |
| | Total Cost per MW | $186,762 | $158,146 |
| CAPEX | Total CAPEX per Customer | $544 | $412 |
| | Total CAPEX per km of line | $31,616 | $23,970 |
| O&M | Total O&M per Customer | $259 | $252 |
| | Total O&M per km of line | $15,062 | $14,663 |

In addition to these metrics, Hydro Ottawa has sought to enhance its evaluation of unit costs through the commissioning of a dedicated benchmarking report on unit cost performance. The utility retained a third-party expert to compare the utility's unit costs in select asset categories and operations, maintenance and administration ("OM&A") programs to a sample group of peer utilities. On the whole, Hydro Ottawa compared favourably to the peer group. For information on this unit cost report, please see Exhibit 1-1-12: Benchmarking. The report in its entirety can be viewed in Attachment 1-1-12(B): Hydro Ottawa Unit Costs Benchmarking Study.

## *4.3. HISTORICAL RELIABILITY PERFORMANCE ANALYSIS*

Hydro Ottawa's objective is to improve the System Reliability Performance Indicators from year to year. Hydro Ottawa utilizes its Capital Expenditure Process (outlined in section 5.2) to enhance its ability to prioritize the replacement of end-of-life assets. Testing, inspection, and maintenance programs, as defined in section 6.2, will continue to be essential to ensure equipment continues to operate as expected and to identify corrective actions to be performed. The utility continually assesses new ways of operating to increase system resilience, and reduce restoration times.

Details of Hydro Ottawa's historical reliability performance metrics can be found in section 4.1.1.2 - System Reliability.

### 4.3.1. Reliability Performance by Cause Code

Hydro Ottawa records all outage causes and monitors the primary causes for trends. Hydro Ottawa follows the OEB's definitions for primary causes as defined in the *Electricity Reporting and Record Keeping Requirements* ("RRRs"). Where trends are identified, Hydro Ottawa performs detailed analysis into the root causes to assess risk and identify investment needs.

Table 4.23 below captures the historical outage information by primary cause.

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1 **Table 4.23 – Reliability Performance by Cause Code**

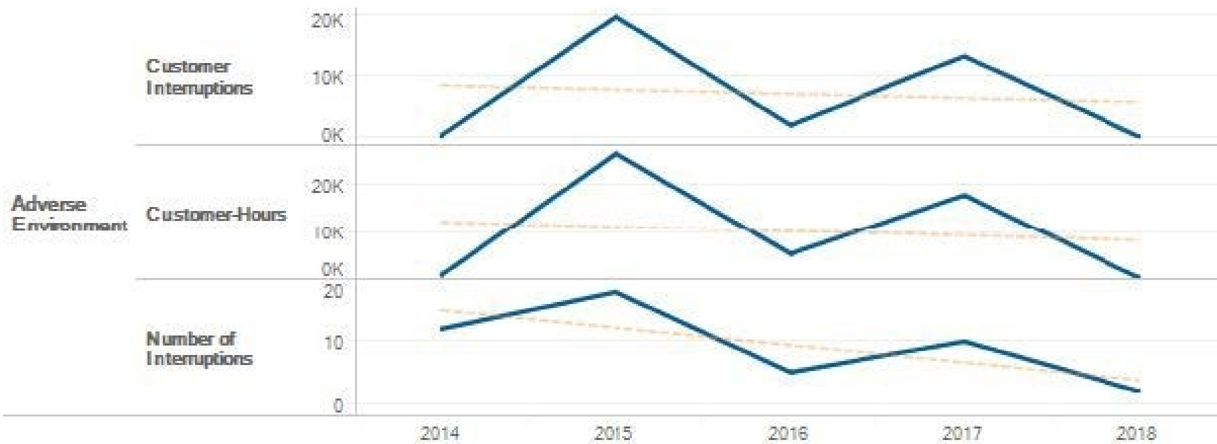
| Primary Cause | | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|
| Adverse Environment | Number of Interruptions | 12 | 18 | 5 | 10 | 2 |
| | Customer Interruptions | 287 | 19,935 | 1,960 | 13,338 | 167 |
| | Customer-Hours | 870 | 26,612 | 5,389 | 17,794 | 378 |
| Adverse Weather | Number of Interruptions | 72 | 29 | 40 | 67 | 101 |
| | Customer Interruptions | 43,110 | 6,715 | 17,467 | 27,839 | 113,916 |
| | Customer -Hours | 117,892 | 8,693 | 35,612 | 93,957 | 727,176 |
| Defective Equipment | Number of Interruptions | 276 | 210 | 200 | 364 | 369 |
| | Customer Interruptions | 88,483 | 82,008 | 58,747 | 62,993 | 89,393 |
| | Customer -Hours | 120,603 | 113,818 | 94,802 | 109,659 | 133,733 |
| Foreign Interference | Number of Interruptions | 146 | 124 | 155 | 163 | 186 |
| | Customer Interruptions | 27,097 | 16,547 | 32,989 | 36,021 | 33,803 |
| | Customer -Hours | 28,608 | 23,829 | 35,659 | 36,999 | 38,512 |
| Human Element | Number of Interruptions | 24 | 19 | 20 | 33 | 31 |
| | Customer Interruptions | 32,295 | 34,456 | 27,288 | 38,459 | 21,144 |
| | Customer -Hours | 38,396 | 36,966 | 5,624 | 42,095 | 14,676 |
| Lightning | Number of Interruptions | 37 | 17 | 32 | 33 | 27 |
| | Customer Interruptions | 29,279 | 11,957 | 24,130 | 15,711 | 21,822 |
| | Customer -Hours | 77,122 | 23,319 | 18,739 | 6,919 | 22,298 |
| Loss Of Supply | Number of Interruptions | 28 | 24 | 11 | 17 | 52 |
| | Customer Interruptions | 71,072 | 214,891 | 58,466 | 66,181 | 278,727 |
| | Customer -Hours | 23,371 | 148,471 | 26,002 | 23,557 | 6,436,022 |
| Scheduled Outage | Number of Interruptions | 1,068 | 1,200 | 1,031 | 863 | 762 |
| | Customer Interruptions | 24,851 | 34,162 | 31,446 | 20,436 | 20,103 |
| | Customer -Hours | 76,844 | 101,699 | 97,984 | 62,770 | 40,273 |
| Tree Contacts | Number of Interruptions | 73 | 99 | 88 | 191 | 157 |
| | Customer Interruptions | 15,652 | 16,253 | 26,006 | 39,675 | 54,923 |
| | Customer -Hours | 24,950 | 25,578 | 58,121 | 115,929 | 183,236 |
| Unknown/Other | Number of Interruptions | 34 | 52 | 37 | 39 | 49 |
| | Customer Interruptions | 11,751 | 18,802 | 32,593 | 17,961 | 43,021 |
| | Customer -Hours | 18,575 | 10,639 | 16,156 | 10,625 | 19,463 |

2

3 Outages due to Adverse Environment are on a declining trend over the last five years, as seen
4 in Figure 4.10 below. Historical outages have been largely due to pole fires occurring as a result
5 of salt contamination on insulators from the City of Ottawa winter de-icing efforts. Hydro Ottawa

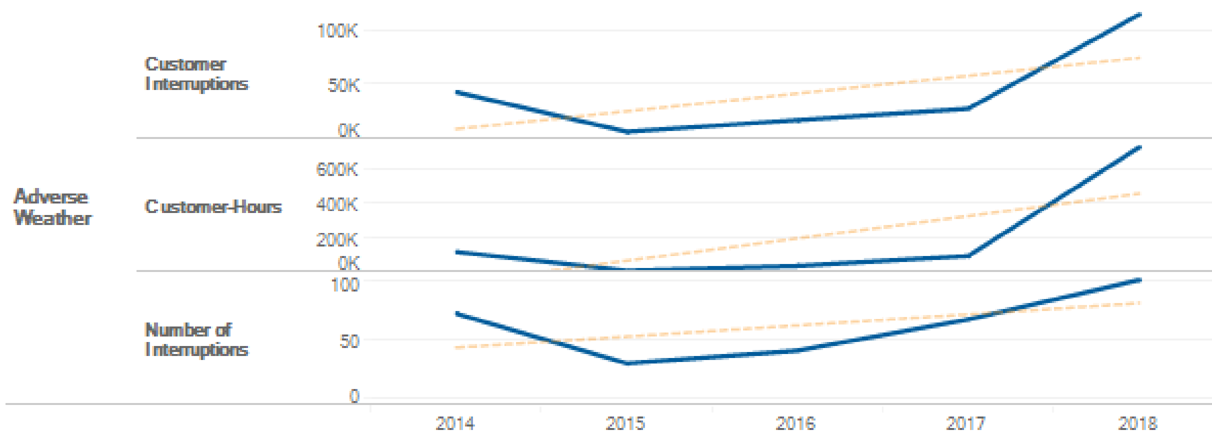
has mitigated these risks by performing a bi-annual insulator wash program to clean insulators of salt and other contamination. In addition, renewal and replacement of insulators with polymer insulators which are less susceptible to this failure mode continues to reduce the overall risk profile.

**Figure 4.10 – Adverse Environment Historical Trend**



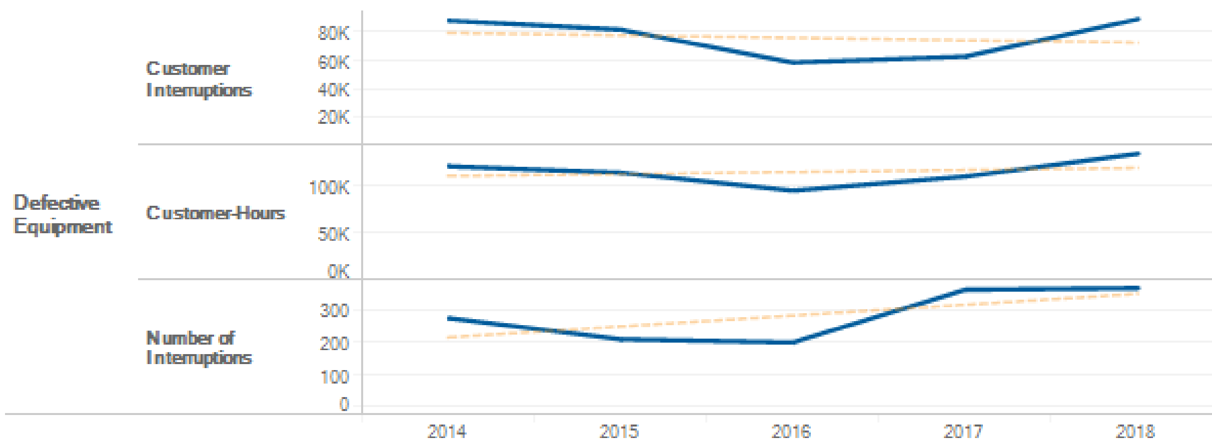

Outages due to Adverse Weather are on an increasing trend over the last five years, as seen in Figure 4.11 below. Historical outages have been largely due to high winds and freezing rain weather. Many of the extreme weather events have resulted in the classification of MEDs as further defined in section 4.3.2. Hydro Ottawa is evaluating the impact and risk of future climate changes on its assets.

**Figure 4.11 – Adverse Weather Historical Trend**



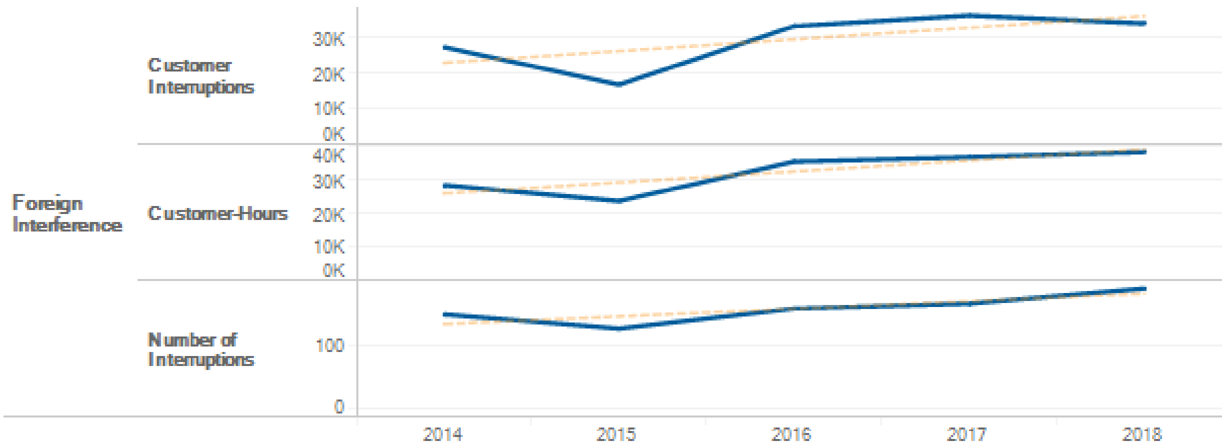

Outages due to Defective Equipment are on an increasing trend over the last five years. However, the impact of these outages on number of customers interrupted and customers-hours are relatively constant, as seen in Figure 4.12. Hydro Ottawa has been mitigating risk due to asset failures by prioritizing renewal investments and targeting asset classes having a higher impact.

**Figure 4.12 – Defective Equipment Historical Trends**



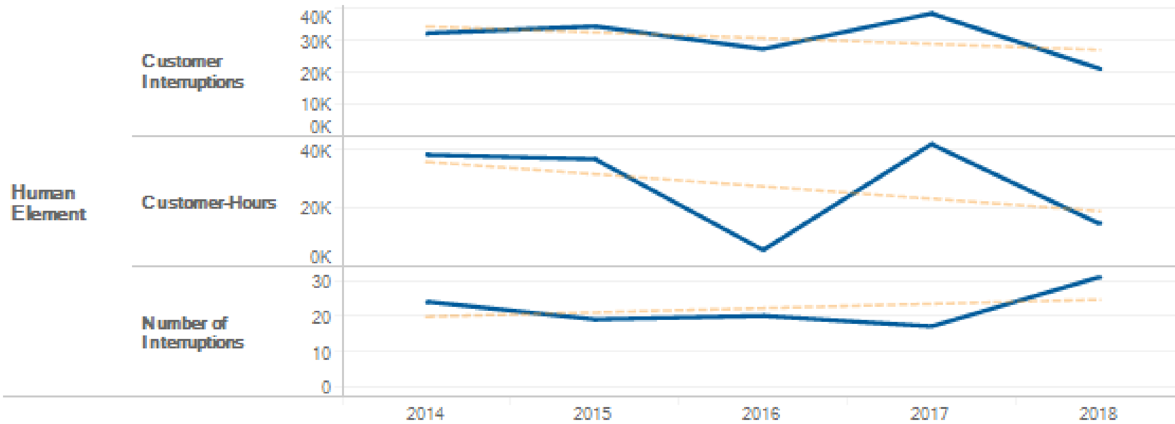

Outages due to Foreign Interference exhibited an increasing trend over the last five years, as seen in Figure 4.13 below. However, the 2013 number of Foreign Interference interruptions were nearly equivalent to the 2018 outcome, suggesting a long-term level trend. Historical outages have been largely due to animal contacts and foreign objects contacting the lines. Hydro Ottawa's standard for new construction requires the incorporation of animal guards. In addition, legacy construction is being retrofitted in a targeted and prioritized manner.

**Figure 4.13 – Foreign Interference Historical Trends**



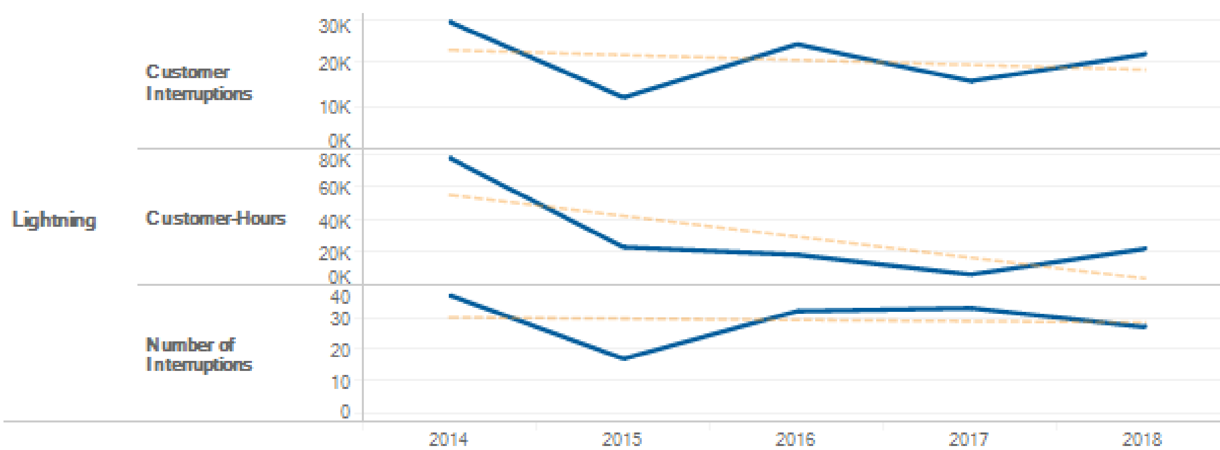

Outages due to Human Element are on a relatively constant trend over the last five years. However, the impact of these outages are on a declining trend, as seen in Figure 4.14 below. Historical outages have been largely due to incorrect records and switching errors. Each incident is reviewed and appropriate actions such as records updates, procedural changes, or staff training  are undertaken to prevent reoccurrence.

## Figure 4.14 – Human Element Historical Trends



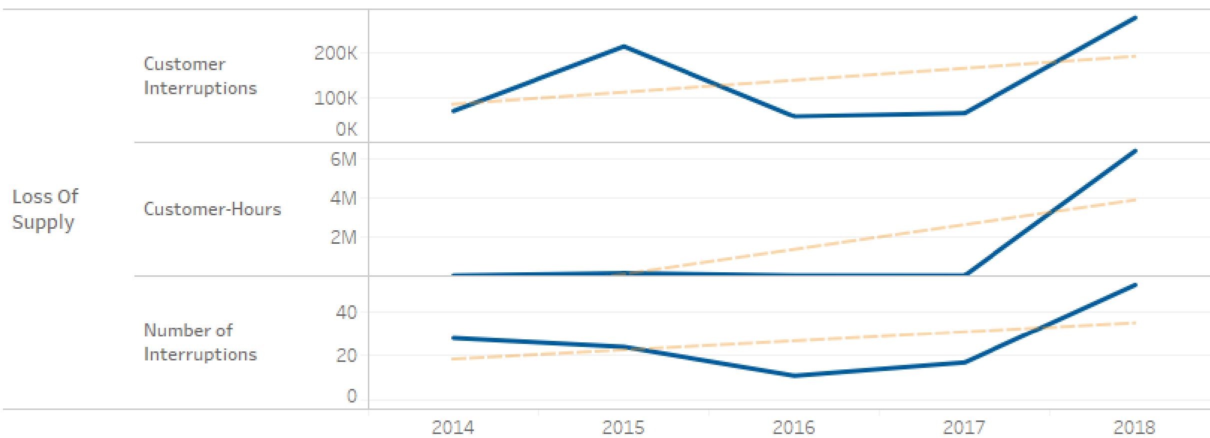

Outages due to Lightning are on a constant trend. However, the impact is on a declining trend, as seen in Figure 4.15. Hydro Ottawa mitigates sustained outages through its system design and application of lighting protection and shielding.

## Figure 4.15 – Lightning Historical Trends



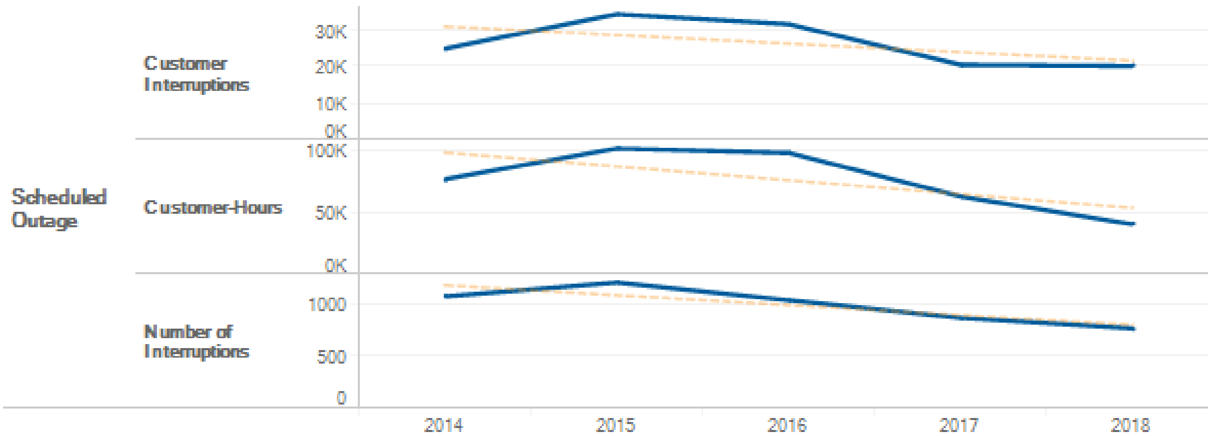
Outages due to LoS increased significantly in 2018. This was largely attributable to the tornado event that occurred in September 2018. From 2014-2017, LoS had a relatively constant frequency and customer impact. Hydro Ottawa works proactively to identify and address supply reliability issues whether working with the transmitter, Hydro One Networks Inc. ("HONI"), to address supply issues, or mitigating their impact through distribution interties.

**Figure 4.16 – Loss of Supply Historical Trends**



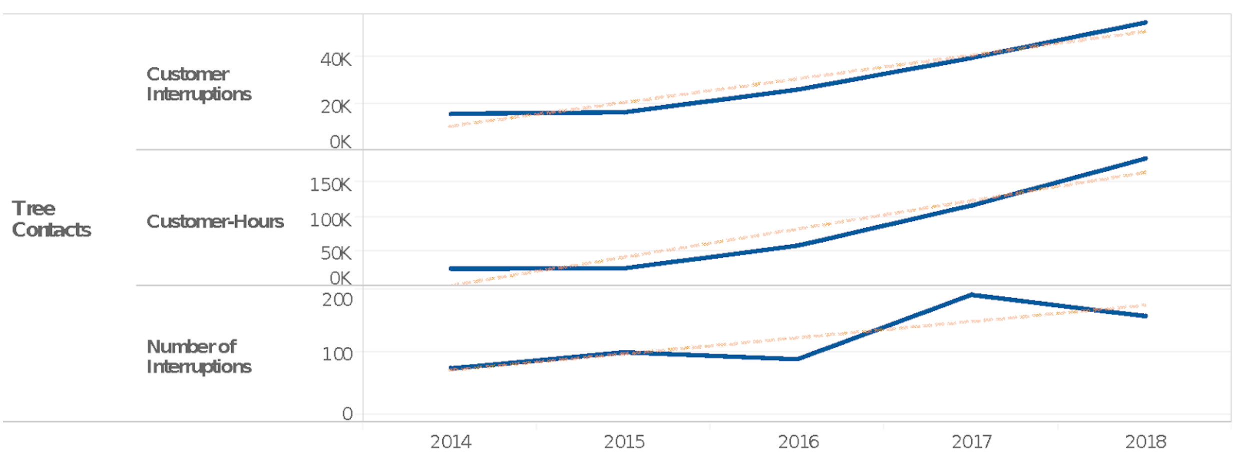

Outages due to Scheduled Outages are on a declining trend over the last five years, as seen in Figure 4.17 below. Hydro Ottawa has made the effort to reduce the impact on customers when planning outages. This includes installing temporary switches and using live-line techniques to minimize the number of customers affected.

**Figure 4.17 – Scheduled Outage Historical Trends**



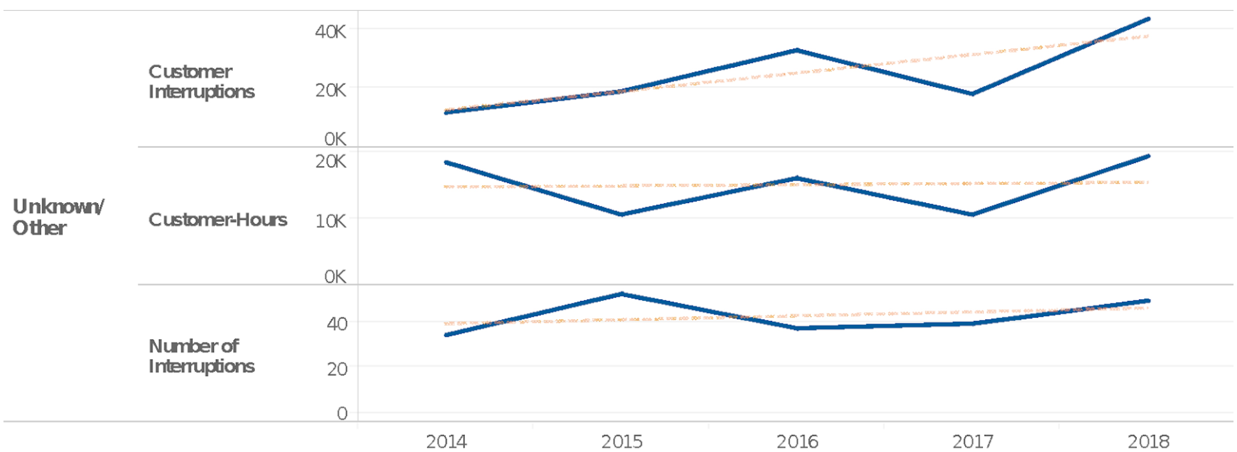

Outages due to Tree Contacts are on an increasing trend over the last five years, as seen in Figure 4.18. The increasing trend is attributed largely to an increase in large tree limbs, and full trees falling into wires from outside the powerline corridor, typically as a result of extreme weather events. Hydro Ottawa has reviewed and continues to evaluate the performance of its vegetation management program. The utility is increasingly working with customers to address risk trees outside the trim zones wherever possible.

**Figure 4.18 – Tree Contact Historical Trends**



Outages due to Unknown/Other are on a slightly increasing trend over the last five years, as seen in Figure 4.19. Hydro Ottawa strives to identify the root causes of outages through line patrols and fault point analysis.

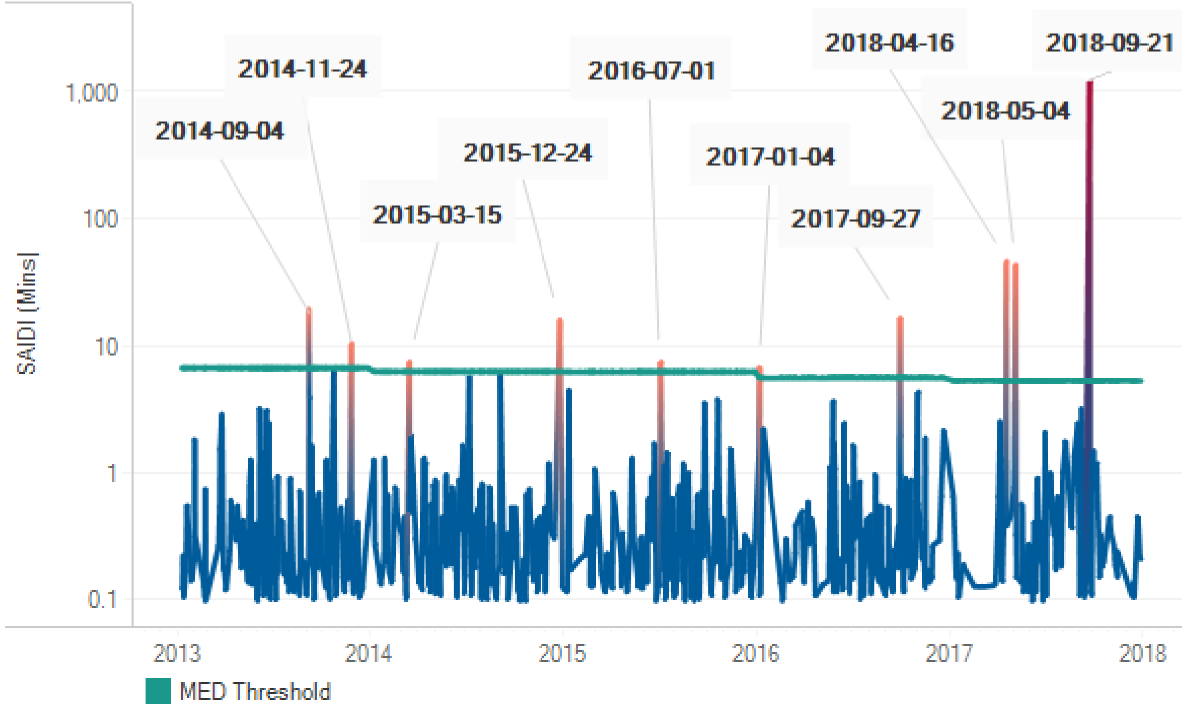
**Figure 4.19 – Unknown/Other Historical Trends**




### 4.3.2. Major Events

Hydro Ottawa uses the IEEE standard *"1366 – IEEE Guide for Electric Power Distribution Reliability Indices"* to identify MEDs. The threshold for the classification of a MED each year is based on the previous five years of daily SAIDI values. Over the last five years, Hydro Ottawa has experienced 10 MEDs, as illustrated in Figure 4.20 below. There was a notable increase in the severity of MEDs in 2018, relative to the preceding four years.

### Figure 4.20 – Major Event Day Threshold




A description of each MED over the last five years can be found below in Table 4.24.

## Table 4.24 – List of Major Event Days

| Date | Event Description |
|---|---|
| **2014-09-04** | On September 4th, 2014, a lightning storm hit the City of Ottawa affecting 26,890 customers for a total of 106,189 customer-hours. |
| **2014-11-24** | On November 24th, 2014, high winds caused outages to 13,565 customers for a total of 56,298 customer-hours. |
| **2015-03-15** | Hydro Ottawa experienced an MED due to pole fires that caused 2 large outages and affected 15,864 customers for a combined total of 40,487 customer hours. The larger of the two outages was a result of a HONI pole that caught fire and caused a loss of supply to Hydro Ottawa customers in the south end of the City. The second outage was a result of a Hydro Ottawa pole catching fire in the core of the City. Both outages were restored within 5 hours. |
| **2015-12-24** | Hydro Ottawa experienced an MED primarily due to two large events that affected 42,401 customers for a combined total of 87,025 customer hours. The first large event was a defective egress riser cable at Nepean TS which caused an outage on the 22M28 and A9M2 44kV sub-transmission lines that affected 4,477 customers for a combined total of 11,791 customer hours. The second large event was the loss of HONI`s S7M 115kV transmission line due to extreme wind that affected 34,297 customers for a combined total of 70,730 customer hours. Extreme winds caused a number of other smaller outages to customers across the service territory. All customers affected were restored by the end of day on December 24th. |
| **2016-07-01** | The Ottawa area experienced high winds and lightning which caused multiple outages throughout the city. The high winds caused trees and branches to fall, breaking conductor and poles, which resulted in lengthy restoration efforts. Many lightning events also caused circuits to trip momentarily and some remained off until crews could assess if any damage was present. A total of 12,297 customers were affected during this event. |
| **2017-01-04** | Hydro Ottawa's service territory experienced a mix of heavy wet snow and freezing rain. The result was many downed trees and limbs making contact with the distribution system. Restoration efforts were prolonged due to clearing of vegetation prior to restoring. A total of 19,130 customers were affected during this event. |
| **2017-09-27** | A micro-burst of wind hit just west of downtown Ottawa resulting in many downed trees and limbs making contact with the distribution system and some broken poles. Restoration efforts were prolonged due to clearing of vegetation prior to restoring. A total of 11,391 customers were affected during this event. |
| **2018-04-16** | Hydro Ottawa's service territory experienced freezing rain and windy conditions resulting in outages across the city. A total of 55,101 customers were affected during this event. |
| **2018-05-04** | Heavy wind gusts across the service territory caused multiple outages from falling trees and broken pole lines. A total of 63,869 customers were affected during this event. |
| **2018-09-21** | Tornadoes (class EF-2 and EF-3) with winds up to approximately 260 km/h touched down in the Ottawa area which caused extensive damage to pole lines and station equipment. Approximately 216,000 customers were affected during this event. |

**Figure 4.21 – Downed Pole Line Following September 2018 Tornado Event**

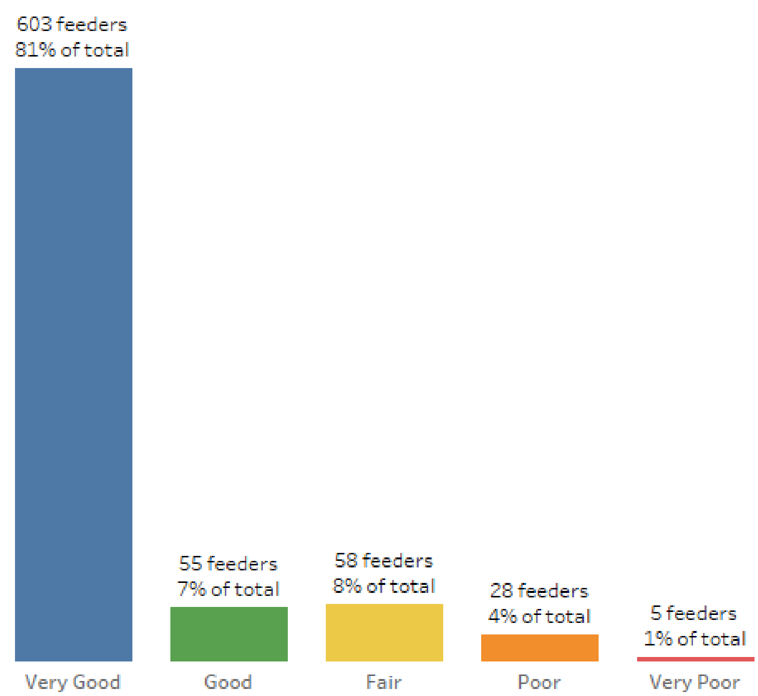
### 4.3.3. Worst Feeder Analysis

Annually, Hydro Ottawa reviews the performance of its feeders with respect to their impact on customer interruptions, customer hours, and frequency of outages. A Feeder Performance Index ("FPI") for each feeder is derived from these criteria and is assigned a ranking. This condition ranking allows for annual performance review and trending while identifying which feeders would most benefit from targeted investments.

Feeders identified as having "Very Poor" performance will be reviewed and have an action plan developed to identify recommendations for improvements. The performance of these feeders will be tracked for a period of five years. If a feeder continues to perform poorly in following years, another review will be performed to ensure that the recommendations and actions have appropriately addressed the issues identified.

As outlined in Figure 4.22, there were five feeders identified as having "Very Poor" performance in 2018. This represents 1% of all feeders. Long-term and short-term fixes to the reliability of these poor performing feeders are implemented through the Worst Feeder Betterment Program.

**Figure 4.22 – 2018 Feeder Condition**




## 4.4. HISTORICAL PERFORMANCE IMPACT ON DSP

Hydro Ottawa uses the KPIs, as described in section 4.1 above, to measure continuous improvement in Customer Oriented Performance, Cost Efficiency & Effectiveness, Asset Performance, and System Operations Performance. These KPIs are quantitative measures used to monitor the effectiveness of Hydro Ottawa's planning processes, efficiencies in carrying out work, as well as to identify shortfalls and areas for continuous improvement.

**Customer Oriented Performance**

Hydro Ottawa continuously seeks feedback from customers on their satisfaction with the services provided by the utility. This feedback is greatly impacted by the distribution system's service reliability. Based on historical performance of Customer Oriented KPIs, Hydro Ottawa has made the following changes:

- The Touch Logic survey questions changed from six to four questions in late 2018 to better reflect the call centre performance.
- Based on 2017 FEMI results, Hydro Ottawa initiated investment projects to address the causes of outages, such as localized cable replacement, overhead switch replacement, targeted vegetation management,  and the installation of line spacers.
- In alignment with the majority of residential and small business customers having expressed support for an accelerated approach to investments in both the overhead and underground distribution system, Hydro Ottawa plans to continue focused investment in the pole and cable renewal programs.

**Asset Performance**

Asset Performance metrics help Hydro Ottawa deliver on its asset management objectives. Based on historical performance of Asset Performance, Hydro Ottawa has made the following changes:

- Defective Equipment Contribution trends are reviewed on an annual basis to establish a target for the frequency and the quantity of assets to be replaced.
- Increased frequency of customer interruption due to cable failure is driving increased investment in the cable renewal program.
- Recent Oil Spilled trends are showing more leaking residential underground transformers, which have increased the cost of remediation. This emphasizes the importance of active inspection and replacement of underground transformers to mitigate this environmental impact.

**System Operation Performance**

Hydro Ottawa monitors the operational performance of the system to identify potential equipment upgrades, thereby ensuring that equipment operates within design ratings and adequate capacity is available. Based on historical performance of System Operations metrics, Hydro Ottawa has made the following changes:

- From 2015-2017, Fallowfield MTS was the one station approaching rated capacity. As a result, plans were put in place to transfer load to adjacent stations in order to decrease loading levels in the short term. The construction of the new station in the South Nepean area will bring loading at this station within acceptable levels.
- Plans for addressing stations and feeders exceeding planning capacity are described in section 7 - System Capacity Assessment.

## *4.5. REALIZED EFFICIENCIES DUE TO SMART METERS*

Hydro Ottawa began the deployment of smart meters in 2006 and concluded in 2010. The smart meter network provides several key advantages over the older mechanical meter fleet, as described below.

### 4.5.1. Monthly Billing Cycles

The largest advantage of smart meters is that Hydro Ottawa now receives daily meter reads for every meter in its fleet. This has facilitated the move to monthly billing cycles as opposed to billing every two months. This increases Hydro Ottawa's level of customer service by smoothing out the billing cycle and improving the predictability of customers' bills. Customers are able to adjust consumption patterns based on load changes on a monthly basis rather than bi-monthly.

### 4.5.2. Meter Health Monitoring

Smart meters provide daily reports on meter health statistics enabling Hydro Ottawa to identify defective meters as the failures occur. Historically, a slow or failed mechanical meter may not have been detected until it was retrieved for reverification (an event which may not occur for several years). This contributes to Hydro Ottawa's financial strength and security by ensuring that the meter fleet is accurately measuring power distribution. Ensuring that the meter fleet is functioning properly improves confidence on the part of customers that they are being billed appropriately. Table 4.25 identifies the number of meter and metering installation defects that Hydro Ottawa has discovered through these remote meter health reports.

**Table 4.25 – Metering Irregularities Discovered Via Smart Meter Reporting**

| Type of Defect | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|
| Defective Primary Fuses | 11 | 19 | 13 | 14 | 17 |
| Unmetered Power Diversion | 0 | 2 | 1 | 0 | 1 |
| Defective Meters | 701 | 652 | 604 | 663 | 538 |

### 4.5.3. Outage Management Functionality

Due to an early adoption of the provincial smart meter initiative, Hydro Ottawa's smart meters have very limited last gasp functionality. In 2006, the self-reporting technology offered limited functionality. As such, Hydro Ottawa relies on alternate outage management tools to determine the scope and magnitude of outages. However, the System Office has the ability to routinely call, or "ping", individual meters to assess the effects of restoration efforts. A meter response indicates the repair was successful, no response indicates that there may be additional issues with the supply. Planned implementation of a Distribution Management System incorporating improved communication links to collectors will allow groups of meters to be called simultaneously and enable a more expedient confirmation of the extent of an outage. Furthermore, strategic installation of meters with last gasp functionality will allow Hydro Ottawa to leverage the self-diagnostic technology while avoiding a full scale replacement.

### 4.5.4. Smart Meter Data and Analytics

A significant advantage of smart meters is the amount of data that they provide. Hydro Ottawa has developed analytical tools to assess system performance. Smart meter data enables access to transformer and circuit loading patterns with granularity down to an hourly interval.

Hydro Ottawa has developed tools that aid in the detection and prediction of unmetered power diversion, abnormal voltage profiles and system losses. The utility identified a signature pattern for failed primary meter fuses. An algorithm uses this signature to flag suspect fuses on a weekly basis which are then investigated. Hydro Ottawa has discovered many defective primary metering fuses which otherwise may have gone undetected for several years and which may have ultimately resulted in significant financial losses.

## 5. ASSET MANAGEMENT & CAPITAL EXPENDITURE PROCESS

This section speaks to the components of Hydro Ottawa's Asset Management and Capital Expenditure processes which are used to translate the asset and system needs into investments that will deliver on the Asset Management Objectives. For each process, details are provided on the tools and methods used, inputs and outputs of information, and how opportunities are identified to coordinate for cost effectiveness from good planning.

Hydro Ottawa's Asset Management and Capital Expenditure Processes are shown in Figure 5.1.

**Figure 5.1 – Asset Management & Expenditure Process**

## *5.1. ASSET MANAGEMENT PROCESS*

The Asset Management Process is rooted in understanding the current and future risks of the assets and systems. Starting with the translation of *2016-2020 Strategic Direction* into Asset Management Objectives (see section 3 - Asset Management Strategy & Objectives for more details), Hydro Ottawa's Asset Managers identify the requirements for data collection, analysis, and risk assessment. Information flows from an established Asset Register to evaluate each asset to determine potential risks and opportunities for investments.

The sub-sections below outline the main components of the Asset Management Process:

- Asset Register
- Asset Condition Assessment
- Testing, Inspection & Maintenance Programs
- Service Quality
- Growth Identification
- Load Forecast
- System Constraints
- Risk Assessment & Review

### 5.1.1. Asset Register

Hydro Ottawa maintains electronic repositories to store its technical, testing, inspection and maintenance information, and geographic data for most of its distribution and station assets (buildings and other non-power delivery assets are excluded). These repositories allow the data to be collected, reported, and queried in a manner that enables efficient dissemination and reporting of information on Hydro Ottawa's assets.

The system of record for Hydro Ottawa's power delivery assets is the Geographical Information System ("GIS"), based on Intergraph's G/Technology platform. With minor exceptions (i.e. secondary conductors in the downtown core), it forms a complete repository of Hydro Ottawa's assets used within its stations and distribution system. These exceptions do not reduce the effectiveness or usability of GIS as they are few in number and typically do not bring additional clarity during analysis. The missing data can be readily retrieved elsewhere if the need arises.

Hydro Ottawa's GIS is used to store, query, and provide reports to enable the analysis and development of investment plans. The data kept in the system is continuously improved through feedback from field staff and data collected through inspection programs. Using a graphical interface, it enables users to view distribution assets on a geo-referenced map showing location, technical nameplate data, and assess their relationship to other nearby assets, including electrical connectivity and relation to civil structures. Further, this system is used by resources in the field while collecting asset condition data before storing it within the same repository.

For Hydro Ottawa's Station assets, the PowerDB system is used for the collection of testing, inspection, and maintenance data as it allows for more complex collection forms. Technical data is stored through customized forms for each asset class and maintenance activity. This technical data can then be exported for further analysis, and is used as input into the health index formulation for specific assets described in section 5.1.2. The geographic information on each station is stored in the GIS. For more information about the Power DB and GIS databases, please refer to Appendix D of Hydro Ottawa's Strategic Asset Management Plan (Attachment 2-4-3(G)).

### 5.1.2. Asset Condition Assessment

Hydro Ottawa uses health index scores for its assets to rate their condition and indicate a probability of failure. The utility consulted with industry experts in the development of its scoring formulation, which is a weighted addition of a number of degradation factors to determine an overall health index score. The health index is an indicator of an asset's condition and remaining life and is assigned a score from 100 to 0. A new asset will have a health index of 100, while an asset in very poor condition would have a health index below 30.

Table 5.1 below presents the health index ranges, corresponding asset condition, and the required action generally associated with each health index.

**Table 5.1 – Asset Condition Based on Health Index**

| Health Index | Condition | Description | Requirements |
|---|---|---|---|
| **85–100** | Very Good | Some aging or minor deterioration of a limited number of components | Normal maintenance |
| **70–85** | Good | Significant deterioration of some components | Normal maintenance |
| **50–70** | Fair | Widespread significant deterioration or serious deterioration of specific components | Increase diagnostic testing; possible remedial work or replacement needed depending on criticality |
| **30–50** | Poor | Widespread serious deterioration | Start planning process to replace or rehabilitate considering risk and consequences of failure |
| **0–30** | Very Poor | Extensive serious deterioration | Asset has reached its end-of-life; immediately assess risk; replace or refurbish based on assessment |

To determine the health index for a given asset, a mathematical formulation specific to the asset under consideration is used to convert various data points that describe the asset's condition down to a single value. These values are then used to prioritize asset replacement, when warranted, and can also be used to determine the probability of instantaneous failure associated with each asset. The probability of failure is determined through a series of lookup tables that equate asset condition to its instantaneous probability of failure.

Hydro Ottawa has assessed the maturity of its Asset Condition Assessment implementation by a third party. The summary of this assessment can be found in Attachment 2-4-3(M): Asset Condition Assessment - Third Party Review. Overall, the third party found that Hydro Ottawa's ACA framework utilized robust formulations that are in alignment with best practices, and that it was tightly integrated with Hydro Ottawa's broader Asset Management related processes, procedures, and outcomes.

### 5.1.3. Testing, Inspection, & Maintenance Programs

Hydro Ottawa's planned testing, inspection, and maintenance programs are the utility's primary means of collecting condition data used to calculate the health index of assets and to identify corrective actions to ensure continued reliable operation.

Hydro Ottawa's planned programs can be divided into three groups:

1. **Predictive**: assessing the condition of the asset
2. **Preventative**: maintaining the condition of the asset
3. **Corrective**: improving the condition of the asset

Predictive programs collect technical details, testing, and inspection data used to identify assets in need of corrective actions while determining the asset's overall condition. These programs use a combination of inspection techniques depending on the asset type being considered and the failure mode(s) that pose an increased risk to safety, reliability, or the environment. The deployment of communication and sensors on certain new or upgraded assets provides the ability to monitor the condition of assets and collect operational data in real-time. This can reduce or eliminate the need for predictive programs to collect asset data. Furthermore, the ongoing monitoring can support the eventual transition from time-based to condition-based maintenance. Details of Hydro Ottawa's implementation of cost effective modernization of the distribution system can be found in section 5.5.

Preventative programs maintain the existing condition of the asset. Some asset types require regular maintenance activities that are time-based, while other assets are maintained after a certain number of operations to ensure that it will continue to operate as designed. These activities include cleaning, tensioning, tightening, calibrating, and realigning various components.

Corrective programs improve the condition of the assets by repairing, replacing, or refurbishing various defective or degraded components. This mitigates the need for replacing the asset by extending the expected operational life.

Details of Hydro Ottawa's asset specific testing, inspection, and maintenance practices can be found in section 6.2 - Asset Lifecycle Optimization Policies & Practices.

Information collected through the inspection, maintenance, and testing programs is stored in the Asset Register as defined in section 5.1.1.

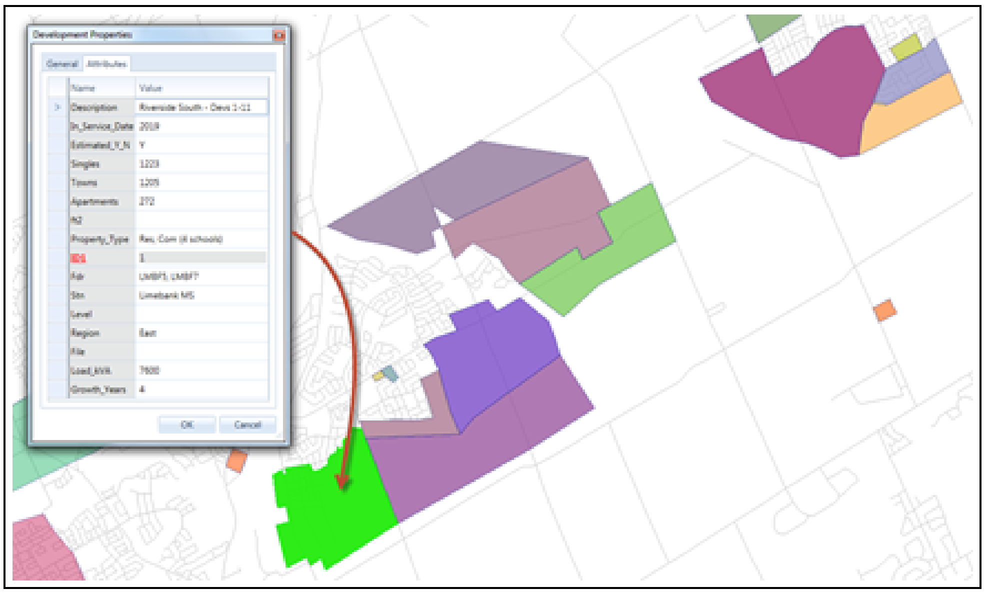
### 5.1.4. Growth Identification

An important predecessor to load forecasting is the ability to identify areas of potential load growth. To ensure that Hydro Ottawa can continue to supply existing and new growth through its service territory, two primary processes are used to identify growth: the City of Ottawa's development application process and Hydro Ottawa's service request process.

Hydro Ottawa is actively engaged in the City of Ottawa's development application process which allows for input and understanding of the City's land use policy through the Official Plan and supporting plans such as community design plans, transportation master plan, and infrastructure master plan. Changes to land use policy will typically have a long-term impact (i.e. greater than five years) on growth opportunities and be more wide reaching throughout the City of Ottawa. Hydro Ottawa is also actively engaged in the implementation of the land use policies by reviewing site plans, subdivision plans, and zoning amendments. Proposals from the implementation of the land use policies are typically short-term (one to two years) to medium-term (two to five years), and are localized to specific areas of the City.

Hydro Ottawa captures this information through GeoMedia, a GIS tool used to record sources of growth and track the progress of current developments, as shown in Figure 5.2 below. The mapping tool plots the impacted area of developments discovered through the growth identification process and stores key information on when the developments will impact the system. This information includes the impacted feeder and station, an estimated in-service date, anticipated load, and the number of years for which the growth is expected to increase. The information stored within the GeoMedia database is then extracted on an annual basis from which station growth forecasts are created and system sustainment projects are created.

**Figure 5.2 – GeoMedia Growth Forecasting Database**




The service request process consists of developers requesting connection to Hydro Ottawa's system. These can range from general services and residential services to commercial service and large developments. These developments include connection requests for projects previously identified through the development application process.

Hydro Ottawa works closely with developers within its service territory to support early identification of required service size and timing of line additions or expansion within these growth areas. This engagement enables these developments and supports Hydro Ottawa load forecasting for capacity investment planning.

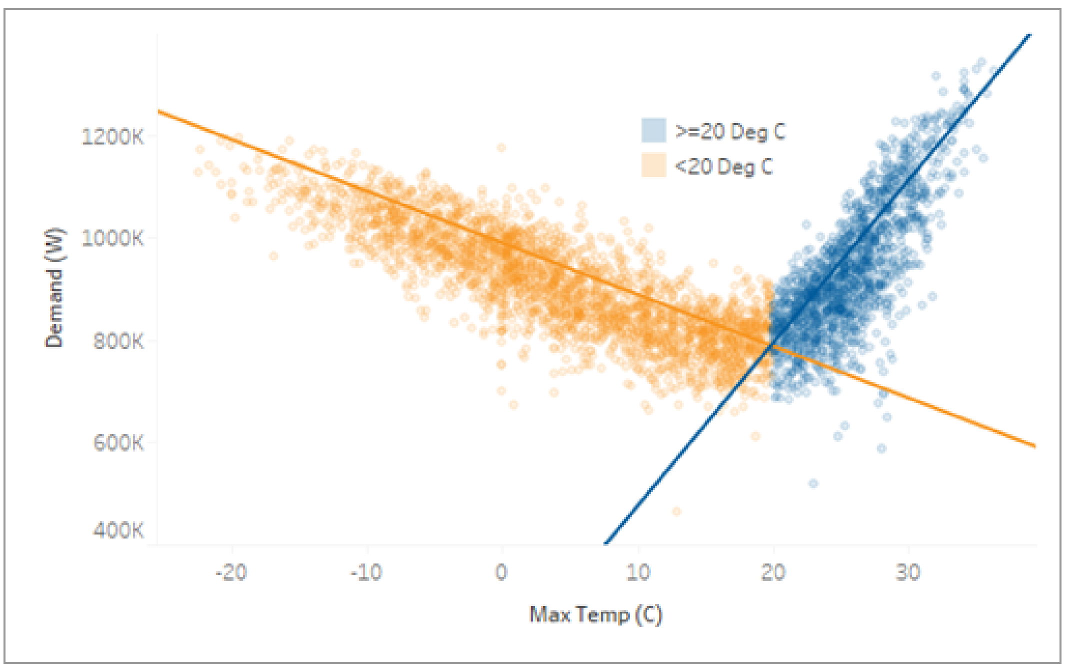
Details about identified load growth can be found in section 7.2 - Ability to Connect New Load.

### 5.1.5. Load Forecast

Using information from identifying growth opportunities, load forecasting identifies how load will increase at the system level. Forecasted load is established at the feeder level and aggregated by station on an annual basis to evaluate the loading impact with respect to equipment limitations and system constraints.

The forecast baseline is first established from weather normalized historical system coincident peak loading to reflect the expected load on an average peak weather day. As seen in Figure 5.3 below, historical maximum daily temperature is correlated with the system loading for that particular day. Hydro Ottawa uses historical data from 2007 to present day to develop the correlation. Each load forecast then accounts for the growth identified in aggregate to the baseline based with their estimated load, energization date, and impacted supply feeder.

**Figure 5.3 – Weather Loading Correlation**




To ensure system adequacy, a 1-in-10-year weather factor is applied to the forecast to represent the expected load on a system peak day with a temperature anticipated only once every ten years. The 1-in-10-year factor ensures the network can withstand expected peak temperatures without exceeding system constraints. It also allows the scheduling and implementation of system investment plans to address capacity and reliability needs without compromising resiliency of supply.

Details about load forecasting can be found in section 7.2 Ability to Connect New Load.

### 5.1.6. System Constraints

The distribution system is designed and planned to supply existing and future customers reliably while conforming to system design constraints. These constraints include equipment thermal and short-circuit limitations, power quality, and restoration capability standards. System constraints must be considered in the design of the transmission supply network, station equipment, and distribution feeder configuration.

Due to the large load and number of customers impacted by transmission system failures, the transmission system is constrained by standards designed to ensure a high level of reliability. Transmission reliability standards are defined by the IESO within the Ontario Resource and Transmission Assessment Criteria ("ORTAC"). Projects to address transmission system constraints are often driven by growth within the distribution system. Hydro Ottawa provides the IESO with updated growth forecasts for the distribution system on an annual basis to help identify and address transmission capacity and ORTAC constraints.

Hydro Ottawa's station planning criteria dictates a constraint to the worst case N-1 contingency scenario. This loading limit is determined as the sum of the transformer capacities after the loss of the largest transformer within an individual station. Transformer summer 10-day LTR ratings are used as the top rating if available on the nameplate. The 10-day LTR rating is the loading supplied by the transformer over a 10-day period while sustaining less than 1% loss of life, assuming peak summer temperatures and a typical daily loading profile. The highest fan rating is used in cases where the summer 10-day LTR rating is not specified by the transformer manufacturer. Hydro Ottawa designs stations to be limited by the transformation; hence cable, bus and breaker thermal ratings within the station should exceed the transformer ratings. In the case of a single transformer station, the station is limited by load transferring capacity to neighbouring stations via feeder ties.

At the feeder level, the system is constrained by conductor thermal limitations and voltage drop. Each feeder is planned to supply connected customers and/or back up other connected feeders in an N-1 contingency while remaining under the thermal limitation of the conductor. On the 4kV system this is achieved by having a dedicated backup feeder available at the station, while for all other systems this is achieved through feeder ties. Feeder planning loading limits are listed in section 4.1.4.2. Additionally, conductor properties, size of loads, and location of loads may lead to voltage drop concerns. Feeders must be configured to deliver voltage levels within the limits stated in CSA CAN3-C235-83.

Constraints of various equipment types are determined by the equipment properties information stored in Hydro Ottawa's Asset Register. Projects and operation guidelines are created to address equipment forecasted to exceed their constraints.

### 5.1.7. Performance Metrics

Hydro Ottawa monitors the performance of its assets and systems to ensure the successful delivery of its Asset Management Objectives. Continuous improvement is achieved through the use of Key Performance Indicators ("KPIs"). Performance targets that are either not met will trigger a review to determine root cause and potential remedial actions.

Details of Hydro Ottawa's performance metrics can be found in section 4 - Performance Measurement for Continuous Improvement.

### 5.1.8. Risk Assessment

The Risk Assessment process looks to identify and quantify all the needs of the system in order to meet the Asset Management Objectives. By evaluating the condition of its assets, growth opportunities and constraints on the system, and the system performance, Hydro Ottawa can establish the potential risks and opportunities to begin to identify the investment requirements.

The utility has established a risk register for assessing, monitoring, and mitigating risks that are present in the system as well as identifying opportunities.

#### *5.1.8.1. Risk Register*

Risks and opportunities associated within Hydro Ottawa's Asset Management System and asset management activities (at a system or asset class level) are identified by employees and communicated to the respective section Manager and/or the Asset Management Council ("AMC"). In addition, Hydro Ottawa's Internal Audit, Risk and Advisory Service group and external audits identify risk and opportunities through applicable audits and reporting. The Asset Manager ensures that routine risk and opportunity identification activities take place during AMC meetings. This includes identifying risks or opportunities over which Hydro Ottawa has control or can be expected to have an influence. These risks and opportunities, along with their rating and control actions, are recorded in Asset Management System Risk Register.

Risks and opportunities are linked to strategic and asset management objectives, and then scored with respect to impact and probability against the associated objective. To mitigate a risk or capitalize on an opportunity, control actions are assigned for each risk or opportunity, and at least one AMC member is assigned to said risk/opportunity and control. The resultant risk or opportunity is then tracked, and once implementation of the control is complete, the residual score of the risk or opportunity is calculated and approved by the Asset Owner.

#### *5.1.8.2. Program and Asset Analytics*

Hydro Ottawa aims to maximize asset value by determining optimal asset replacements and capital and operations and maintenance ("O&M") solutions (e.g. by comparing costs and benefits and mitigating risks). Analysis is performed at both an Asset Program Replacement Level and through Project Optimization, as described in the Strategic Asset Management Plan (Attachment 2-4-3(G)).

**Program Analytics**

Program level replacement policies for each asset can be found in Attachment 2-4-3(E): Material Investments. Analysis is performed to determine the optimal replacement policy based on a number of factors, including the following:

- Asset type
- Current asset demographics and expected service life
- Probability of failure curve (by asset type)
- Asset condition
- Asset consequence of failure
- Cost effectiveness of different replacement policies

**Project Optimization**

Hydro Ottawa utilizes the asset investment planning and management software tool C55 to evaluate and optimize projects to create a plan that balances performance, risk, and cost. This process is described in more detail in section 5.2.2 Project Evaluation.

#### *5.1.8.3. System Constraints*

Risks associated with Hydro Ottawa's ability to service new customers due system constraints are evaluated through a regional system study, as detailed in section 7.0 - System Capacity Assessment. By identifying and forecasting load growth against system constraints, Hydro Ottawa can identify investment timing requirements. Alternative solutions for addressing the identified risk are reviewed and evaluated as part of the regional system study and take into account both short-term and long-term needs in order to optimize investment plans.

#### *5.1.8.4. Performance Metrics*

The evaluation of performance metrics can identify risks to Hydro Ottawa's Asset Management Objectives. Metrics not meeting their desired targets will raise awareness for a more detailed analysis into the issues present. Results from this analysis are evaluated to determine if proposing investments will mitigate the risk and bring the metric into a desired tolerance in an acceptable time frame.

## 5.2 CAPITAL EXPENDITURE PROCESS

Hydro Ottawa's Capital Expenditure Process, as shown in Figure 5.1 above, includes phases which are executed following the Asset Management Process:

- Project Concept Definition
- Project Evaluation
- Project Review
- Project Optimization
- Project Execution

### 5.2.1. Project Concept Definition

The Project Concept Definition phase gathers all internal and external drivers to describe the needs of the company's organizational environment. Concept projects and project alternatives are created to meet requirements, mitigate or remove risk, and meet Asset Management Objectives. Table 5.2 outlines the description of the drivers by Investment Category. The Investment Categories are:

- System Access (section 8.2)
- System Renewal (section 8.3)
- System Service (section 8.4)
- General Plant (section 8.5)

## Table 5.2 – Driver Description

| Investment Category | Driver | Description |
|---|---|---|
| **System Access** | Customer Service Request | Customer request for new connection (load or generation) |
| | Third Party Requirements | Request by a third party for plant relocation or upgrade to an existing service |
| | Mandated Service Obligation | Regulatory requirement to maintain distribution licence under the OEB's Distribution System Code or requirement as per Hydro Ottawa's Conditions of Service |
| **System Renewal** | Assets at End of Service Life<br>i. Failure<br>ii. Failure Risk<br>iii. Substandard Performance<br>iv. High Performance Risk<br>v. Functional Obsolescence | i. Asset no longer meets functional requirements<br>ii. Asset is at risk to no longer meet functional requirements<br>iii. Asset still meets functional requirements; however, falls below standards for operability or efficiency<br>iv. Asset is at risk of failure in a way that can cause harm or damage to other equipment or assets or would put the distribution system in a detrimental state<br>v. Asset is functionally obsolete with no spare parts, tools, and/or software to continue operation |
| **System Service** | Capacity Constraint | Requirement for additional capacity (station transformation or circuit) due to planned or realized load increases |
| | Reliability | Requirements driven by poor distribution system performance such as abnormally (high) duration or frequency of interruptions |
| | System Operability | Requirements for improved system operability and visibility |
| **General Plant** | System Capital Investment Support | • Capital contributions to HONI for connection projects<br>• Requirement for fleet/vehicle acquisition |
| | System Maintenance Support | Requirement for tools and associated equipment |
| | Business Operations Efficiency | Requirements for Information Technology software and systems |
| | Non-System Physical Plant | Building infrastructure requirements |

#### *5.2.1.1. System Access*

System Access investments are obligated activities. For this reason the investments are not prioritized through the Asset Management and Capital Expenditure Processes, but rather prioritized based on resources and working with the requesting party.

**Customer Service Request**

Customer Service Requests arise from the needs of load or generation customers for new connections. For example, this includes servicing for new commercial buildings, residential subdivisions, or generators, and encompasses any system expansion required to supply the site of development.

**Third Party Requirements**

Third Party Requirements are initiated from requests received for the relocation or upgrade (modifications) of assets or infrastructure (e.g. pole relocation for road widening).

**Mandated Service Obligations**

Mandated Service Obligations are requirements of a distributor as defined by the *Distribution System Code* ("DSC") as well as any additional obligations as defined by Hydro Ottawa's Conditions of Service.

#### *5.2.1.2. System Renewal*

**Assets at End of Service Life**

Hydro Ottawa's system assets range in age from new to over 50 years old. The management of these assets are critical to providing safe, reliable, and efficient electricity distribution services to customers.

Hydro Ottawa regularly assesses its asset replacement strategy through the risk assessment process identified in section 5.1.8. The objective is to confirm that the assets deliver the required functions at the desired level of performance and that this level of performance is sustainable for the foreseeable future, while staying within the acceptable levels of risk.

Areas which are addressed in Hydro Ottawa's asset replacement strategy review are the financial, technical, and management elements needed for making sound, innovative, or best practice asset management decisions.

Hydro Ottawa looks ahead 20 years with a focus on the first five years. For the initial five-year period, most of the specific planned projects have been identified – and if not, program level spending needs have been identified. Beyond this period, the required program level spending needs have been identified based on the long-term sustainment needs. Based on long-term trends, current asset demographics, known asset issues, or needs on the system, it is likely that new and planned projects will evolve through the forecasted period.

The intent of the asset replacement strategy is to optimize the lifecycle costs for each asset class (including procurement, design, operation, maintenance, renewal, and disposal) to meet reliability service targets and future demand. Each year, the aim is to improve the plan by taking advantage of new information and changing technology.

The following list describes the key variables that are used to inform the Asset Lifecycle Optimization:

- Testing, inspection, and maintenance records to inform condition
- Asset demographic and nameplate information
- Asset failure statistics – number of failures and frequency by asset type (SAIFI)
- Financial useful lives
- Financial records – cost per replacement.

The following list describes the outcome of the Asset Lifecycle Optimization:

- Recommended asset replacement rates, refurbishment, and associated annual spend
- Asset condition (health index)
- Projected failure rates based on spending/replacement levels

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#### *5.2.1.3. System Service*

**Capacity Constraints**

Hydro Ottawa routinely assesses the capability and reliability of the distribution system in an effort to maintain adequate and reliable supply to customers. Where gaps are found, appropriate plans for additions and upgrades are developed, which are consistent with all regulatory requirements for the connection of customers and with due consideration for safety, environment, finance, and supply system reliability/security. Hydro Ottawa summarizes the results of this capacity planning process in section 7 - System Capacity Assessment in which the short-term and long-term capacity needs for the service territory are identified.

In this regard, the supply needs in the service territory have been assessed to determine if additions and/or upgrades are required to maintain adequate and reliable/secure system capacity. Hydro Ottawa is composed of several subsystems which are segregated by operating voltage and geographical boundaries. The capacity planning process reviews and summarizes the existing and future constraints for each subsystem, identifying short-term and long-term projects. Forecasted growth, asset replacement schedules, and reliability are all factors in planning the system.

The following describes the key variables that are used to inform the capacity planning process:

- Historical station transformer loading from the system-wide annual peak day (weather normalized and adjusted to a one-in-ten year peak for forecasting)
- Historical feeder loading from the system-wide annual peak day (weather normalized and adjusted to a one-in-10 year peak for forecasting)
- Station, station transformer, and feeder planning capacity and ratings;
- Asset condition
- System configuration and operating characteristics (and restrictions)
- Number of Hydro Ottawa customers
- Historic energy purchased and delivered
- Summer and winter peak load

- City of Ottawa Official Plans and Community Development Plans
- Land use designation and population and employment projections
- Known developments through conversation with developers and City staff
- Energy Resource Facility connections and capacity
- Station capacity to connect generation and plans in place to address any restrictions
- Details and plans resulting from the Integrated Regional Resource Planning ("IRRP") process with the IESO and HONI
- Details relating to Connection Cost Recovery Agreements ("CCRAs") with HONI for station or transmissions projects

For more detail refer to section 7 - System Capacity Assessment.

**Reliability**

Hydro Ottawa continuously assesses the distribution system's service reliability. Where issues are found, appropriate actions are identified to address these concerns. Service reliability is integral to all work undertaken as part of system planning and asset management. The reliability planning process provides a platform for thorough review of system reliability and identifies planned works which are designed to directly impact system reliability.

Reliability driven projects are those which are designed to reduce outage frequency or duration. Automation is a key reliability initiative. In general, work considered as part of the system reliability plan includes the following:

- Deployment of remote sensors
- Deployment of remotely operable and autonomous devices
- Deployment of field devices to provide fault indications locally
- Supporting technologies to automation (i.e. communication & SCADA)
- Modifications of existing installations to address specific interference (i.e. animal guards, circuit spacing)

The reliability planning process may point to asset replacements that may be required. Successful lifecycle management of Hydro Ottawa's assets has a direct impact on system reliability. These activities focus on assets that are optimally maintained throughout their life, asset replacement prior to failure, and system planning to increase operability and reduce downtime.

The following describes the key variables that are used to inform the reliability planning process:

- Historical outage statistics (primary cause, secondary cause, duration, number of customers affected, circuit affected, station affected, date of interruption);
- Power quality measures (System Average RMS Frequency Index – voltage sags and swells); and
- Worst Feeder evaluation.

The following describes the results of the reliability planning process:

- Projects to improve the Worst Feeders reliability performance
- Initiatives to improve overall reliability (specific to top three causes of interruption from the previous year)
- Details on automation plans and how they will impact reliability

**System Operability**

Hydro Ottawa routinely reviews the existing system to identify opportunities for Distribution Enhancement projects that reduce operational constraints and improve system operability. Efficiency driven projects are those which are designed to reduce restoration times and decrease the number of personnel required for routine switching.

The following describes the variables that are used to identify areas that benefit from projects related to operational efficiency:

- Frequency of historical switching operations (often or never used)
- Criticality of connected load circuits (sub-transmission, critical infrastructure)
- Location of equipment (such as main switching centres or distribution trunk ties)
- Historical restoration issues (grading, vegetation, secure locations)

The following describes the results of the reliability planning process:

- Critical switches identified for upgrades to remote operable units
- Decommissioning redundant/unused legacy equipment from the system upon renewal
- Relocation of equipment or normal-open points

#### *5.2.1.4. General Plant*

General Plant investments follow a similar approach to the Asset Management and Capital Expenditure Processes, but are not evaluated within Copperleaf C55, Hydro Ottawa's investment optimization software. This is due to their large nature, generally spanning several years. They are instead, initiated and justified with detailed business cases.

As directed in Attachment 1-1-9(A): Corporate Memorandum - 2020-2025 Priorities and Budget Guidelines, all capital investment by the utility should provide for customer growth and the replacement of aging infrastructure to maintain plant reliability as per the needs analysis documented in the DSP. Capital investment key considerations include, but are not restricted to, the following:

- Affordability;
- Reliability;
- Efficiency, cost-effectiveness, and enhanced preparation for technological changes;
- Planned investments related to accommodating the connection of renewable energy generation;
- Planned investments for the development and implementation of the smart grid to support grid modernization and expenditures as required by legislation;

- Provision of more customer choice and addressing customers' preferences and expectations; and
- Coordination of infrastructure planning with customers, the transmitter, other distributors, and the IESO or other third parties where appropriate.

All new information technology ("IT") requirements must first be supported by IT Project Requests and submitted as a joint application between the requesting Division and the IT Prime Contact. This ensures the project is in line with the company priorities as well as the Information Management/Information Technology Strategy.

For development of the 2021-2025 budget, customers were engaged through the customer survey process. The results below reflect the robust support expressed by customers for innovation,General Plant, and technology investments.

- Innovation: 75% of customers support Hydro Ottawa's strategy of "leading change and engaging in industry pilots," whereas customers are split on whether Hydro Ottawa should limit expenditures in this category to service today's customers and existing needs.
- General Plant: 83% of customers feel that Hydro Ottawa should make the necessary investments to manage the distribution system efficiently and reliably. In addition, 83% feel that Hydro Ottawa should make investments in fleet on a vehicle-by-vehicle basis based on a set criterion.
- Finding efficiencies through technology investments: 85% support Hydro Ottawa's view on technological investments. Those that do are split on what should be prioritized – improvements or lowering distribution rates.

All technology investments will be evaluated through a Business Benefits Realization process. The results are measured against the objectives to ensure the benefits were achieved through the investments.

**System Capital Investment Support**

System Capital Investment Support captures the requirements for capital contributions to HONI for transmission-connection projects as well as for Hydro Ottawa fleet acquisition.

**System Maintenance Support**

System Maintenance Support covers the requirements for tools and associated equipment used by Hydro Ottawa crews.

**Business Operations Efficiency**

Business Operations Efficiency is the requirement for IT software and systems used to support daily business activities.

**Non-System Physical Plant**

Non-System Physical Plant captures the life cycle requirements for buildings.

### 5.2.2. Project Evaluation

The Project Evaluation phase creates business cases in support of the project alternatives. Each alternative is valued based on Hydro Ottawa's Corporate Strategic Objectives using the Value Model, described below, in order to assess the project's alternatives based on their value. The evaluation of project alternatives is completed within Copperleaf's industry leading Asset Management software, C55.

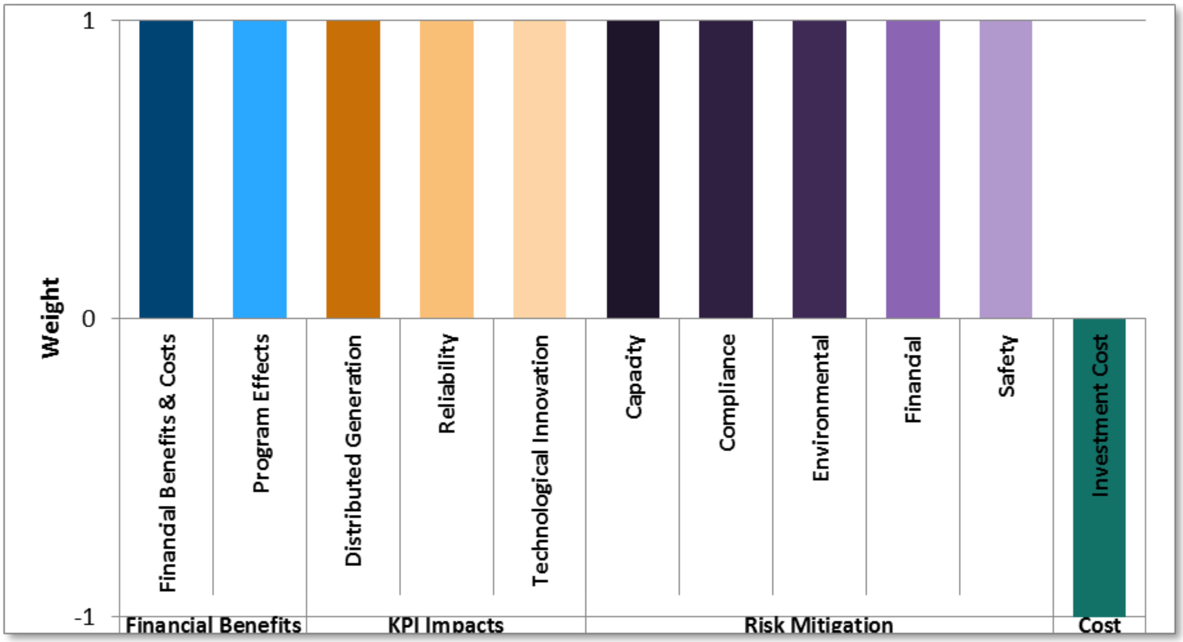
Project concepts and their alternatives are then reviewed to determine if they are mandatory projects. Mandatory projects are typically dictated through the DSC or the *Electricity Act, 1998*. They range from customer connections to line relocations. These projects are prioritized if they help address immediate concerns to health and safety, the environment, or alleviate constraints to the operation of the system. These projects may move directly to the Execution phase, potentially taking precedence over planned projects and causing deferral or delays. Otherwise, the projects make their way into the Project Review phase before being prioritized.

Project alternatives are then scored by identifying their risk and/or benefit as it relates to Hydro Ottawa's Asset Management Measures through the use of the Value Model. The evaluation Value Model is comprised of 11 Value Measures grouped into four Value Categories, as follows:

- Financial Benefits
  - Financial Benefits & Costs
  - Program Effects
- Key Performance Indicator ("KPI") Impacts
  - Distributed Generation
  - Reliability
  - Technological Innovation
- Risk Mitigation
  - Capacity
  - Compliance
  - Environmental
  - Financial
  - Safety
- Cost
  - Investment Cost

Each of the Value Measures is normalized to the same scale where one value point is equal to approximately $1,000. This means that within the Value Function, each of the Value Measures (except Investment Cost) is weighted with the same value of +1. Investment Cost is a negative contributor to the Value Measure, and as such, is weighted with a value of -1, as shown below.

**Figure 5.4 – Value Category Weighting**




The Value Measures for each project are computed for each year (the benefits or risks in one year can be different than the next – for example, the risk of a poor condition asset failing increases with time). They are then converted into a single number by taking the present value back to the current fiscal year using the system defined discount rate (5.89%). This means that if a project has a negative value, the cost of the project outweighs its benefits.

The following sections outline the details for the calculation of each of the Value Measures.

### *5.2.2.1. Financial Benefits*

**Financial Benefits & Costs**

The Financial Benefits & Costs are computed in dollars and then normalized to the Value Measure by dividing by 1000.

This Value Measure is calculated using the following equation, the components of which are defined in Table 5.3 below:

$$Financial\ Benefits\ \&\ Costs = (CLAB)(HLR) + (OLAB)(HLR)(10) + CCST + (OCST)(10) - (OADD)(10)$$

**Table 5.3 – Financial Benefits & Costs Variables**

| Variable Name | Description |
|---|---|
| CLAB | Capital Labour Saved (hours) |
| OLAB | O&M Hours Saved (hours) |
| HLR | Hourly Labour Rate (dollars/hour) |
| CCST | Other Capital Cost Savings (dollars) |
| OCST | Other O&M Savings (dollars) |
| OADD | Additional O&M Costs resulting from this investment (dollars) |

- Hourly labour rate ("HLR") is $80/hours; and
- O&M Costs are weighted at 10:1 to Capital Costs.

**Program Effects**

Program Effects utilizes the results of the Program Analytics (see section on Project Optimization), and is incorporated into the project value, where applicable.

### *5.2.2.2. KPI Impacts*

**Distributed Generation**

Hydro Ottawa prioritizes Energy Resource Facility ("ERF") investments based on customer requests and follows regulated timelines for response and connection.

Hydro Ottawa strives to integrate all proposed residential and commercial customer generation projects into the grid. Several projects are proposed every year. Hydro Ottawa works with project managers and the customer to integrate the proposed generation into the distribution system. The process for accepting these projects involves the following: analyzing the generation capacity of the connecting feeder and interface transformer; verifying that the relevant station transformer can accept reverse flow; ensuring that the short circuit changes and voltage fluctuations will cause no material impact on either the distribution or transmission grid; and reviewing the proposed single line diagram, electrical protection scheme, and site plan for adherence to all Hydro Ottawa, ESA, and IESO standards and requirements. In the event that the proposed generation connection is not possible, Hydro Ottawa works with the customer to provide a solution. This solution may involve expanding the distribution system to meet customer needs or relocating the project to a more fitting property. Where work on the distribution system is required for the connection, the project is coordinated to ensure regulatory timelines are met while optimizing crew time.

Hydro Ottawa also prioritizes investments within its system which help to enable the connection of ERFs. If a given project benefits the ability to connect ERFs, then 30 value units are applied to aid in prioritization.

**Reliability**

The following information is collected specific to each investment:

**Table 5.4 – Reliability Variables**

| Variable Name | Description / Question Answered |
| --- | --- |
| FAIL | How many failures per year will be avoided by implementing this investment? (based on historic rates of failure) |
| PEAK | For each of the failures, what would be the expected peak load lost, or in the case of redundant equipment, the peak load at risk? (kW) |
| DUR | What is the average duration of the outage caused by the failures? (hours) |
| DURR | If this is redundant equipment, and there is a failure, what is the duration of the period for which redundancy will be lost? (hours) |
| NCUS | What is the average number of customers impacted by each failure? |
| TYPE | Customer Type:<br>• Residential<br>• Mixed Residential / Commercial or<br>• Commercial / Industrial |
| WORS | Has this feeder been identified on the Worst Performing Feeder Report in the past 2 years, OR has this area been identified as an area of concern? |

The Reliability measure is then calculated through a sequence of steps:

### 5.2.2.3. Customer Interruption Cost

Costs associated with interruptions are assigned based on customer type and the frequency and duration of the interruption, as outlined in Table 5.5.

**Table 5.5 – Customer Interruption Costs**

| Metric / Customer Type | Residential | Mixed Residential / Commercial | Commercial / Industrial |
| --- | --- | --- | --- |
| Frequency Cost per kW | 2.00 | 20.00 | 20.00 |
| Duration Cost per kWh | 4.00 | 20.00 | 30.00 |

1. **Outage Duration**

The duration of the outage is computed as:

$$Duration = DUR + (0.05)(DURR)$$

Where,

- DUR represents the duration of the interruption that is experienced by the customer(s); and
- DURR represents the duration for which redundancy will be lost.

The time when redundancy has been lost has been included with an impact of 5% since it is possible that a second failure occurs during this time creating an interruption. Computing the likelihood of a secondary failure is complex and varies from situation to situation. Accordingly, 5% has been selected as a reasonable expectation, and has been used by Copperleaf at other utilities.

2. **Customer Cost of Outage Duration**

The Cost of Customer Minutes of Interruption is computed as:

$$cmiCost = (FAIL)(Duration)(60)(NCUS)(\frac{\$1}{min})$$

Where Duration is calculated in Step 2.

3. **Cost of Customer Minutes of Interruption**

The Cost of Customer Minutes of Interruption is converted to a cost using a factor of $1 per minute of interruption. This value has been derived using the figures for Mixed Residential / Commercial provided in Table 5.5 above, as follows:

$$Cost\ per\ minute = \frac{Duration\ Cost\ (\frac{\$}{kWh}) \times Power\ Consumption(kWh)}{60min}$$

$$Cost\ per\ minute = \frac{(20)(3)}{60}$$

$$Cost\ per\ minute = 1$$

Where,

- An assumed average consumption of 3 kWh has been used as derived Hydro Ottawa statistics from 2013 (7,570 GWh billed and 315,000 customers).

### 4. Frequency Cost

Frequency is computed as:

$$frequencyCost = (FAIL)(PEAK)(frequency\ cost\ per\ kW)$$

Where frequency cost per kW is defined in Table 5.5 above.

### 5. Duration Cost

Duration Cost is computed as:

$$durationCost = (FAIL)(PEAK)(Duration)(Duration\ cost\ per\ kWh)$$

Where,

- Duration is calculated in Step 2; and
- Duration cost per kW is defined in Table 5.5 above.

### 6. Reliability Cost

Reliability Cost is computed based on the highest of cmiCost, frequencyCost, and durationCost as:

$$reliabilityCost = max(cmiCost,\ frequencyCost,\ durationCost)$$

### 7. Reliability Value

Reliability Value is then computed from the Reliability Cost using:

$$reliability\ Value = \frac{reliabilityCost[1+(WORS)(0.25)]}{1000}$$

Where, if the feeder impacted has been identified as a Poor Performing Feeder, as defined in section 4.3.3 in the last two years or has been identified as an area of concern, the value is inflated by 25%. To convert the measure from dollars to units, the value is divided by 1000.

### Technological Innovation

The Technological Innovation measure is computed as:

$$Technological\ Innovation = (10)(TI1)$$

Where,

**Table 5.6 – Technological Innovation Variables**

| Variable Name | Question Answered | User Selection | Value |
|---|---|---|---|
| TI1 | Does this investment introduce or apply new technology that has never been used at Hydro Ottawa before? (Does not include enhancements to existing technology) | Yes | 1 |
| | | No | 0 |

#### *5.2.2.4. Risk Mitigation*

The Value of Risk Mitigation is computed using the same methodology for all five Value Categories:

- Capacity
- Compliance
- Environmental
- Financial
- Safety

To compute the value, the Baseline Risk and the Residual Risk are specified and the Value is calculated as follows:

$$Value\ of\ Mitigated\ Risk = Baseline\ Risk - Residual\ Risk$$

Where, Baseline Risk is the risk present if the investment is not completed and Residual Risk is the risk present if the investment is completed.

For both the Baseline Risk and the Residual Risk, the Consequence and Probability are specified based on the Risk Categories and Probabilities (Table 5.7 and Table 5.8 below) and are converted to unit values using the Risk Matrix (Figure 5.5 below).

1 **Table 5.7 – Risk Categories**

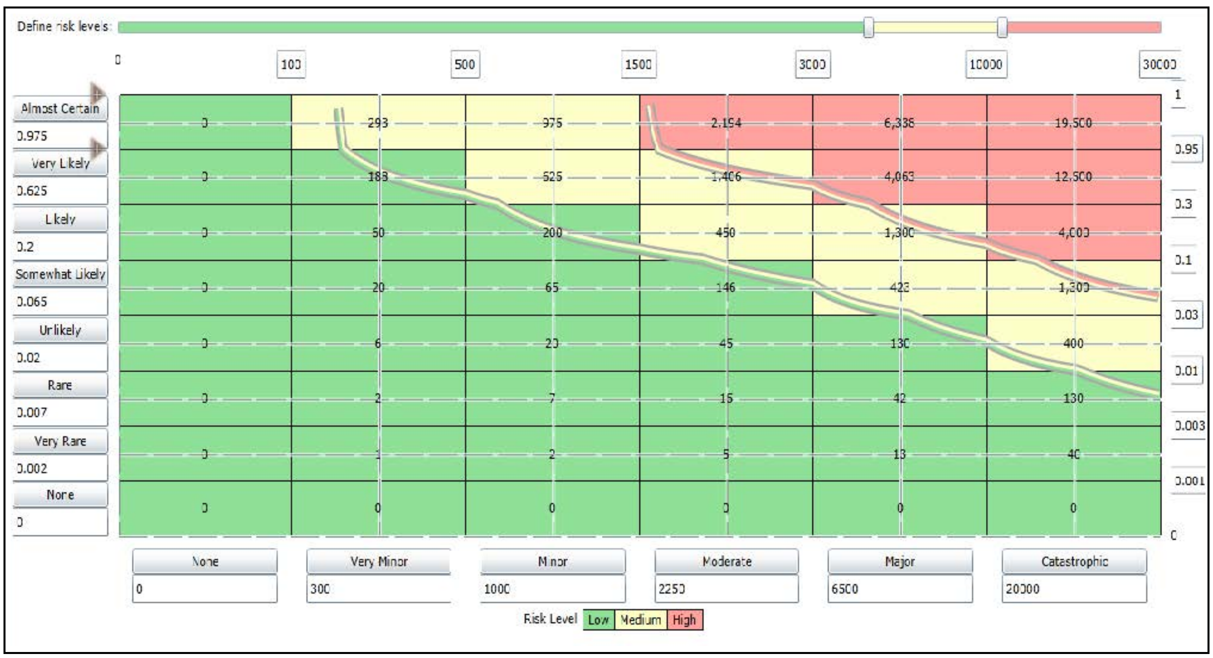
| Risk Category | Consequence | | | | | |
|---|---|---|---|---|---|---|
| | **Catastrophic** | **Major** | **Moderate** | **Minor** | **Very Minor** | **None** |
| **Capacity** | Unable to service a new load | Can supply all load but exceeding thermal limits | Can supply all load but exceeding planning limits | N/A | N/A | Able to supply load without exceeding planning limits |
| **Compliance** | Federal/Provincial: Regulated (including OEB, CSA). Including voltages exceeding the standard levels defined in the Conditions of Service | N/A | Municipal: Regulated (local level through Municipal by-laws) | Corporate /Other: Corporate or other requirements, including replacement of recalled equipment, and equipment no longer operating as originally designed | Legislation Pending: May become regulated in the future (i.e. bills announced in parliament or pending legislation) | None: no corporate or legal requirements |
| **Environmental** | Release of more than 2000L of oil | Release of 1000L to 2000L or oil | Release of 200L to 1000L of oil | Release of 100L to 200L of oil | Release of less than 100L of oil | Immaterial consequence |
| **Financial** | >$10M annually | >$3M annually | >$1.5M annually | >$500k annually | >$100k annually | <$100k annually |
| **Safety** | Possibility of injury has been mitigated by operating restriction where the cost of those restrictions are >$10M or result in >10M CMI annually | Possibility of injury has been mitigated by operating restrictions where the cost of those restrictions are >$3M or result in >3M CMI annually | Possibility of injury has been mitigated by operating restrictions where the cost of those restrictions are >$1.5M or result in >1.5M CMI annually | Possibility of injury has been mitigated by operating restrictions where the cost of those restrictions are >$500k or result in >500k CMI annually | Possibility of injury has been mitigated by operating restrictions where the cost of those restrictions are >$100k or result in >100k CMI annually | Immaterial consequence |

2

### Table 5.8 – Risk Probability

| Probability | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Almost Certain** | **Very Likely** | **Likely** | **Somewhat Likely** | **Unlikely** | **Rare** | **Very Rare** | **None** |
| Imminent: >95% chance of occurring this year | Greater than 30% chance of event occurring this year | Greater than 10% chance of event occurring this year (e.g. 1 in 10 year event) | Greater than 3% chance of event occurring this year (e.g. 1 in 33 year event) | Greater than 1% chance of event occurring this year (e.g. 1 in 100 year event) | Greater than 0.3% chance of event occurring this year (e.g. 1 in 333 year event) | Greater than 0.1% chance of event occurring this year (e.g. 1 in 1000 year event) | Event unlikely to occur in next 1000 years |

### Figure 5.5 – Risk Matrix




To illustrate the use of the Risk Matrix, the replacement of a station-class transformer without modern oil containment by a station-class transformer with modern oil containment would mitigate a risk of ‘Catastrophic’ environmental consequence, with a probability from ‘Very Rare’ to ‘Unlikely’, depending on the age and condition of the asset. The replacement of a distribution-class transformer would mitigate the risk of ‘Very Minor’ consequence, with a probability from ‘Rare’ to ‘Somewhat Likely’, depending on the age and condition of the asset. Approximate annual risk mitigation scores for these scenarios would be 130 and 2, respectively. The two lines in Figure 5.5 above delineate the regions of each Risk Level in the Risk Matrix: Low, Medium, and High.

#### *5.2.2.5. Cost*

**Investment Cost**

The investment cost is entered in dollars and then normalized to the Value Measure scale by dividing by 1000.

#### *5.2.2.6. Mandatory Compliance Investments*

Investments that have been identified as mandatory or “must do” based on being an imminent safety or regulatory concern will be flagged and will pass through at the top of the optimization process. These investments will still be scored based on the Value Measures and will typically show mitigated risk under the Compliance or Safety category.

### 5.2.3. Project Review

During the Project Review phase, the valuation of each project is reviewed individually and compared to similar projects to ensure a consistent approach has been applied. As well, the relative ranking of projects, compared to one another, is assessed to validate that projects have been ranked according to expectations based on engineering judgement. If discrepancies are found, the project valuation will be corrected.

### 5.2.4. Project Optimization

The Project Optimization phase uses C55 to rank each project based on its value, as calculated through the Project Valuation phase. Constraints are then applied to create a detailed project list for Hydro Ottawa Executive Management Team approval.

**Project Optimizer**

The Optimizer algorithm within C55 selects the combination of projects that carry the highest overall value while fitting within specified constraints. The Optimizer takes the following as inputs:

- Project or program alternatives, including budgets and value (as calculated in the Execution Phase); and
- Constraints (dependencies, time horizons, financial, resource, etc.).

The goal of the optimization is to determine the optimal portfolio of projects which maximizes the value to the organization given a set of projects/programs within a set of constraints (e.g. budget envelope), and uses a Mixed Integer Linear Programming ("MILP") optimization engine enabling fast computation time.

Projects classified under the Pole Renewal and Underground Cable Renewal programs are optimized independently from all other projects. This is done to meet the replacement levels recommended by the Asset Management Plan for each asset type.

**Project List**

A Preliminary Project List is created based on the Optimization process and expert knowledge of the needs and impact of the proposed projects. This list is further refined based on known expenditure and resource constraints to create the Detailed Project List.

While it is preferred that the timing for all investments are based on this optimization, mandated investments will arise, typically due to external drivers, such as regulatory or legislative mandates or health and safety concerns. When such investments occur, they will have reasoning clearly documented and the impact to planned objectives will be reviewed.

The Detailed Project List of prioritized investments then moves on for approval from Hydro Ottawa's Executive Management Team and Board of Directors before proceeding to execution.

This ensures that Corporate Strategic Objectives are being met through the proposed investment plan. Constraints may be re-evaluated and updated to meet objectives or adjust the level of mitigated risk.

### 5.2.5. Project Execution

The Execution phase follows a Hydro Ottawa internal project management methodology called "Project Coach" which defines the core lifecycle for projects. Project Coach is based on the internationally accepted standard for project management: Project Management Body of Knowledge ("PMBOK") issued by the Project Management Institute.

Project Coach provides specific guidelines, procedures, work instructions, and industry best practices that will allow Hydro Ottawa personnel to perform project work in an efficient, effective, and high quality manner. Processes described in Project Coach are intended to be scalable and applicable to all projects, regardless of complexity. Through use of this tool, a consistent approach to planning, scheduling, and execution of projects can be implemented.

Project Coach describes six steps in the execution of the project:

1) **Planning & Project Initiation (Plan)** – The project charter, scope, and objectives are created. Key players take steps to initiate the project and engage any needed authorization.
2) **Design** – The project charter, scope, and objectives are reviewed and approved. Preliminary and detailed project design and estimates are created.
3) **Procurement & Circulation (Procure)** – The project design is approved. Material and services are procured.
4) **Scheduling (Schedule)** – The project is scheduled with key milestones and deliverable dates.
5) **Construction (Construct)** – The project is executed with a continuous review on progress and risk to completion.

6) **Closure (Close)** – The project documentation, financials, and reviewed lessons learned are completed. Feedback and lessons learned are registered and communicated for continuous improvement.

## 5.3. NON-DISTRIBUTION SYSTEM ALTERNATIVES

Hydro Ottawa was a key stakeholder in the IRRP process,, as developed by the IESO and updated by the OEB. The IRRP develops and analyzes forecasts of demand growth for a 20-year time frame, determines supply adequacy in accordance with the ORTAC, and develops regionally integrated solutions to address needs that are identified. These include conservation, demand management, distributed generation, large-scale generation, transmission, and distribution. Hydro Ottawa continues to work with the IESO and HONI in developing optimal solutions to the transmission and bulk system needs within the Ottawa area. Please refer to section 1.10.2 for more details. The development of the next cycle of the IRRP began in 2018 and is expected to be completed in the first quarter of 2020.

## 5.4. CUSTOMER ENGAGEMENT ACTIVITIES

Hydro Ottawa undertakes numerous customer engagement activities to solicit feedback and keep customers informed about the work which may impact them.

**Customer Satisfaction Survey**

Each year, Hydro Ottawa engages an external research firm to conduct an annual Customer Satisfaction Survey. The survey helps the utility understand the satisfaction levels of Hydro Ottawa customers relative to Ontario comparators. It also reveals how customer perceptions, issues, and concerns are evolving over time. The types of questions posed to customers in this annual survey cover the following topics:

- LDC knowledge, integrity, involvement, and trust
- Overall customer satisfaction scores
- % of respondents indicating they had a blackout or outage in the past 12 months
- % of respondents indicating they had a billing problem in the past 12 months

- What customers think of electricity costs
- Level of customer engagement
- Company Image
- Customer view of importance to pursue implementation of the Smart Grid

The survey results factor into the setting of annual performance objectives and the establishment of relative priorities.

Interviews are conducted with a wide range of questions covering such topics as system reliability performance, investment to improve reliability, acceptable length of outages, design of the system (overhead versus underground), and willingness to pay more for system enhancements.

Based on survey results, Hydro Ottawa has created a capital plan that paces investments in order to minimize rate impacts, while continuously improving efficiencies and productivity with respect to distribution planning and implementation. Hydro Ottawa is continuing to improve capital project prioritization, specifically in the areas of data collection and risk management. Please see Attachment 1-2-1(C) and Attachment 1-2-1(D) for the results from Hydro Ottawa's 2018 Customer Satisfaction Survey, organized by responses from residential and small business customers and large commercial customers, respectively.

Hydro Ottawa also conducts monthly telephone surveys of customers who have recently called the utility's contact centre. This survey measures factors such as the following:

- Level of satisfaction with the Contact Centre
- Level of knowledge of the staff who dealt with the customer
- Level of courtesy of the staff who dealt with the customer
- The ability to deal with the customer's issue (First Call Resolution)

The use of these surveys helps to determine if Hydro Ottawa is improving performance, from the customer's perspective, year-over-year. Further, these surveys help identify emerging issues which influence planning and resolution priorities. Annual plans are more informed and aligned as a result of customer feedback generated from these two surveys.

**Customer Consultations on Major Projects**

Hydro Ottawa regularly consults customers with regards to major projects that will potentially impact customer property or neighbourhoods, such as cable replacement or distribution transformer replacement.

The consultation process first involves informing the potentially impacted customers of the pending work, followed by a customer open house aimed at creating open dialogue. During the open houses, Hydro Ottawa staff inform customers on the scope, schedule, and the general process to be undertaken to perform the work. It is also a venue for customers to provide their feedback and voice their concerns that staff can then immediately address. The open house strategy was developed based on feedback received from customers in the past and have since proven to enable a productive and successful project for both the customers and Hydro Ottawa. The utility Ottawa believes, as has been demonstrated through these sessions, that strong and open communication with customers is essential. Customers have commented that they appreciate these consultation sessions as they provide a forum for discussion and airing their concerns, while allowing Hydro Ottawa to inform them of project needs and the concept of reliability.

**Participation with Electrical Contractors Association**

Hydro Ottawa actively communicates with the Electrical Contractors Association ("ECA") of Ottawa to ensure strong communications between the utility and the numerous contractors that work in Ottawa. This need was identified by the ECA as part of the customer persona activity that Hydro Ottawa initiated in 2013. As a result, Hydro Ottawa now ensures any and all questions are answered and actively communicates new information to the ECA. Topics such as changes to the Conditions of Service are explained and discussed to ensure a clear understanding of requirements. Feedback received in this continuous manner allows Hydro Ottawa planners to better understand future needs, timing of developments and issues and concerns around design standards and planning practices.

**Hydro Ottawa Website**

Customers are solicited for their direct feedback on Hydro Ottawa's corporate website, as well as on the secured MyAccount customer portal. Customers can send in their complaints and inquiries, the resolution of which are tracked and managed by a complaint management application. The use of complaint management software helps Hydro Ottawa identify complaint trends and opportunities for improvement.

### *5.5. COST EFFECTIVE MODERNIZATION OF THE DISTRIBUTION SYSTEM*

Hydro Ottawa takes advantage of opportunities that arise during system planning to implement cost-effective modernization of the distribution system in order to make it more efficient, reliable, and provide more customer choice. Such opportunities include the following:

- When replacing assets at the end of life, or evaluating projects to improve reliability, Hydro Ottawa incorporates new technology where appropriate, including:
  - Replacing end of life switches with smart, Supervisory Control and Data Acquisition ("SCADA")-controlled switches capable of remote operation thus reducing crew and truck time previously required for switching and power restoration.
  - Installing fault circuit indicators ("FCIs") based on past experience and evaluation of single line diagrams for ideal installation locations. The smart FCIs report is communicated back to the system office through the SCADA network, which provides indication to the operators as to the location of the fault, speeding up switching and restoration time by reducing the time spent on troubleshooting.
  - Through the use of these technologies a reduction of manual efforts is achieved, thereby creating better efficiencies and enhanced reliability. They also allow for

greater O&M savings than their initial investments, thus reducing the overall lifecycle cost.

- When station transformers are identified for replacement, the new units will have reverse flow capabilities to eliminate potential restrictions to connecting ERFs.
- The recent SCADA upgrade will facilitate the implementation of DMS and OMS in a single platform. This investment will enhance the efficiency and performance of the system operators in the control room by removing separate interfaces and incorporating SCADA, DMS, and OMS into a single view.
- Through their MyAccount online accounts, customers are able to download daily and hourly consumption data which facilitates their ability to make decisions about their electricity cost. (Residential customers are also able to use a mobile application for this purpose).

# 6. ASSET LIFECYCLE OPTIMIZATION

Hydro Ottawa manages its assets throughout their lifecycle to optimize the value they deliver over the period that they are in service. Hydro Ottawa's lifecycle optimization includes planning and design, installation and commissioning, operation and maintenance, and renewal and decommissioning.

This section will cover Hydro Ottawa's lifecycle optimization in the following subsections:

- Asset Demographics and Condition
- Asset Lifecycle Optimization Policies and Practices
- Asset Lifecycle Risk Management

## *6.1. ASSET DEMOGRAPHICS AND CONDITION*

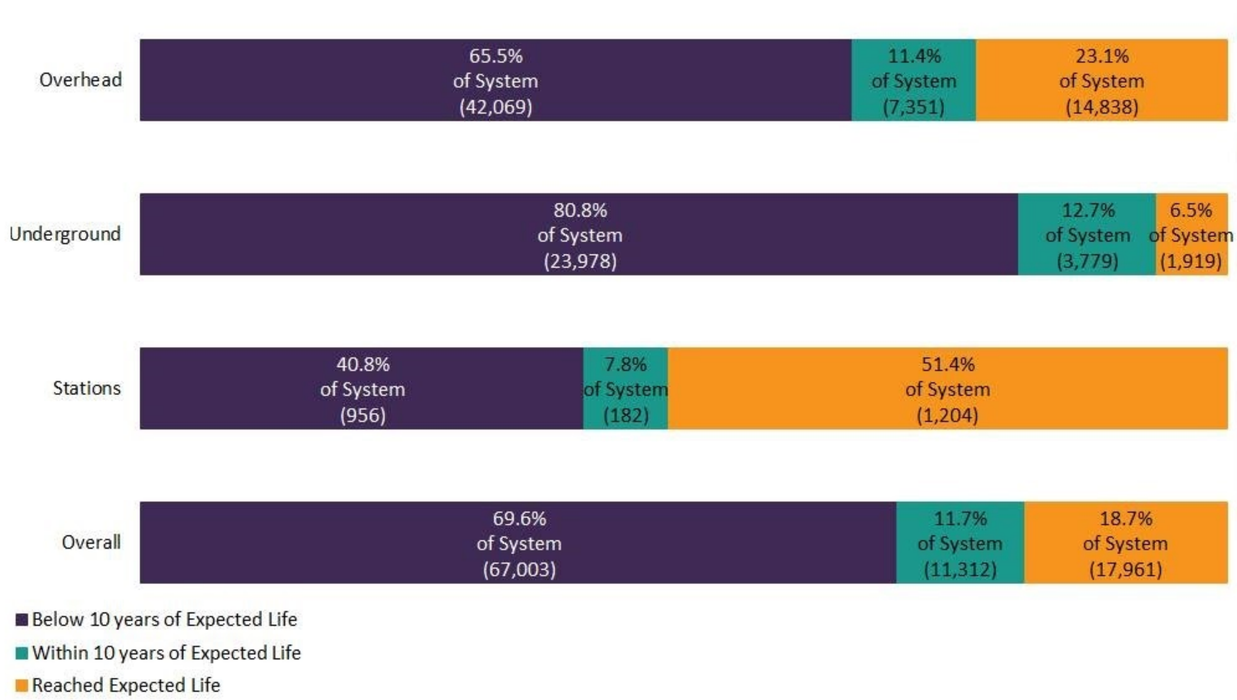
The following sections summarize the demographics and condition assessment for the major asset classes within Hydro Ottawa's system. Asset condition is based upon health index calculations which are unique for each asset class. Details of Hydro Ottawa's Asset Condition Assessment Process can be found in section 5.1.2. Details of the utility's System Renewal Investments can be found in section 8.3.

Hydro Ottawa manages assets in three main systems: Stations, Overhead, and Underground. Each system has distinct types of assets that are specific to the system and are subject to different types of risks. Managing assets within each system allows for the coordination of activities and investments.

Hydro Ottawa's overall asset demographics, as seen in Figure 6.1 below, show that a large portion of the asset population has reached its expected service life. For example, 19% of all assets have reached their expected service life and now pose a higher risk of failure. An additional 12% of assets are within 10 years of reaching their expected service life.

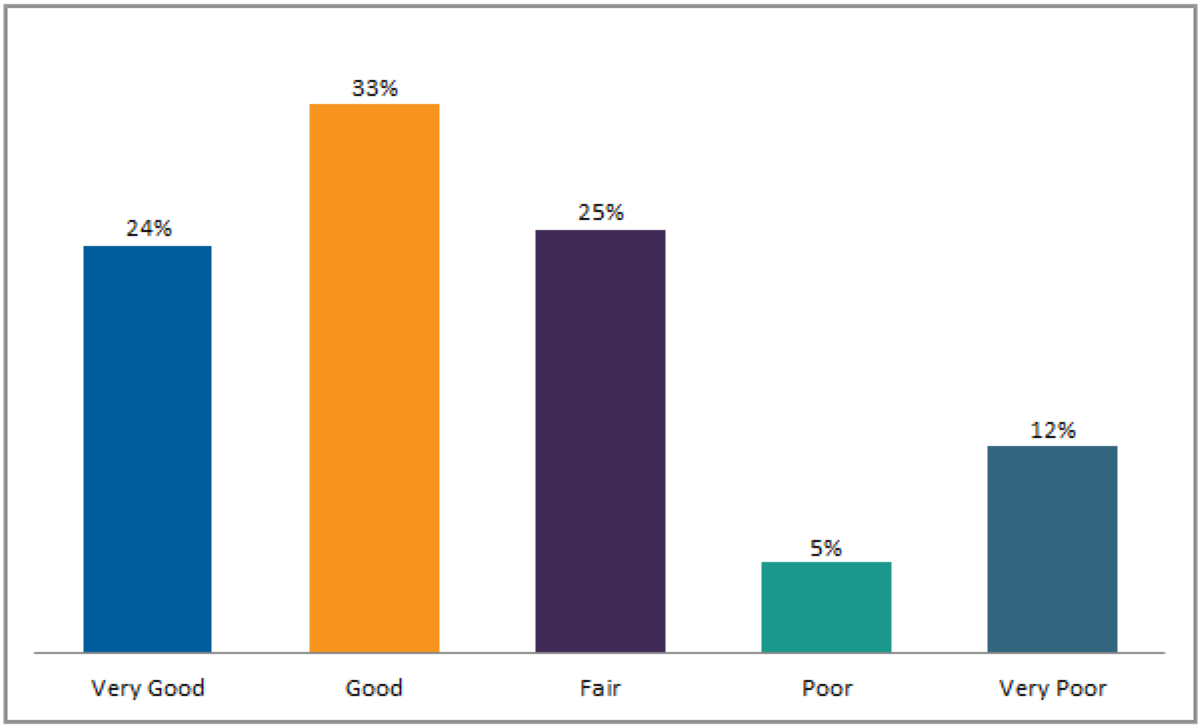
A large portion of station assets have reached the end of their expected service life. However, there are no station assets in Poor or Very Poor condition. Continued condition monitoring of assets, including dissolved gas analyzers and temperature monitoring, is being used to assess the health of aging assets. Station assets are continuously inspected and maintained as part of Hydro Ottawa's station equipment maintenance programs in order to identify any developing deficiencies before the asset fails.

**Figure 6.1 – Overall Asset Age Demographics**




Hydro Ottawa's overall asset condition ratings are summarized in Figure 6.2 below. As indicated, there are 17% of assets in Poor or Very Poor condition. Hydro Ottawa's asset investment and maintenance programs are targeted to minimize assets in these conditions in order to mitigate the potential risk of failure.

**Figure 6.2 – Overall Asset Condition**




The following sections detail the demographics and condition of each asset class.

### 6.1.1. Station System Assets

Hydro Ottawa station assets are an important part of delivering power to customers. These assets are located within the fence of an electrical station. Out of the 91 stations that service Hydro Ottawa's customers, Hydro Ottawa fully owns 73. Hydro Ottawa and Hydro One Networks Inc. ("HONI") jointly own 12 stations. These stations consist of various assets, some owned by HONI, and others owned by Hydro Ottawa. HONI wholly owns six stations that supply Hydro Ottawa customers. A list of these stations and their ownership is provided in Appendix B: Hydro Ottawa Station Table.

### *6.1.1.1. Station Transformers*

Station transformers are one of Hydro Ottawa's most critical asset classes due to the ability to affect thousands of customers. Hydro Ottawa owns 167 station transformers which operate at various voltages, connected to either Ontario's electric transmission grid or connected to the local sub-transmission system. Hydro Ottawa also supplies distribution stations and customers through 37 station transformers owned and maintained by HONI. Hydro Ottawa does not manage HONI-owned station transformers. Figure 6.3 and Table 6.1 below detail the various components of a station transformer.

**Figure 6.3 – Station Transformer**

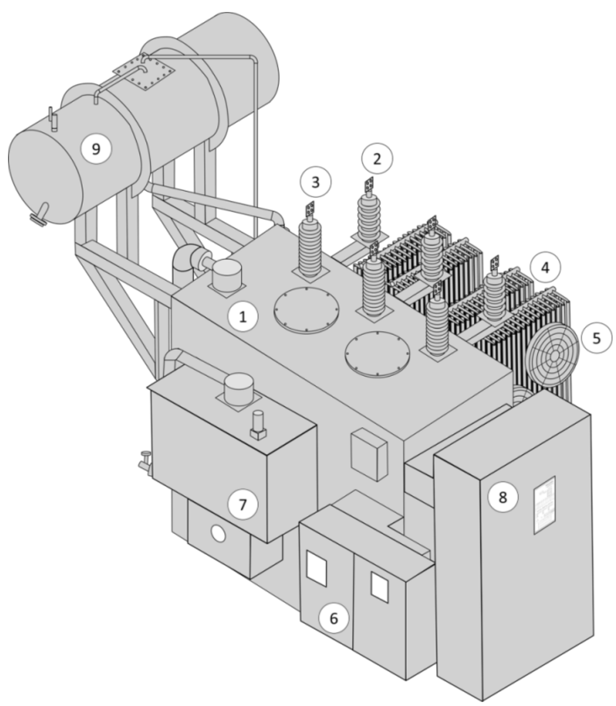



**Table 6.1 – Station Transformer Components**

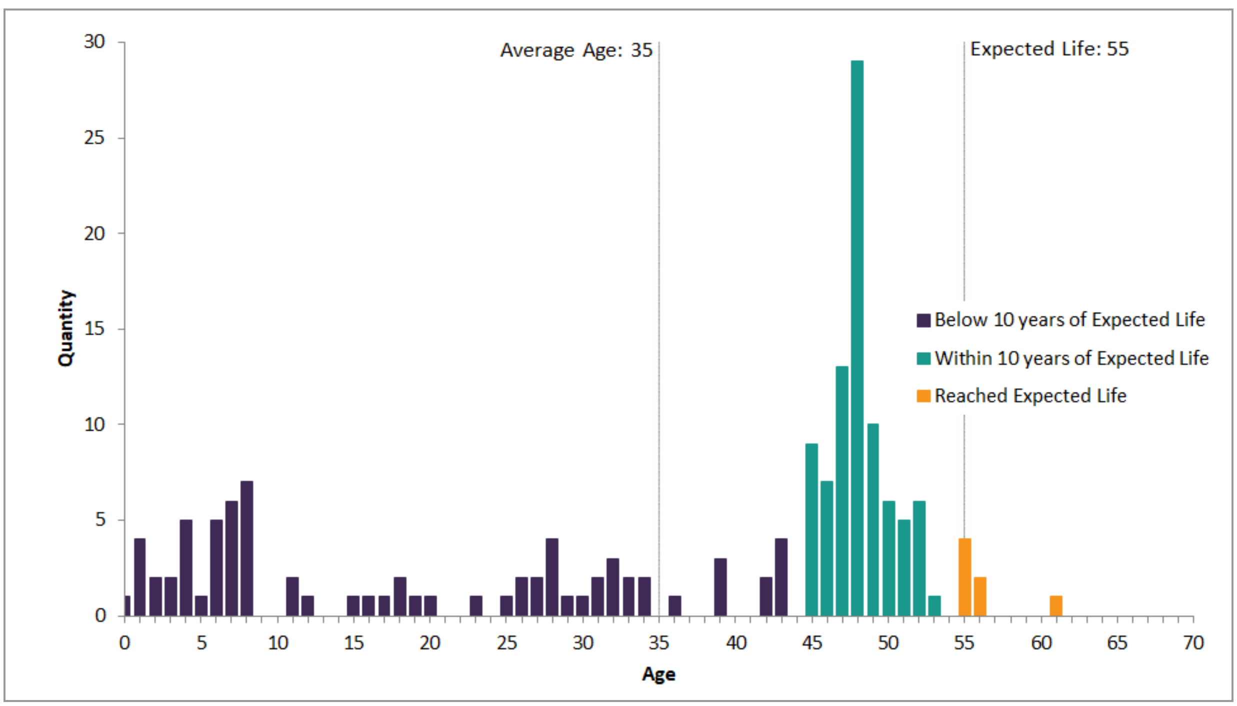
| Figure Number | Component | Function |
|---|---|---|
| 1 | Enclosure | Station transformer enclosures maintain isolation of the high and medium voltage equipment from outside sources while ensuring security from the public for increased safety. Additionally, the enclosure protects the inside equipment from damage and increases system reliability by isolating it from weather, animals and contaminants. |

| Figure Number (Cont'd) | Component (Cont'd) | Function (Cont'd) |
|---|---|---|
| 2 | Surge Arrestors | Station surge arresters protect the system and equipment by suppressing voltage surges from various causes (e.g. lightning). |
| 3 | Bushings | Station transformer bushings support an insulated flow of current from the connecting conductors to the inside connections through the grounded enclosure. |
| 4 | Radiators | The radiators external to the station transformer's core support the asset's successful operation through cooling of the oil using natural convection. As warm oil flows up into the radiator, cooler oil flows back into the transformer. The management of station transformer temperature is vital to ensuring it can support the designed transformation capacity without degrading internal components over its lifecycle. |
| 5 | Fans | The cooling fans further support the oil cooling mentioned above as the fanned air cools the oil travels within the radiators. These fans allow a station transformer to achieve increased electrical transformation capacity through managing the temperature. Fans are typically controlled on and off through relays at specific temperature thresholds. |
| 6 | Control Cabinet | A station transformer's control cabinet encloses and protects various monitoring and protection systems (described below) from damage by isolating it from weather, animals, contaminants and the public. |
| 7 | Tap Changer | The on-load tap changer is used to regulate the voltage of the station transformer by changing the transformer's winding ratio. The tap changer can rotate up or down to either increase or decrease the ratio. This ensures that the voltage supplied by the station is constant, even in cases where the incoming voltage is too high or too low. This results in high-quality power being distributed from the station into the distribution network. |
| 8 | Bushing Enclosure | The bushing enclosure is used on station transformers with side mounted bushings, typical for connecting underground conductors. The bushings and cables are contained within the metal enclosure which protects them from the outdoor elements described by the station transformer enclosure above. |
| 9 | Conservator | The conservator tank provides space for a station transformer's oil to expand and contract as the transformer's load increases and decreases. When electrical load increases, the transformer's temperature rises causing the oil to expand into the conservator tank. When the load decreases, the temperature decreases causing the oil to contract and flow down from the conservator into the main tank. This separation also ensures oxidation occurs in the conservator and not in the main transformer tank. Hydro Ottawa also installs fully sealed station transformers which do not use a conservator tank. |
| Not Shown | Monitoring and Protection Systems | Monitoring and protection systems are used to ensure that a station transformer operates to its full expected life safely. Various sensors are used to measure temperature, gas accumulation and pressure. The results control cooling systems on the transformer, signal alarms to system operators and operate breakers to isolate and protect the transformer. Additionally, the results are used to drive maintenance or renewal activities. |

| Figure Number (Cont'd) | Component (Cont'd) | Function (Cont'd) |
|---|---|---|
| **Not Shown** | Online Dissolved Gas Analyzer | Online dissolved gas analyzers continuously monitor gas accumulation in the station transformer's oil to ensure operation over its lifecycle. If a transformer experiences a fault, various gases accumulate in the transformer oil. Tracking the rate of change of these gases can provide an early indication of developing faults in a transformer. |
| **Not Shown** | Core, Windings, Oil | A station transformer's core, primary and secondary windings and oil insulation are sealed within the transformer's enclosure. These elements work together to convert supplied electricity from a high or medium voltage to outgoing electricity at a lower voltage through the use of electrical and magnetic induction. This allows for electricity to be stepped down from a transmission or sub-transmission voltage to a distribution voltage for economic delivery throughout Hydro Ottawa's service territory. |

The average age of Hydro Ottawa's station transformers is 35 years; Figure 6.4 illustrates the population demographics.

**Figure 6.4 – Station Transformer Age Demographics**

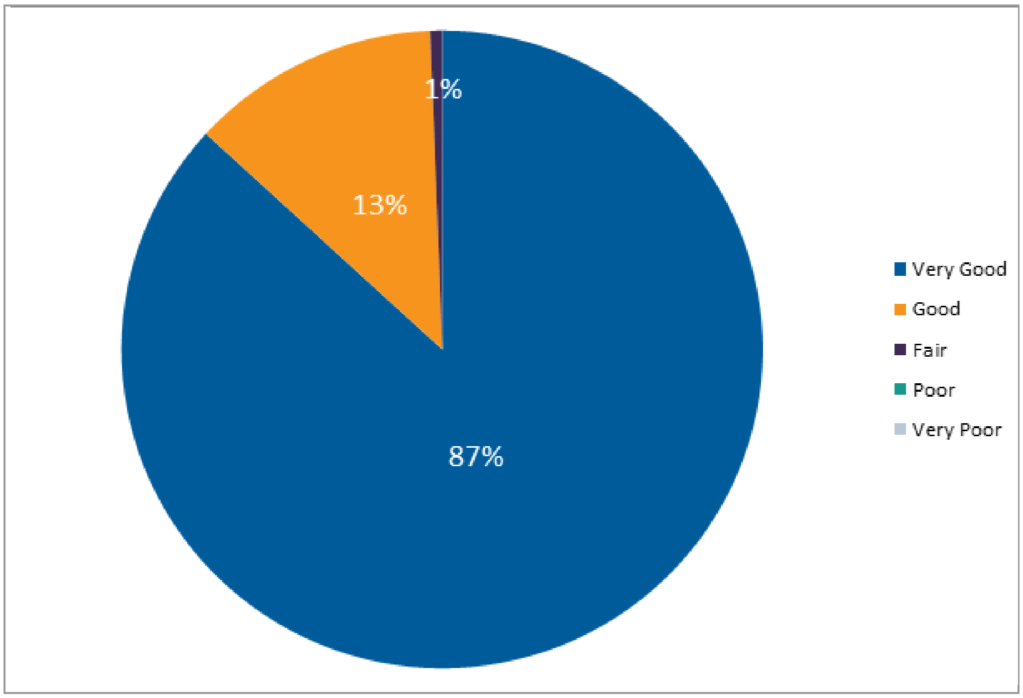


The expected service life of station transformers, where the probability of failure is approximately 1.5% or greater, is an age of 55 years. There are seven transformers that have reached the expected service life and 86 within 10 years of their expected service life.

**Figure 6.5 – 28 kV Station Transformer at Terry Fox MTS**

The health index of a transformer is determined through various criteria such as visual inspections, power factor tests, load history, infrared scanning, oil analysis (dissolved gas analysis and degree of polymerization), as well as additional criteria for on-load tap changers if applicable. The resultant health index is a condition rating from Very Good to Very Poor. This rating is an accurate representation of the current condition of the transformer and is used to drive maintenance and renewal programs. Hydro Ottawa has an active maintenance and monitoring program for its station transformers given their criticality in the system. A summary of known Hydro Ottawa's station transformer conditions is shown in Figure 6.6. The majority of station transformers are in Good or Very Good condition as a result of proactive preventative maintenance practices and ongoing monitoring, including Dissolved Gas Analysis.

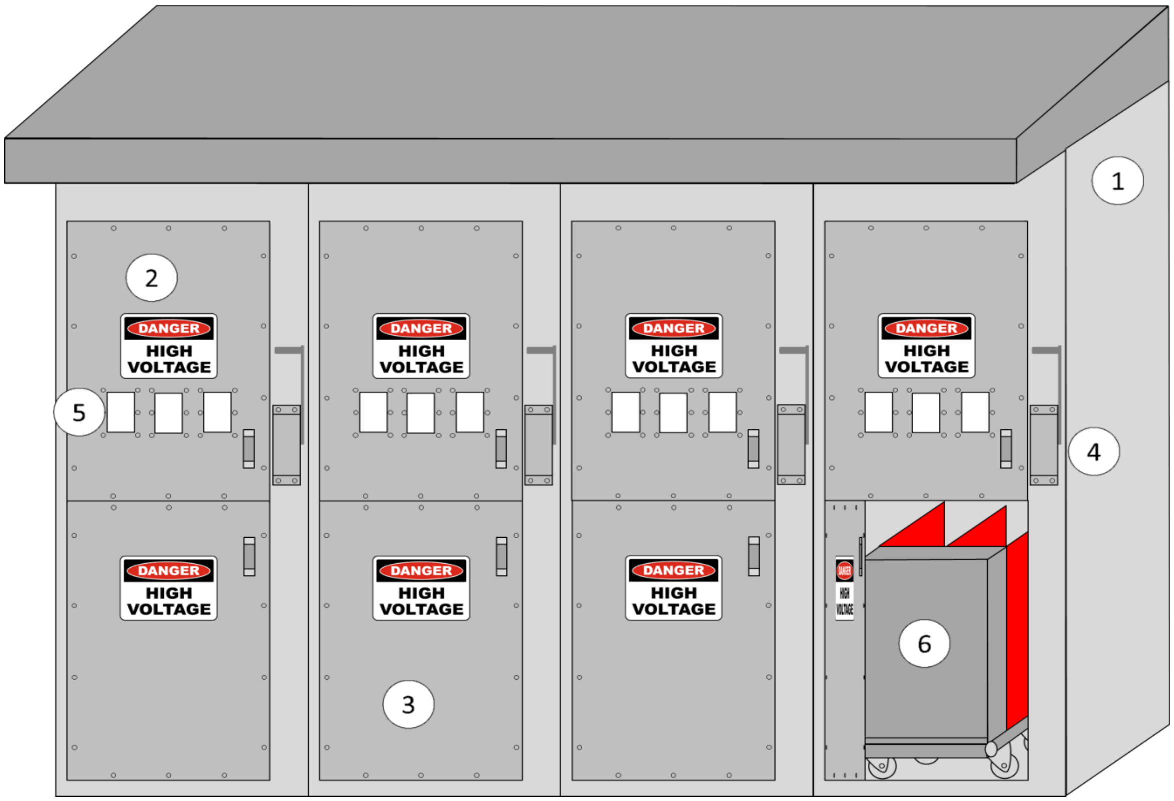
**Figure 6.6 – Station Transformer Condition Demographics**




### *6.1.1.2. Station Switchgear*

Hydro Ottawa owns and maintains switchgear assemblies in 85 stations, which include Hydro Ottawa-owned stations, as well as stations with shared ownership with HONI. The station switchgear asset class consists of breakers, switches, bus insulation, support structures, protection and control systems, arrestors, control wiring, ventilation, and fuses. Figure 6.7 and Table 6.2 below detail the various components of a station switchgear lineup.

**Figure 6.7 – Station Switchgear and Breakers**



1 **Table 6.2 – Station Switchgear and Breaker Components**

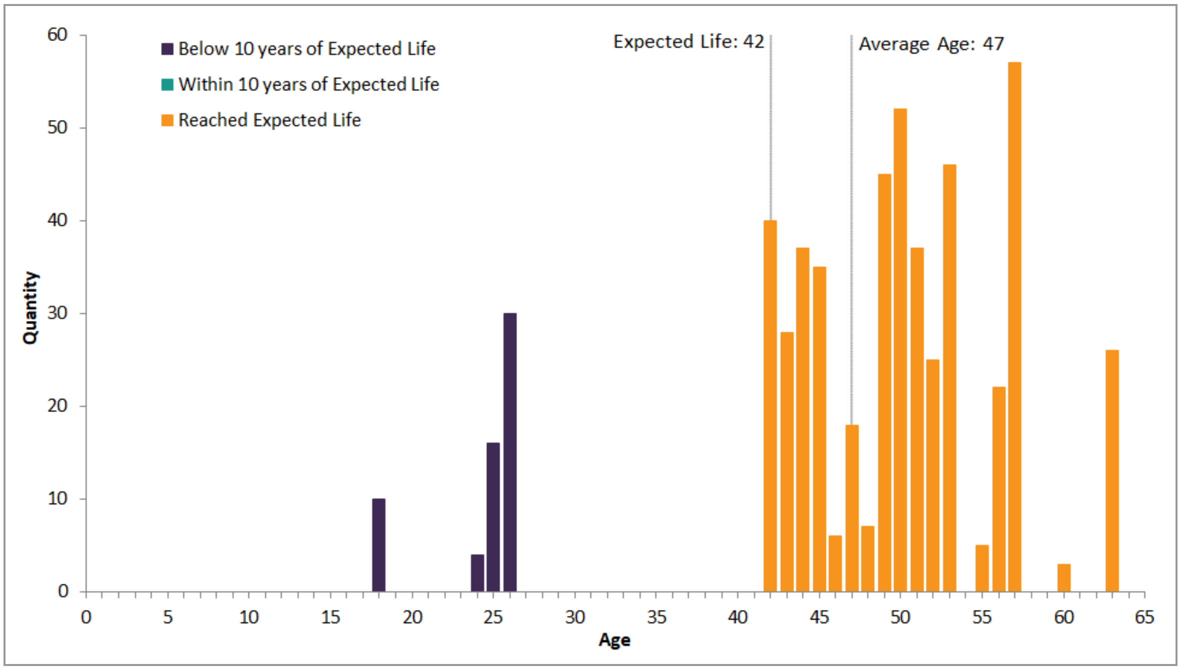
| Figure Number | Component | Function |
|---|---|---|
| 1 | Enclosure/ Plenum | Enclosures maintain isolation of the medium voltage and high voltage equipment from outside sources and provide a barrier between energized equipment and the persons at the station. Additionally, the enclosure protects the inside equipment from damage and increases system reliability by creating a barrier. Finally, the enclosure houses the insulation, bus bars, switches, breakers, control cabling and isolation pieces of the switchgear. The plenum is part of the arc resistant design of a switchgear, which services to strategically direct and contain the forces associated with an arc flash to avoid catastrophic failure of the enclosure of the switchgear. |
| 2 | Control Cabinet | The control cabinet houses all of the low voltage and control signals, such as instrument transformer feedback, that are used to operate and provide communication signals from breakers. |
| 3 | Breaker Door | The breaker door isolates the breaker from the medium voltage equipment and provides a mechanism for removing breakers for isolation from the attached bus. |
| 4 | Breaker Switch | The breaker switch is used to open and close the circuit breaker's connection to the bus, housed within the switchgear. |
| 5 | Switchgear Window | Breaker windows allow a view into the switchgear enclosure for inspection and to visually identify connected or disconnected breakers. |
| 6 | Circuit Breaker | The circuit breaker is a protection and isolation device used to connect an electrical bus to a feeder or another electrical bus. Circuit breakers are rated for a specific current at which they will open, breaking load, as a protection device. The circuit breaker can be activated locally or remotely, and via other protective relays that can be wired into the control cabinet and breaker trip circuit. |

2

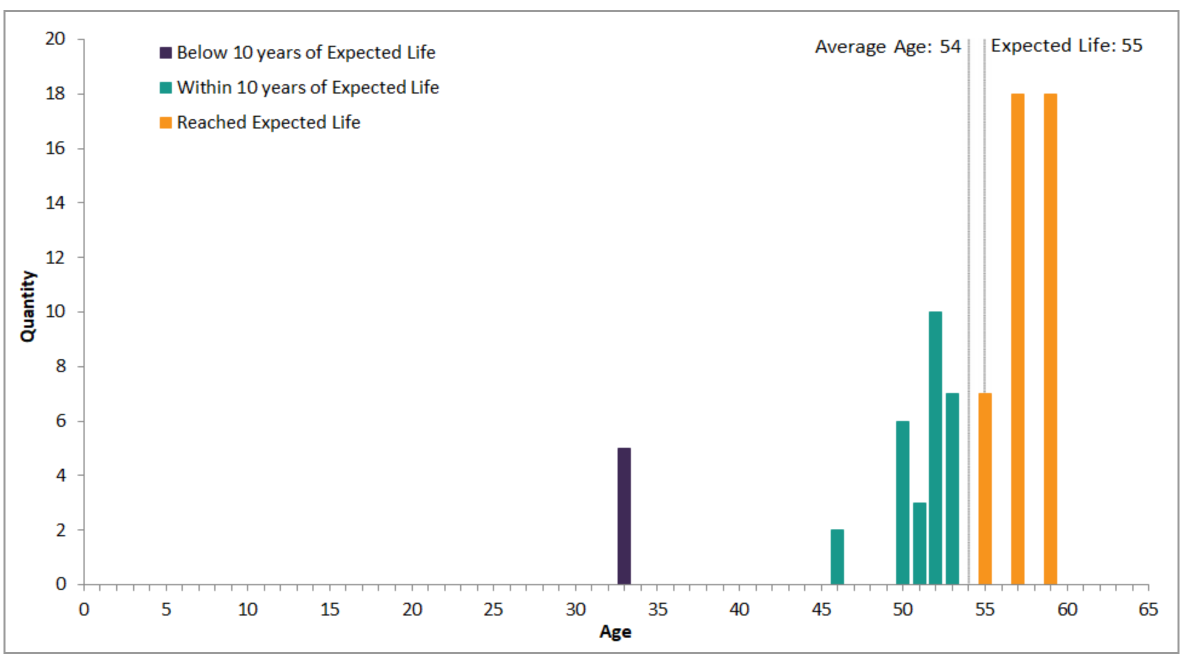
**Figure 6.8 – Station Switchgear at Woodroffe TS**


Due to the different expected operating life of each breaker type, it is more appropriate to break out station breakers per type, rather than as one asset group, Figures 6.9 to 6.12 below illustrate the population demographics of each type. The expected service life of air breakers is 42 years, and the average age is 47. The expected service life of oil breakers is 55 years, and the average age is 54. The expected service life of gas (SF6) breakers is 51 years, and the average age is 24. The expected service life of vacuum breakers is 46 years, and the average age is seven. There are 532 breakers that have reached their expected service life, and 49 that are within 10 years of their expected service life.

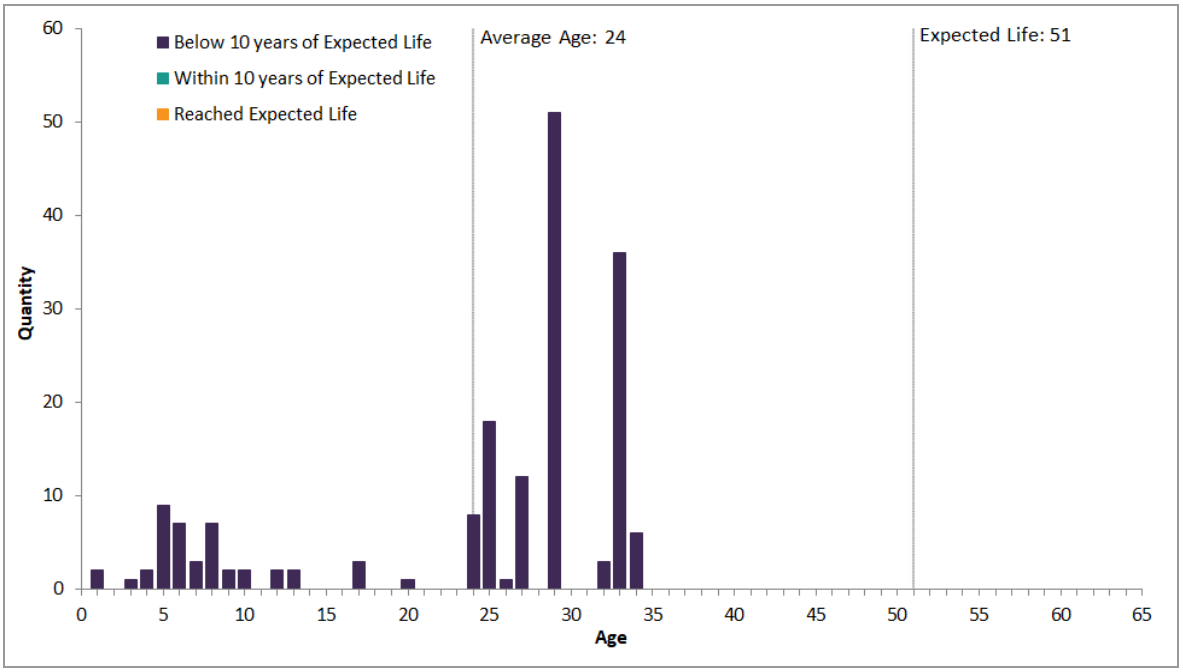
## Figure 6.9 – Station Air Breaker Age Demographic



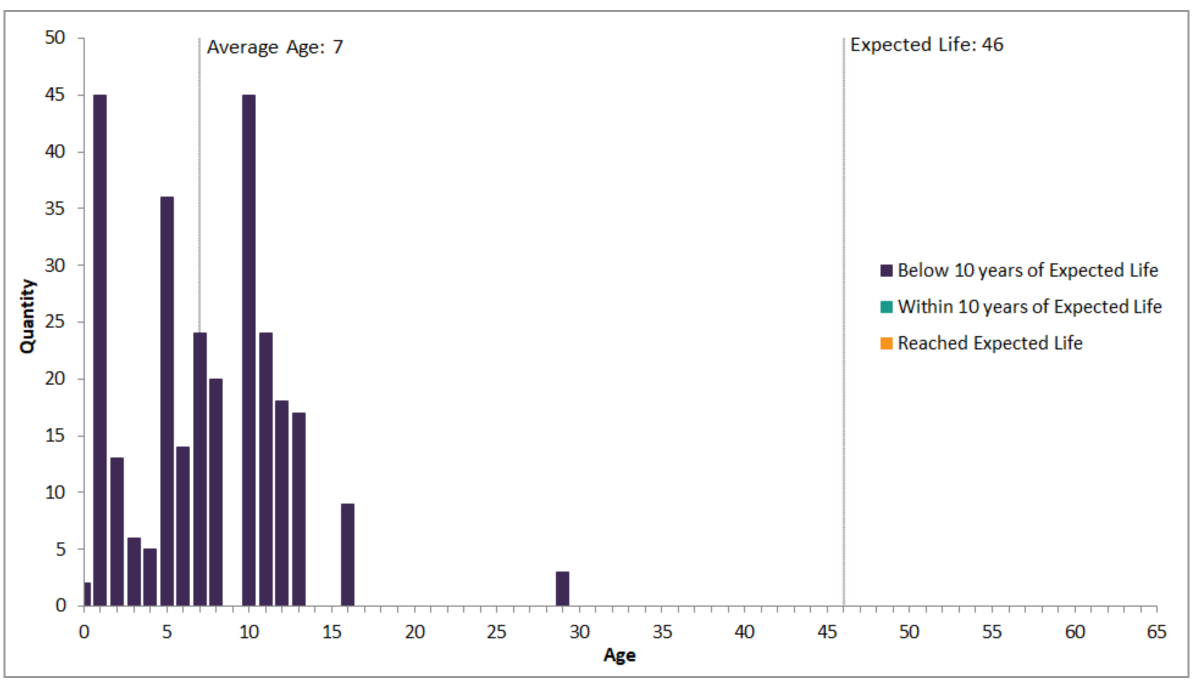

## Figure 6.10 – Station Oil Breaker Age Demographic



## Figure 6.11 – Station Gas Breaker Age Demographic

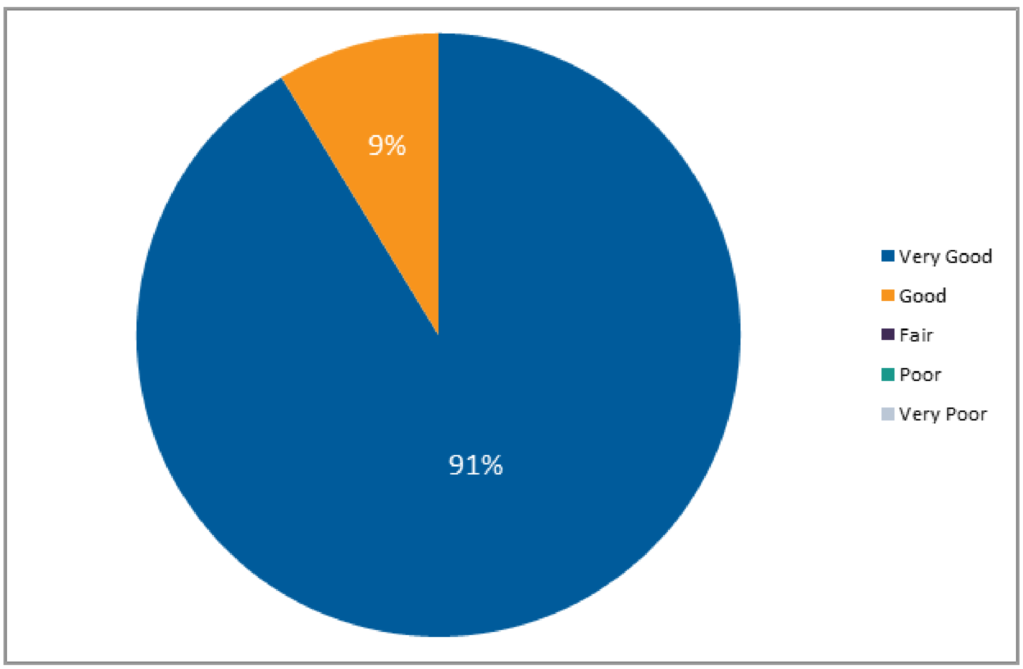



## Figure 6.12 – Station Vacuum Breaker Age Demographic



The health index for Station Switchgear takes into account the many functional and supporting parts of the equipment. A qualitative assessment of the equipment condition, based on subject matter experience, is done on the switches, breakers, bus, insulation, and supporting structures. The equipment is then reviewed for functional obsolescence and the availability of spare parts. The health index is calculated using this information and the age of the equipment. A summary of known Hydro Ottawa's station breaker conditions is shown in Figure 6.13. The majority of station breakers are in Good or Very Good condition as a result of proactive preventative maintenance practices and ongoing inspection.

**Figure 6.13 – Station Breaker Condition Demographics**




### *6.1.1.3. Station Batteries*

Hydro Ottawa's station batteries and chargers asset class provide power for operating station breaker trip and closing coils, DC lights, and relays when the station service power is lost. Hydro Ottawa owns 63 station battery banks and chargers within its stations. Figure 6.14 below illustrates a station battery bank. Table 6.3 below lists its components.

**Figure 6.14 – Station Batteries**

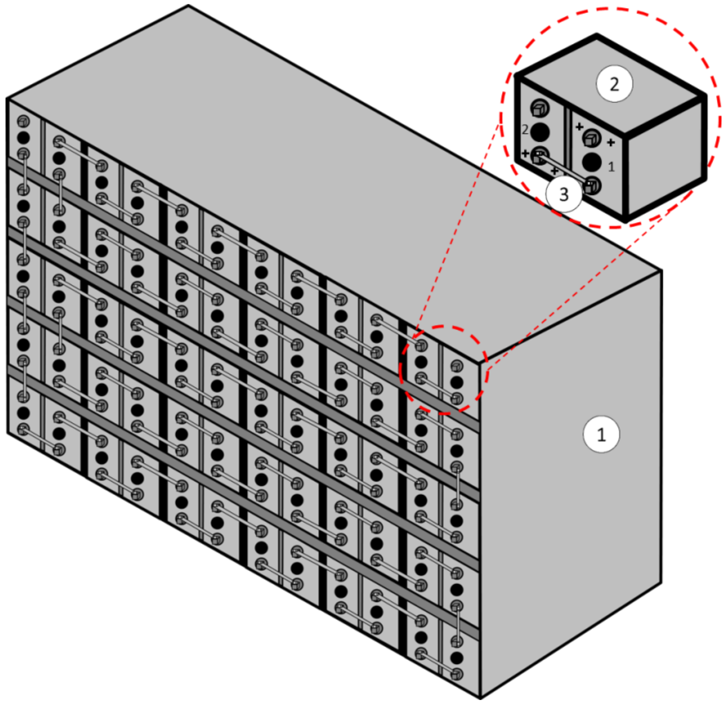



**Table 6.3 – Station Battery Bank Components**

| Figure Number | Component | Function |
|---|---|---|
| **1** | Battery Bank | The battery bank serves as the power source for DC systems in substations, which includes equipment such as relays and tripping coils. The bank supplies these systems and allows for their continued function when there is an electrical interruption. |
| **2** | Battery Cell | Battery cells independently hold charge and provide a specific voltage to be used in summation for the battery system. Individual battery cells can be replaced eliminating the need for replacement of the whole battery bank. |
| **3** | Battery String Connection | Battery string connections allow for battery cells to be connected in series, creating a sum voltage of all cells connected that is equal to the nominal rating of the battery. |
| **Not Shown** | Battery Charger | Battery chargers supply electricity to the battery cells to ensure they are able to support the connected DC systems. The charger also provides alarms in the case of abnormal conditions. |

Due to the different expected operating life of each battery type, it is more appropriate to break out batteries per type, rather than one asset group. Figure 6.15 and Figure 6.16 illustrate the population demographics for each battery type. Vented lead acid (“VLA”) batteries have an expected operating life of 25 years, with an average age of eight years. Valve-regulated lead acid (“VLRA”) batteries have an expected operating life of 15 years, with an average age of six years. There are no batteries that are past their expected service life and six batteries that are within 10 years of their expected service life.

**Figure 6.15 – Station VLA Battery Bank Age Demographics**

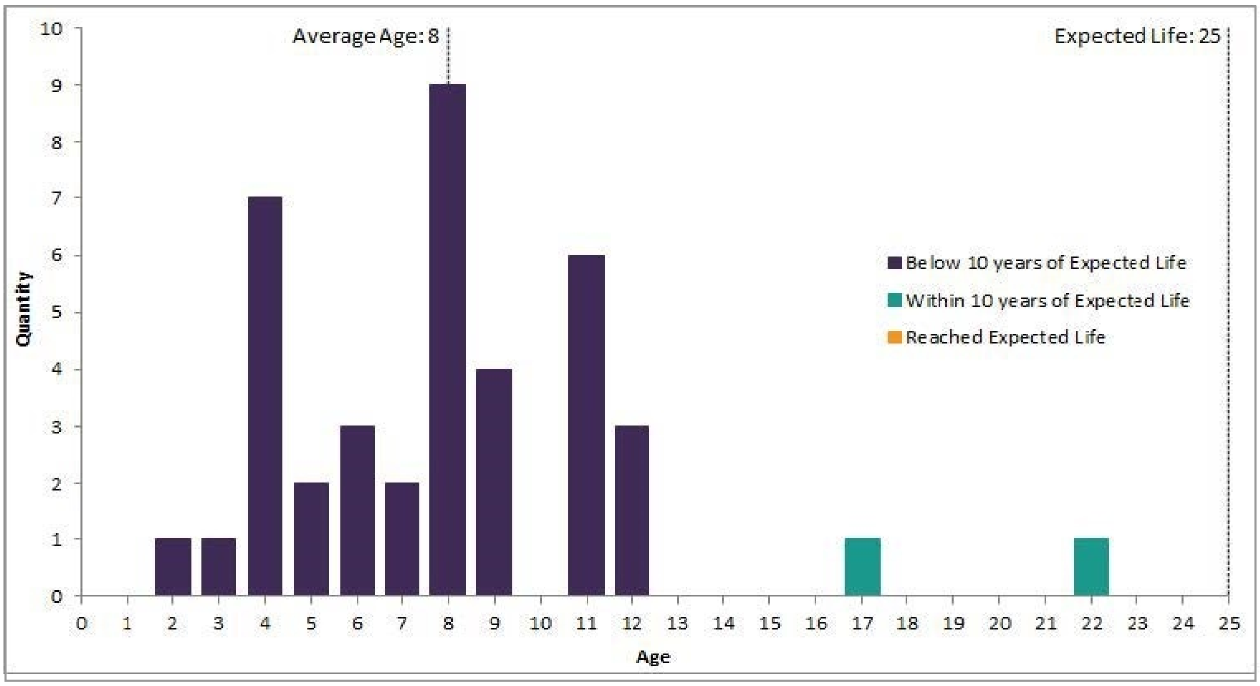
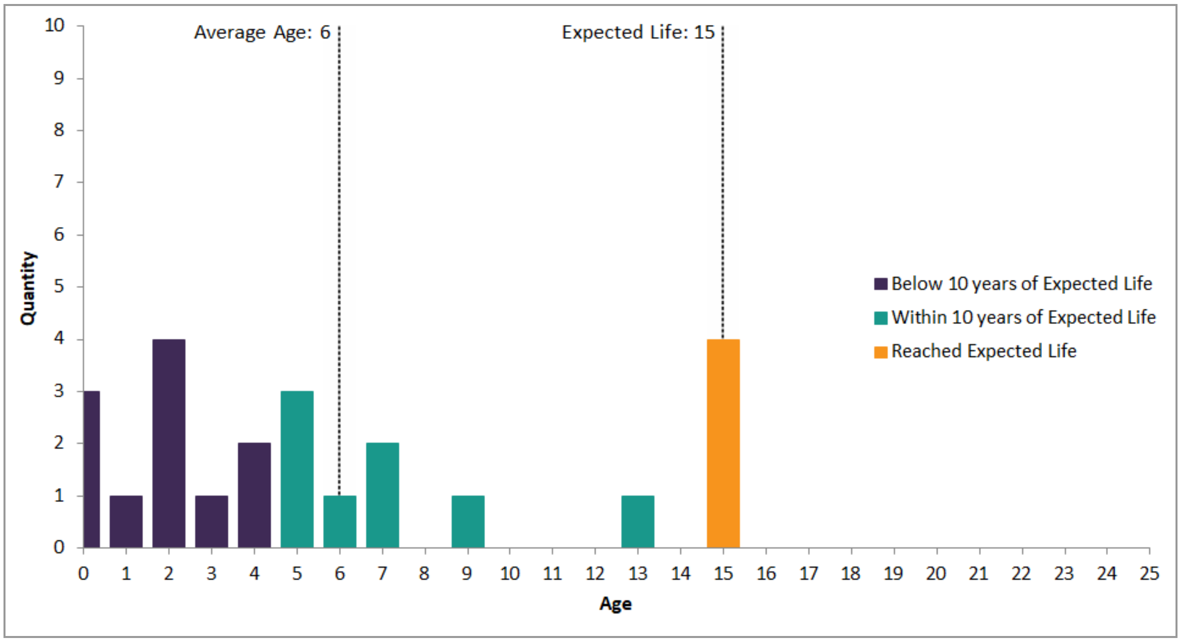


**Figure 6.16 – Station VRLA Battery Bank Age Demographics**




### *6.1.1.4. P&C*

Hydro Ottawa's Protection & Control ("P&C") equipment facilitates the control and monitoring of the distribution system. Of the components contained within the P&C asset class, protective relay has a proactive testing and maintenance program. Hydro Ottawa owns 1,006 station protective relay sets. Figure 6.17 below illustrates two main types of protection relays, Electromechanical (left) and Microprocessor (right). Table 6.4 below lists their components.

## Figure 6.17 – Station Protective Relays

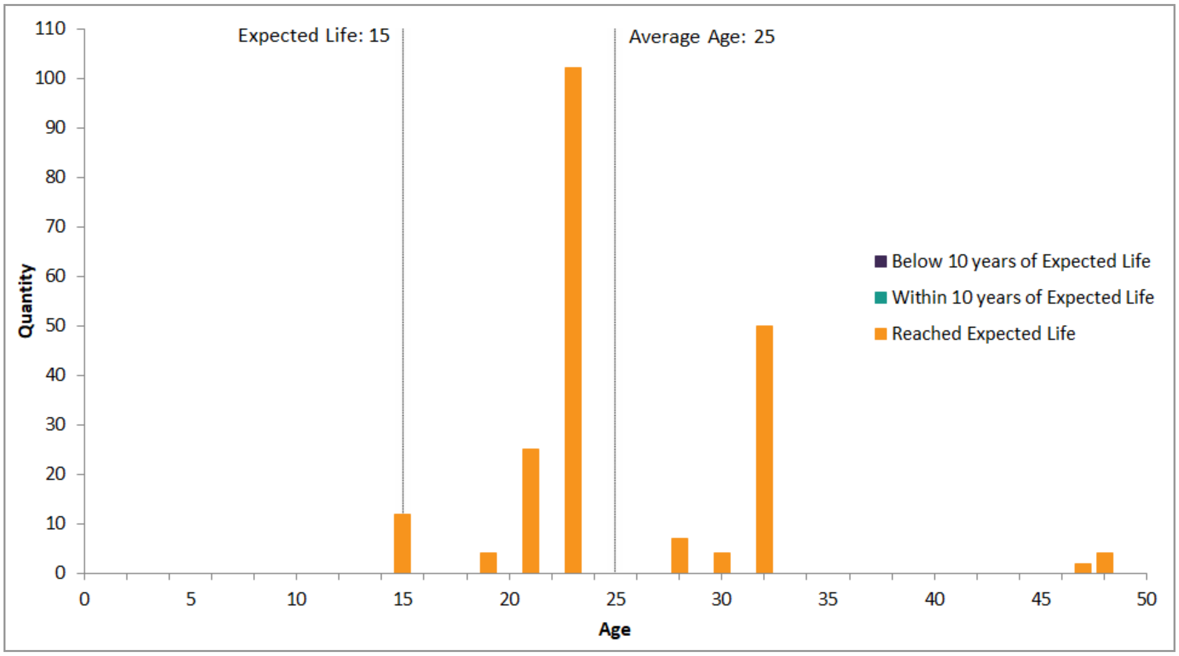

## Table 6.4 – Protection Relay Components

| Figure Number | Component | Function |
|---|---|---|
| 1 | Time Dial | The time dial is used to vary the operating time of the relay. By changing the timing, various protection devices can coordinate with each other. |
| 2 | Instantaneous Trip Setting | The instantaneous trip setting is a value in amperes that when exceeded, will initiate an immediate trip output from the relay. The tripping of the relay is used to protect downstream equipment from electrical damage and maintain public and employee safety. |
| 3 | Tap Trip Setting | The tap trip setting is a value in amperes that when exceeded, will initiate a trip output from the relay following the specified curve associated with the relay and settings. The tripping of the relay is used to protect downstream equipment from electrical damage and maintain public and employee safety. |
| 4 | Induction Disc | The induction disc begins rotating when the amperage exceeds the trip setting and initiates the tripping of the relay and protective device. The time required for the disk to spin and trip the contact is set by the time dial. |
| 5 | Breaker Status | Breaker status lights provide feedback as to the breaker position. |
| 6 | Display | The display shows settings and provides information on the relay's measurements, allowing for local control and troubleshooting of distribution system events and the minimization of outages. |
| 7 | Indicating Lights | Indicating lights provide various statuses related to the relay's status and operation. |
| 8 | USB & Communications Port | USB & communication ports are used for local connection and for local data transfer to and from relays. |

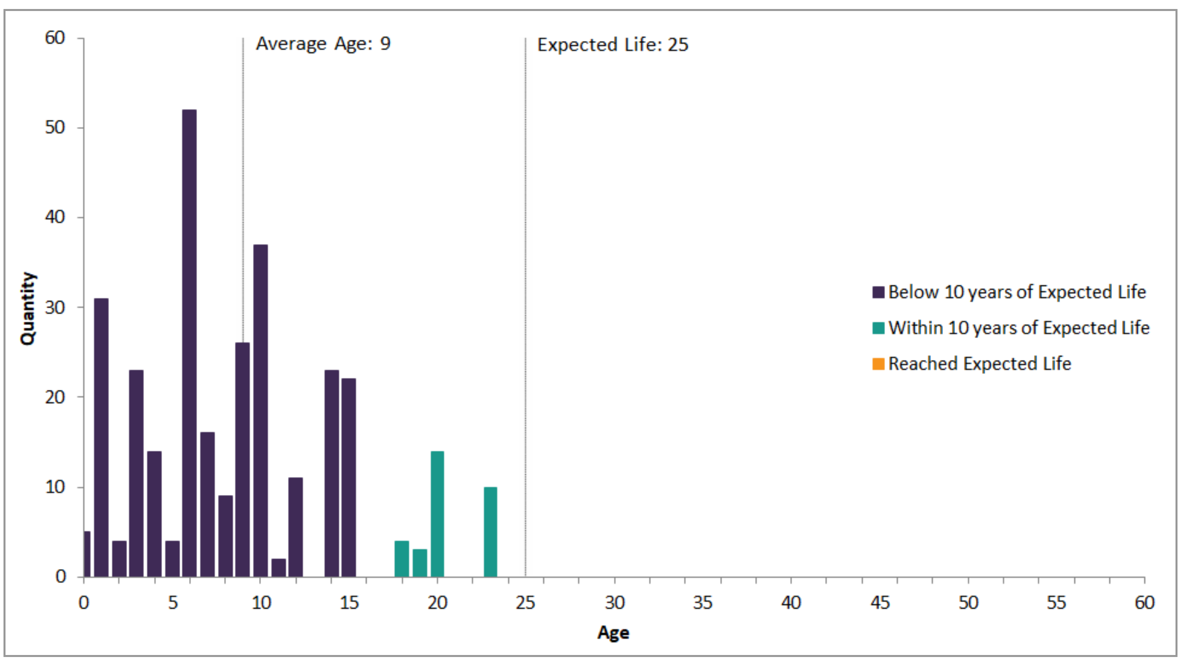
Figures 6.18 through 6.20 below illustrate the population demographics of protective relay sets as well as shows their average age. The expected service life of protective relays is dependent on the relay type, and as such is 40 years for electromechanical, 15 years for electronic, and 25 years for microprocessor based relays.

**Figure 6.18 – Station Electromechanical Relay Demographics**

## Figure 6.19 – Station Electronic Relay Demographics




## Figure 6.20 – Station Microprocessor Relay Demographics



### 6.1.2. Overhead System Assets

Hydro Ottawa overhead system assets are integral for the distribution of electricity. The overhead system is Hydro Ottawa's standard design for delivering power and can be located in a range of locations. Overhead system assets are broken into the following main asset classes:

- Distribution poles and fixtures
- Overhead distribution transformers
- Overhead distribution switches

#### *6.1.2.1. Distribution Poles*

Hydro Ottawa owns 47,506 wood poles[1] and 1,000 non-wood poles, and operates on an additional 13,781 wood and 338 non-wood poles owned by third parties. Figure 6.21 below illustrates a wood pole with all of the fixtures and overhead conductor system attachments. Table 6.5 below lists the individual components.

[1] Quantities of Hydro Ottawa owned wood and non-wood poles as of Jan 2, 2019.

## Figure 6.21 – Distribution Pole with Fixtures and Overhead Conductor System

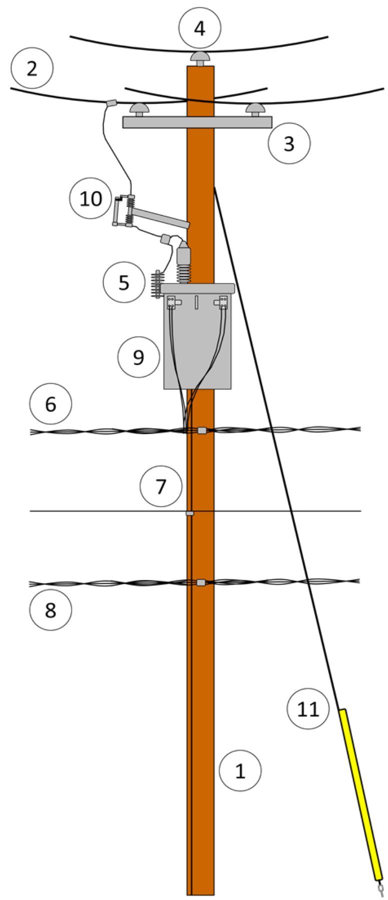


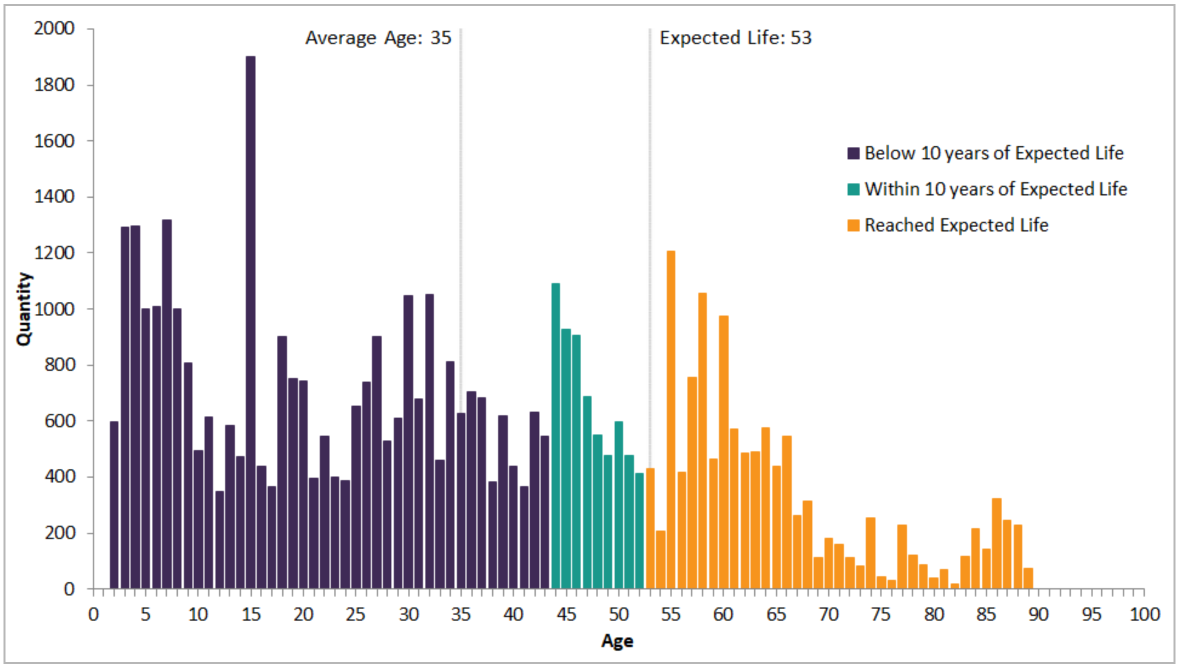
**Table 6.5 – Pole Components**

| Figure Number | Component | Function |
|---|---|---|
| 1 | Poles | Poles support maintaining clearances for public and employee safety. They also support the transition of conductor between the overhead and underground electrical systems and equipment such as overhead switches, transformers, communication equipment and metering collectors. |
| 2 | Primary Overhead Conductor | Primary overhead conductor distributes electricity at medium voltages across the service territory. It also allows for a means of installing fault indicating equipment allowing for expedited fault finding and restoration. |
| 3 | Cross Arms | Cross arms support insulators and other electrical equipment such as overhead switches. They are also used as an anchoring point on dead-end poles. |
| 4 | Insulators | Insulators support overhead conductors while protecting equipment from the flow of current. |
| 5 | Surge Arrestors | Surge arresters protect the system and equipment by suppressing voltage surges from various causes (e.g. lightning). |
| 6 | Secondary Overhead Conductors | Secondary overhead conductor distributes low voltage electricity suitable for customer use. |
| 7 | Grounding Conductor | Grounding conductor allows for a low impedance path for current to ground to limit buildup of unsafe voltage on the electricity system and equipment. |
| 8 | Third Party Equipment | Poles support third party equipment such as telecom wires, signs and third party low voltage services (e.g. street lighting). |
| 9 | Overhead Transformer | Pole mounted transformers are described in section 6.1.2.2. |
| 10 | Fused Cut Out | Fused cutouts are described in section 6.1.2.3 |
| 11 | Guy Wires and Anchors | Guy-wires and anchors support unbalanced lateral loading and can be used to support the pole under inclement weather. A high visibility plastic cover is used for public and employee safety. |

**Figure 6.22 – Installation of New Pole Line**

The average age of this asset class is 35 years. Figure 6.23 below illustrates the population demographics. The expected service life of wood poles is 53 years. There are 12,089 poles that have already reached the end of their expected service life and an additional 6,128 poles within 10 years of the end of their expected service life.

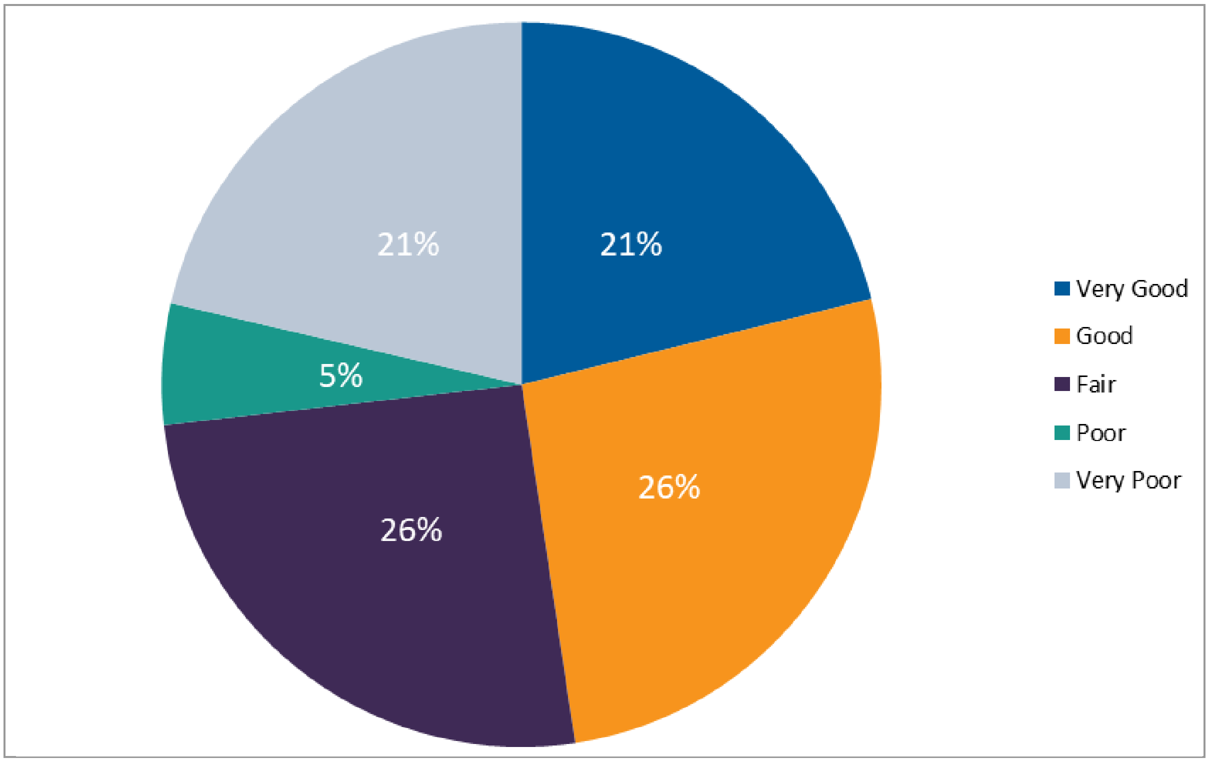
### Figure 6.23 – Distribution Wood Pole Age Demographics[2]




The health index for wood poles is largely based on the estimated remaining mechanical strength in the pole's butt determined using resistograph measurements. Assessment of the pole's condition, and the condition of the ancillary equipment attached to it, are included as part of the process to identify candidate assets for corrective actions. A summary of known Hydro Ottawa's distribution pole conditions is shown in Figure 6.24 below.

[2] Datum of March 20, 2019 is used for age demographics.

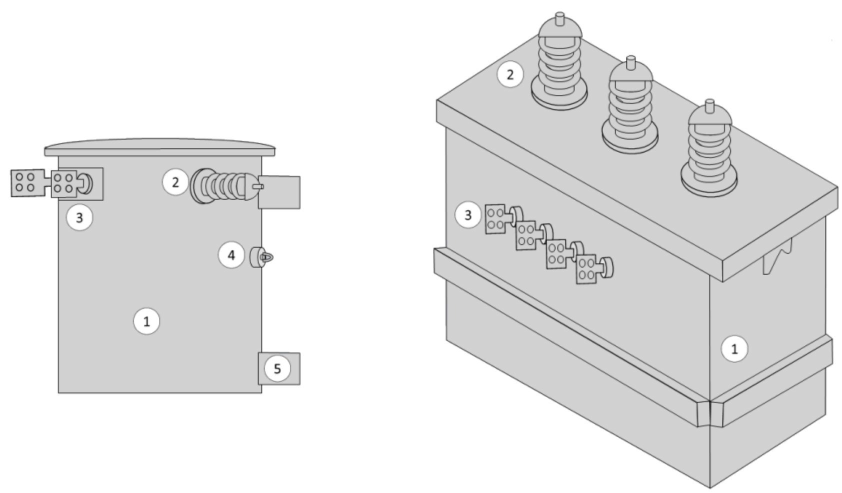
**Figure 6.24 – Distribution Wood Pole Condition Demographics**



### *6.1.2.2. Overhead Transformers*

Hydro Ottawa owns and operates 15,619 overhead transformers. These are installed in both front and rear lot to service customers. Figure 6.25 illustrates two types of overhead transformers (single phase (left) and three phase (right). Table 6.6 below lists its components.

**Figure 6.25 – Overhead Transformer**



1 **Table 6.6 – Overhead Transformer Components**

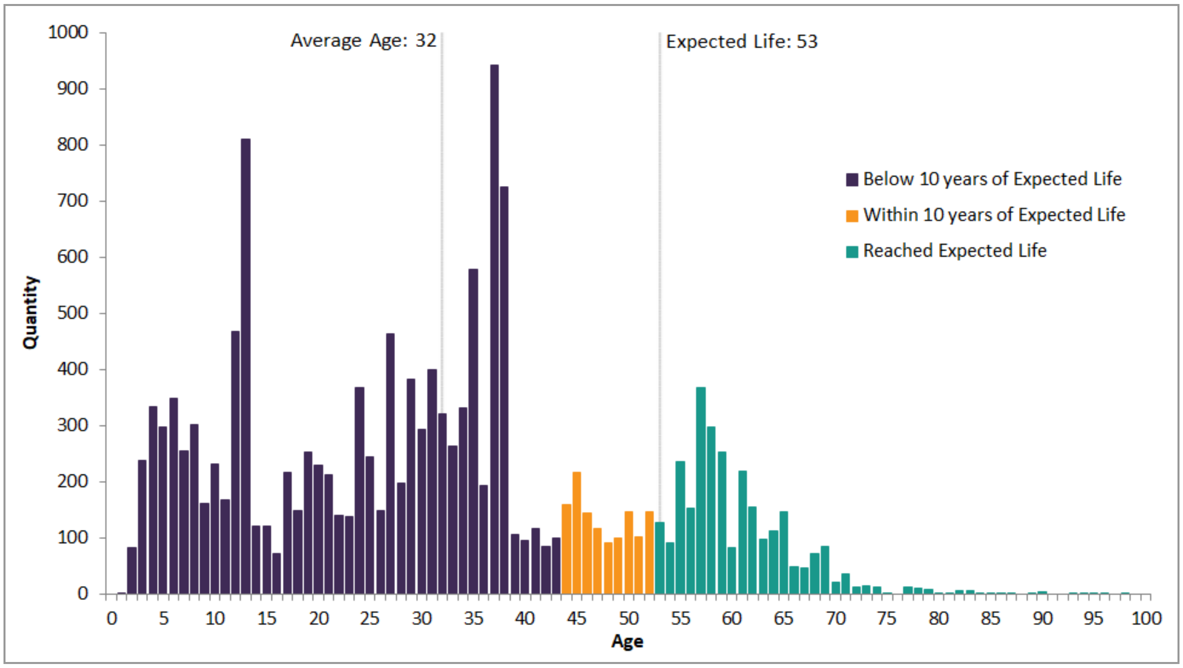
| Figure Number | Component | Function |
|---|---|---|
| 1 | Enclosure | Distribution overhead transformer enclosures maintain isolation of the medium and low voltage equipment from outside sources while ensuring security from the public for increased safety. Additionally, the enclosure protects the inside equipment from damage and increases system reliability by isolating it from weather, animals and contaminants. |
| 2 | Primary Bushing | Primary bushings support an insulated flow of current from the connecting primary overhead conductor to the inside connections through the grounded enclosure. |
| 3 | Secondary Bushings | Secondary bushings support an insulated flow of current from the inside connections through the grounded enclosure to the secondary conductor. |
| 4 | Tap Changer | The tap changer is used to regulate the voltage of the distribution overhead transformer by changing the transformer's winding ratio. The tap changer can rotate up or down to either increase or decrease the ratio. This ensures that the voltage supplied by transformer is constant, even in cases where the incoming voltage is high or low. This results in the distribution of high-quality power. |
| 5 | Hanging Lugs | Hanging lugs are used to mount distribution overhead transformers, such as to poles. |
| Not Shown | Ground Connection | The ground connection allows for a low impedance path for current to ground to limit buildup of unsafe voltage on the electricity system and equipment. |
| Not Shown | Surge Arrestors | Surge arresters protect the distribution overhead transformer by suppressing voltage surges from various causes (e.g. lightning). |

2

**Figure 6.26 – Installation of Overhead Transformer**

The average age of this asset class is 32 years. Figure 6.27 below illustrates the population demographics. The expected service life of overhead transformers is 53 years. There are 2,749 transformers that have already reached the end of their expected service life, while an additional 1,223 overhead transformers are within 10 years of the end of expected service life.

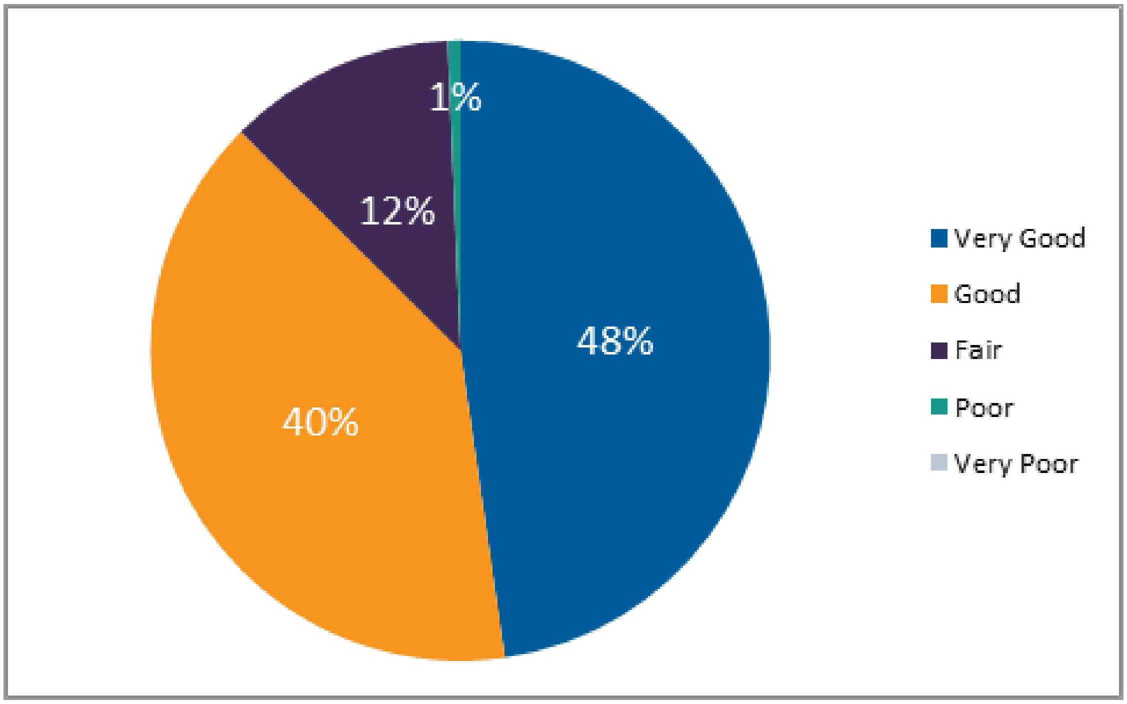
**Figure 6.27 – Overhead Transformer Age Demographic[3]**




The health index for overhead transformers is based on age and asset condition data collected from planned programs of inspection that use both visual and thermographic inspection techniques. A summary of known Hydro Ottawa's overhead transformer conditions is shown in Figure 6.28 below.

[3] Datum of January 29, 2019 is used for age demographics.

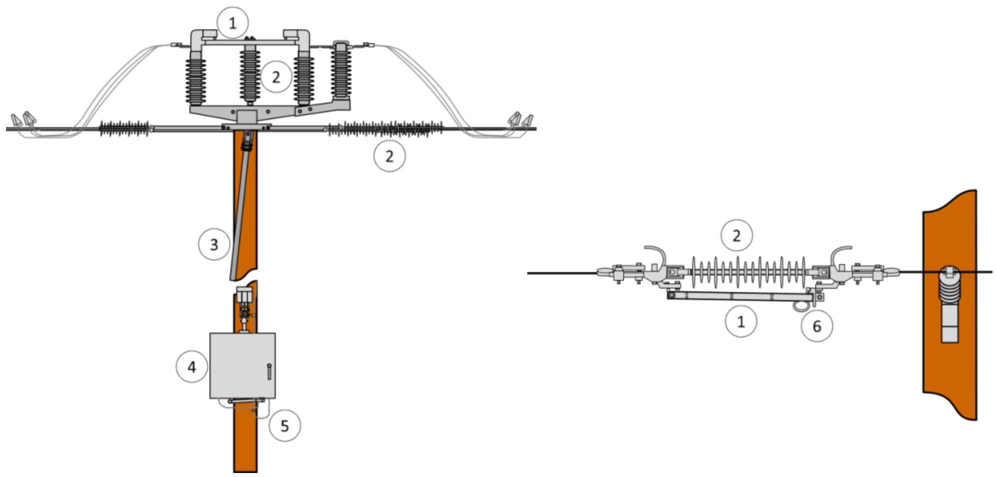
**Figure 6.28 – Overhead Transformer Condition Demographic**




### *6.1.2.3. Overhead Distribution Switches and Reclosers*

Hydro Ottawa's distribution overhead switch and recloser asset class consists of all overhead load break switches, reclosers, fuse cut-outs and inline switches, with a primary voltage rating up to and including 44 kV. In general, the purpose of this asset class is to isolate faulted sections of Hydro Ottawa's distribution system; minimize the impact to customers; isolate sections of the distribution system to enable work to proceed while affecting the smallest part of the distribution system possible; isolate customers through requests; and provide backup supply from other feeder(s). Figure 6.29 below illustrates overhead switches and Table 6.7 below lists its components.

## Figure 6.29 – Overhead Switch




## Table 6.7 – Overhead Switch Components

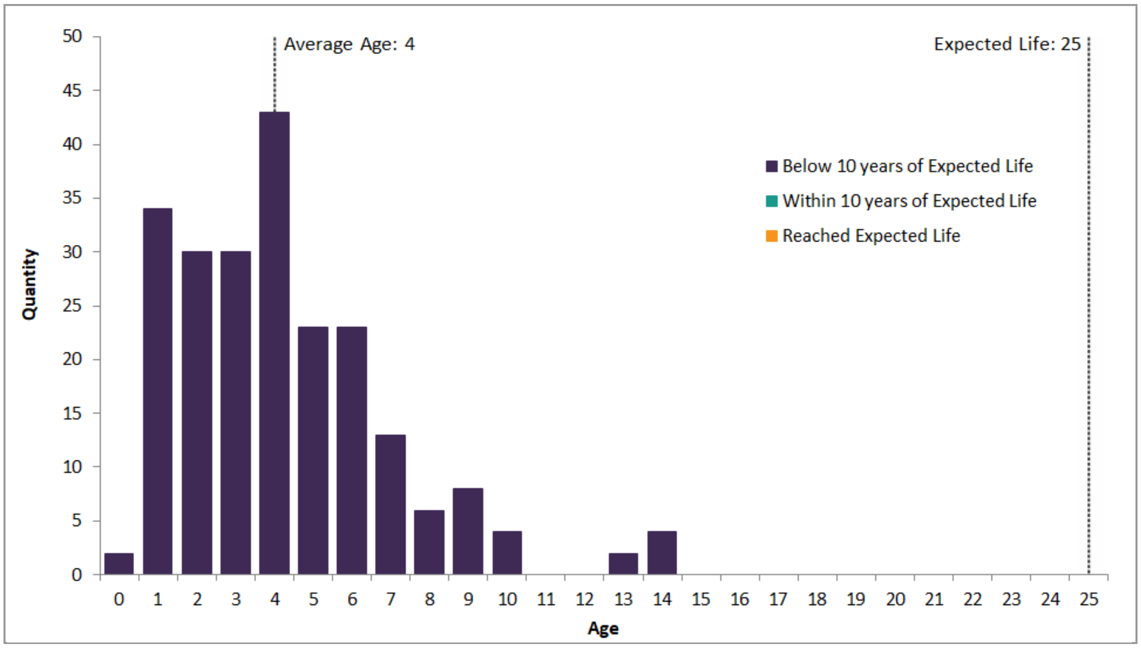
| Figure Number | Component | Function |
|---|---|---|
| **1** | Solid Blade | The solid blade of an overhead switch allows the flow of current when closed and interrupts the flow of current when opened. |
| **2** | Insulator | Insulators support overhead conductors while protecting equipment from the flow of current. |
| **3** | Operating Pipe | Operating pipe is the mechanism that engages the solid blade to open or close allowing for switching from the ground versus the top of the pole. |
| **4** | Control Cabinet | Control cabinets house the low voltage equipment necessary to communicate with, monitor, and control motor operated switches. |
| **5** | Control Wire | Control wire connects the control cabinet to the overhead switch's motor. |
| **6** | Hot Stick Operating Hook | The hot stick operating hook is a mechanical access point to manually open an overhead switch using a hot stick tool. |
| **Not Shown** | Communication Device | A communication device is an antenna or modem that provides remote operability to an overhead switch through the use of the control box and overhead switch's motor. |
| **Not Shown** | Fused Cutout | Fused cut-outs allow the flow of current when the current flowing through the fuse is less than the rated value of the fuse. The fuse melts and breaks when the current flowing through the fuse exceeds the rated value. |

Hydro Ottawa owns numerous types of overhead switches with different functionality dependent on the required application. Hydro Ottawa owns 34,991 sets (set refers to one or more switches operating in concert, but not necessarily mechanically connected) of distribution overhead switches throughout the service territory (26,958 in-line fuses and fused cut-outs).[4] Most of the utility's overhead switches, including in-line fuses and fused cut-outs, are subject to a proactive inspection program but are not subjected to proactive maintenance. Hydro Ottawa focuses its proactive inspection and maintenance programs on its 222 higher complexity switches and whose failure carries a greater impact, including the utility's overhead switches that are both loadbreak and gang operated.

The average age of Hydro Ottawa's overhead load break/gang operated switches with a known age is 4.3 years, Figure 6.30 below illustrates the population demographics for this asset class. The installation date is unknown for 53% of these assets. The expected life of overhead load break/gang operated switches is 25 years. All of these switches are below 10 years of their expected life.

[4] Datum of March 6, 2019.

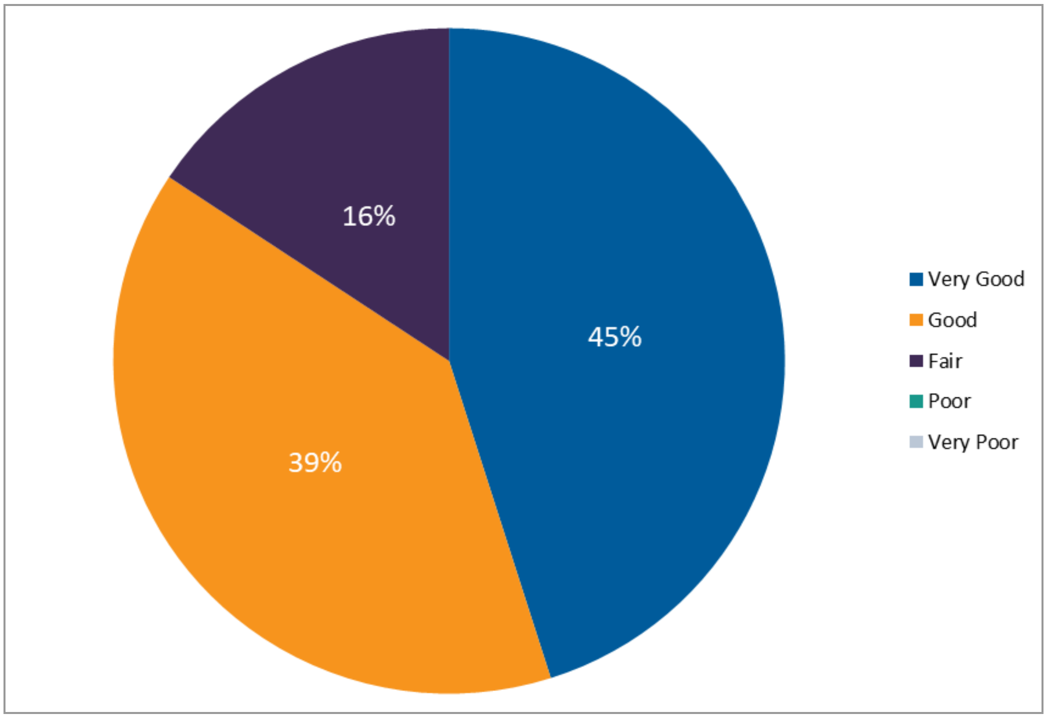
**Figure 6.30 – Overhead Switch Age Demographics[5]**




The health index for overhead complex switches is largely based on age and the results from thermographic scans. A complex switch is typically a three-phase gang-operated device that is capable of interrupting load. Other criteria include the condition of insulators, solid blades, and operating mechanism. A summary of known Hydro Ottawa's overhead switch conditions is shown in Figure 6.31 below.

[5] Datum of June 20, 2019 is used for the age demographics.

**Figure 6.31 – Overhead Switch Condition Demographics**




### 6.1.3. Underground System Assets

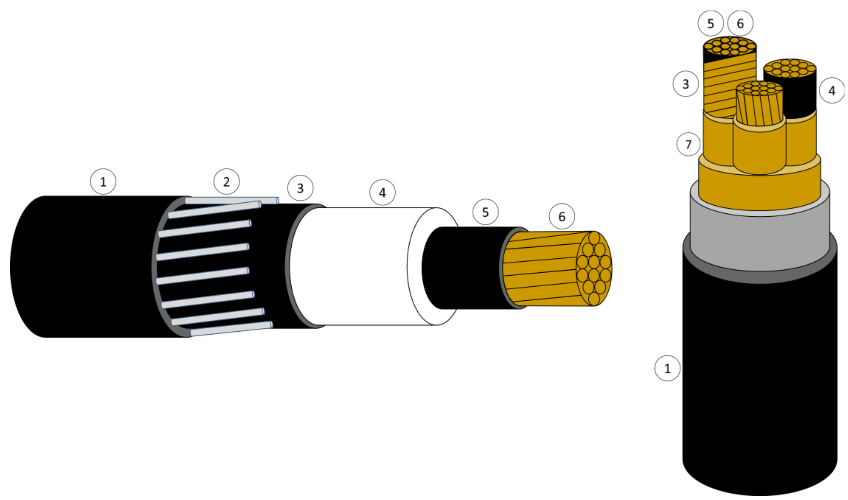
Hydro Ottawa underground system assets are integral for the distribution of electricity. The underground system consists of distribution assets and their respective supporting civil structures that enable delivery of energy to areas where the feasibility of the overhead system is reduced or where it is preferential to have increased aesthetics. Underground system assets are broken into the following categories:

- Distribution cables (PILC, polymer)
- Underground transformers
- Underground switchgear
- Vault transformers
- Underground Civil structures

### *6.1.3.1. Distribution Cables (PILC)*

Hydro Ottawa owns and operates 367 km of triple conductor Paper Insulated Lead Cable ("PILC").[6] It was primarily installed in the core of Ottawa on the 13kV system and is some of the oldest cable in the service territory. Due to higher material costs, increasing procurement lead times, and the need for specialised trades, Hydro Ottawa is moving to phase out this type of cable with polymer insulated cable. Figure 6.32 illustrates both polymer (left) and PILC (right) underground cables. Table 6.8 below lists the individual components.

**Figure 6.32 – Distribution Cable**



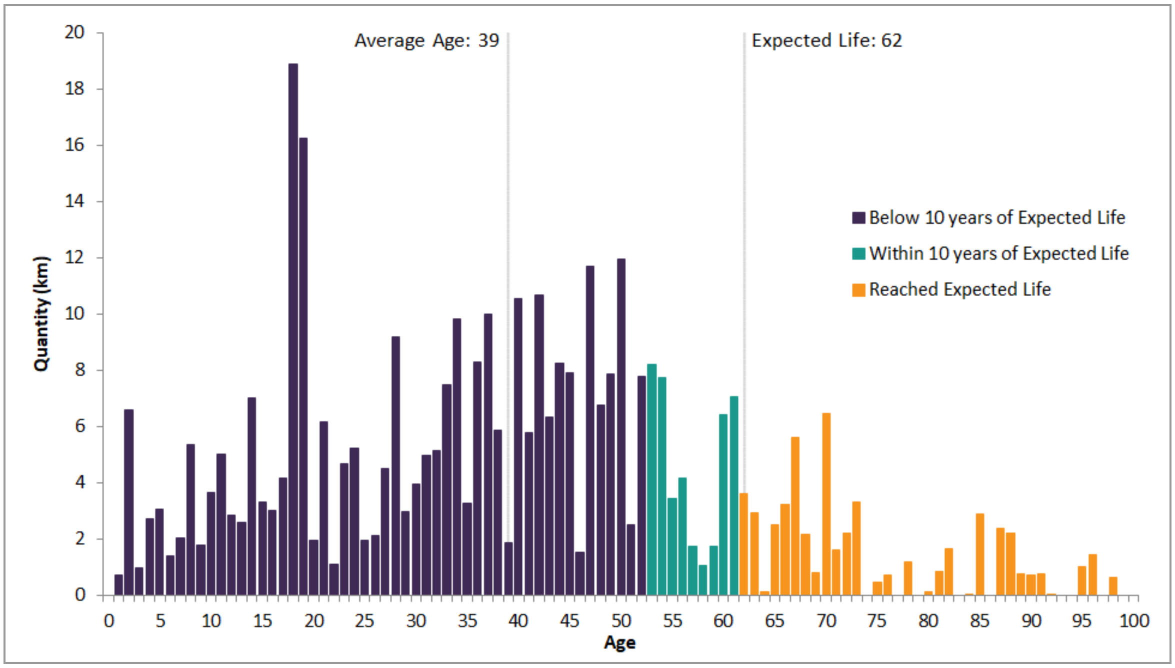

[6] Datum of February 5, 2019 is used in this instance.

**Table 6.8 – Distribution Cable Components**

| Figure Number | Component | Function |
|---|---|---|
| 1 | Jacket | The cable jacket is an outer barrier that protects the cable from mechanical and moisture ingress. |
| 2 | Concentric Neutral | The concentric neutrals act as a shield and a neutral cable of carrying unbalance current. |
| 3 | Insulation Shield | The insulation shield ensures that unwanted electromagnetic interference is not transmitted along the cable and that excess energy is dissipated to ground properly. |
| 4 | Insulation | Insulation provides electrical and physical isolation between conductors and components of the cable. |
| 5 | Conductor Shield | The conductor shield protects individual conductors from electromagnetic interference. |
| 6 | Conductor | The conductor carries electrical current, and is a path for the flow of electricity from source to supply equipment, such as from transformers to customers. |
| 7 | Impregnated Paper Insulation | Impregnated paper insulation is an oil based type of insulation that provides electrical and physical isolation between conductors. This type of insulation is used for paper insulated lead covered cables. |

The average age of Hydro Ottawa's PILC cable is 39 years, Figure 6.33 below illustrates the population demographics. The expected service life of PILC is 62 years. There are 52.2 km of PILC cable that has already reached the end of its expected service life and 41.5 km within 10 years of the end of its expected service life.

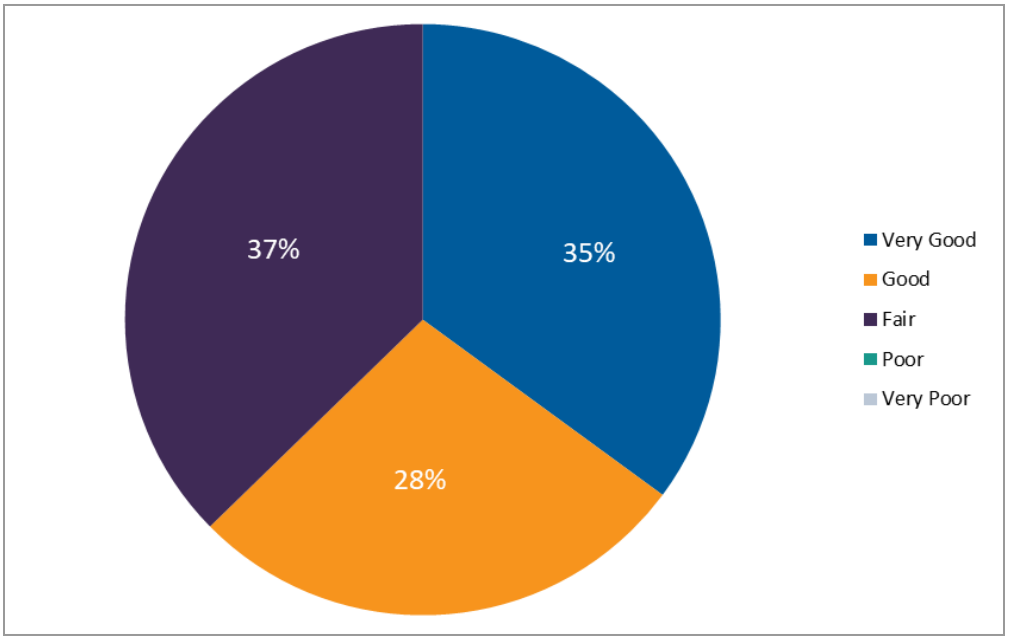
**Figure 6.33 – Distribution Cable PILC Age Demographics**[7]




The health index for PILC cables is based on a combination of age and failure rate. A summary of known Hydro Ottawa's distribution PILC cable conditions is shown in Figure 6.34 below.

[7] Datum of February 2, 2019 is used for age demographics.

**Figure 6.34 – Distribution Cable (PILC) Condition Demographics**




### *6.1.3.2. Distribution Cables (Polymer)*

Hydro Ottawa owns and operates 2,578 km of single conductor polymer cable (Cross-Linked Polyethylene ["XLPE"], Ethylene Propylene Rubber ("EPR"), and Butyl Rubber).[8] The installation of this cable uses a mix of concrete encased duct, direct buried duct, and direct buried cable, which can add to the cost and labour requirements when replacing under planned and unplanned events.

The vast majority of the underground polymer cable is XLPE. EPR makes up a small portion of underground cables and has only recently been introduced as a replacement for PILC cable as it is phased out. For this reason, the condition assessment of underground polymer cable is focused on testing of XLPE cable.

The average age of this asset class is 26 years. Figure 6.35 illustrates the population demographics. The expected service life of XLPE is 45 years. There is 813 km of XLPE cable

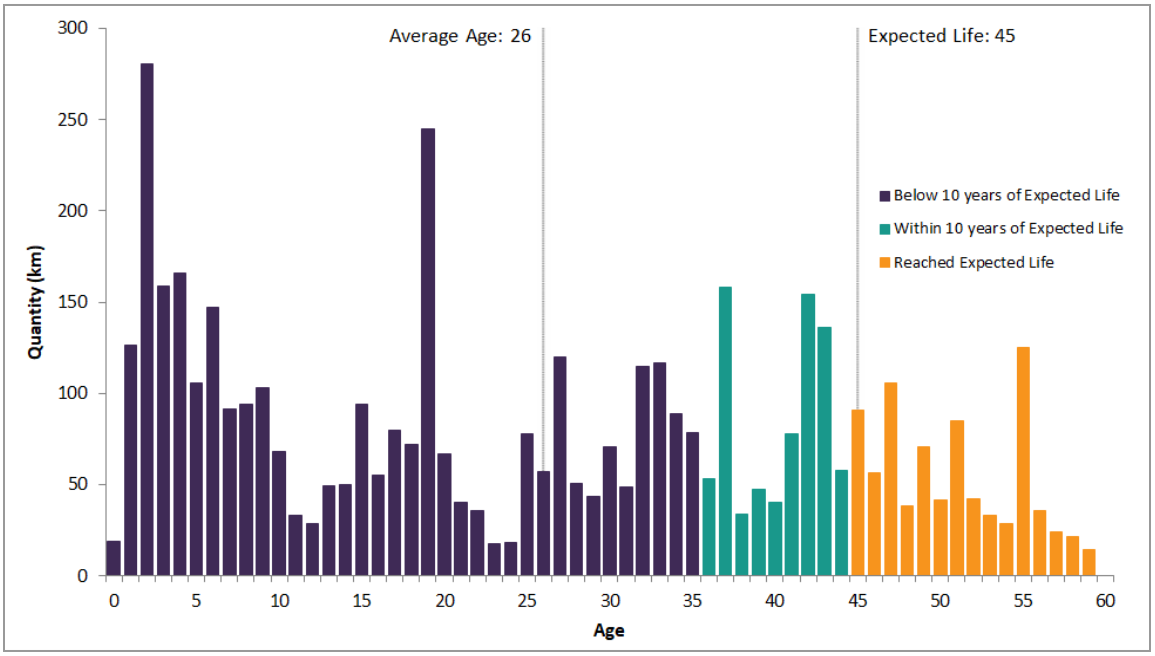
[8] Datum of February 5, 2019 is used in this instance.

that has reached the expected service life and 758 km within 10 years of the end of its expected service life.

**Figure 6.35 – Installation of XLPE Cable in a Station Basement**

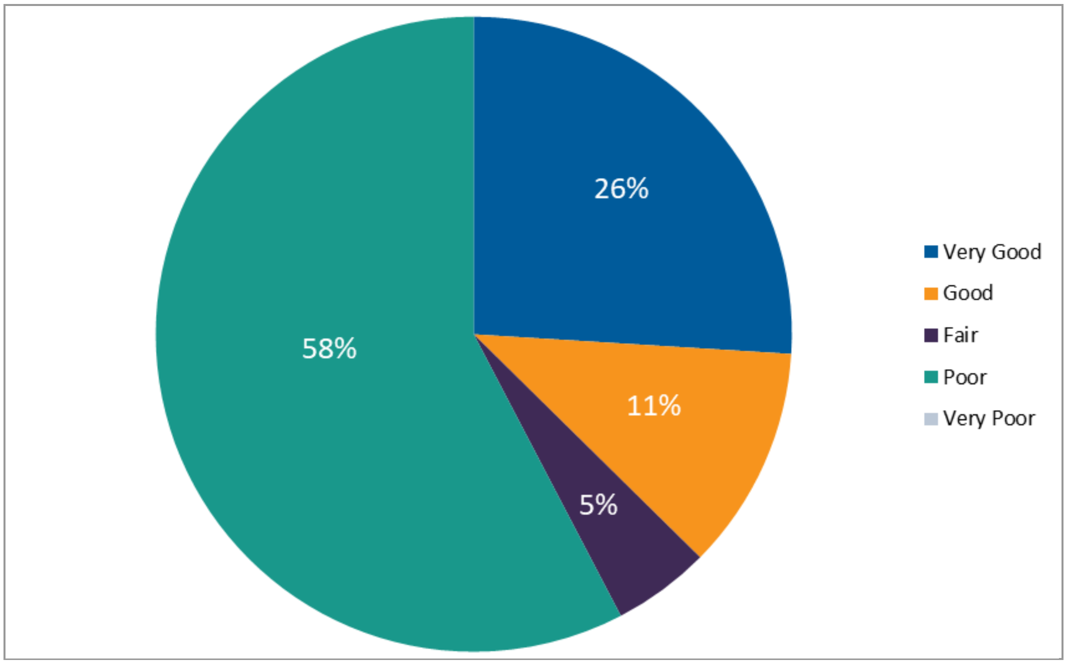
The health index for XLPE cables is based on a combination of age and failure rate. A summary of known Hydro Ottawa's distribution XLPE cable conditions is shown in Figure 6.36 below.

### Figure 6.36 – Distribution Polymer Cable Age Demographics[9]




[9] Datum of February 2, 2019 is used for age demographics.

**Figure 6.37 – Distribution Polymer Cable Condition Demographics**




### *6.1.3.3. Underground Transformers*

Hydro Ottawa owns and operates 16,882 underground transformers.[10] These are installed in both front and rear lot to service customers. Figure 6.38 below illustrates two types of underground transformers: padmount transformers (left) and Kiosk transformers (right). Table 6.9 below lists the individual components.

[10] Datum of February 5, 2019 is used in this instance.

## Figure 6.38 – Underground Transformers

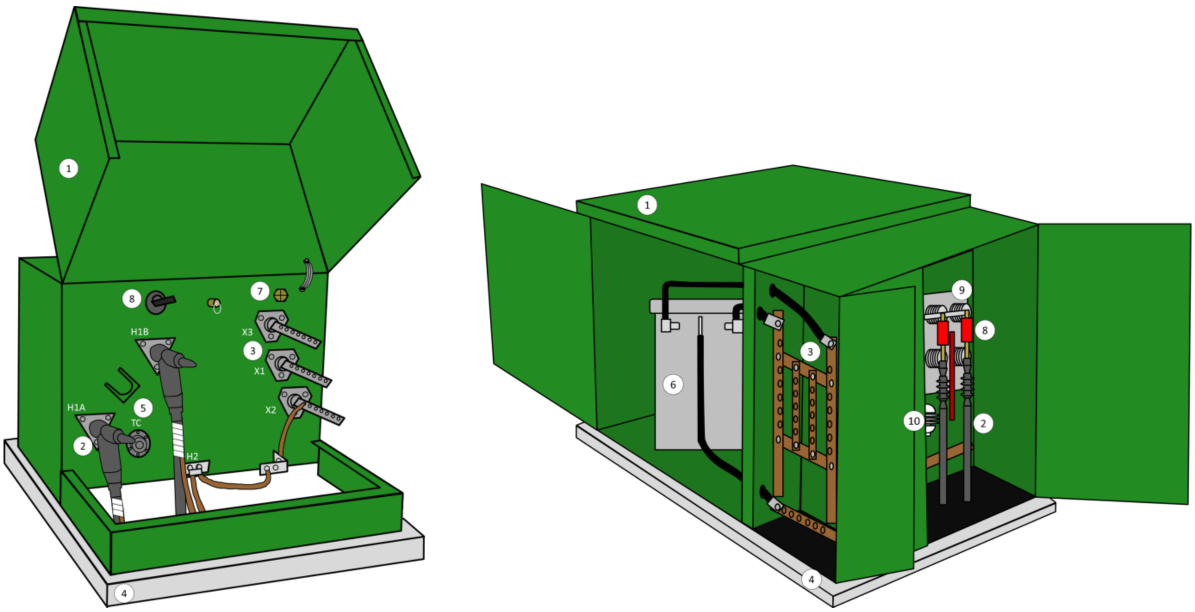


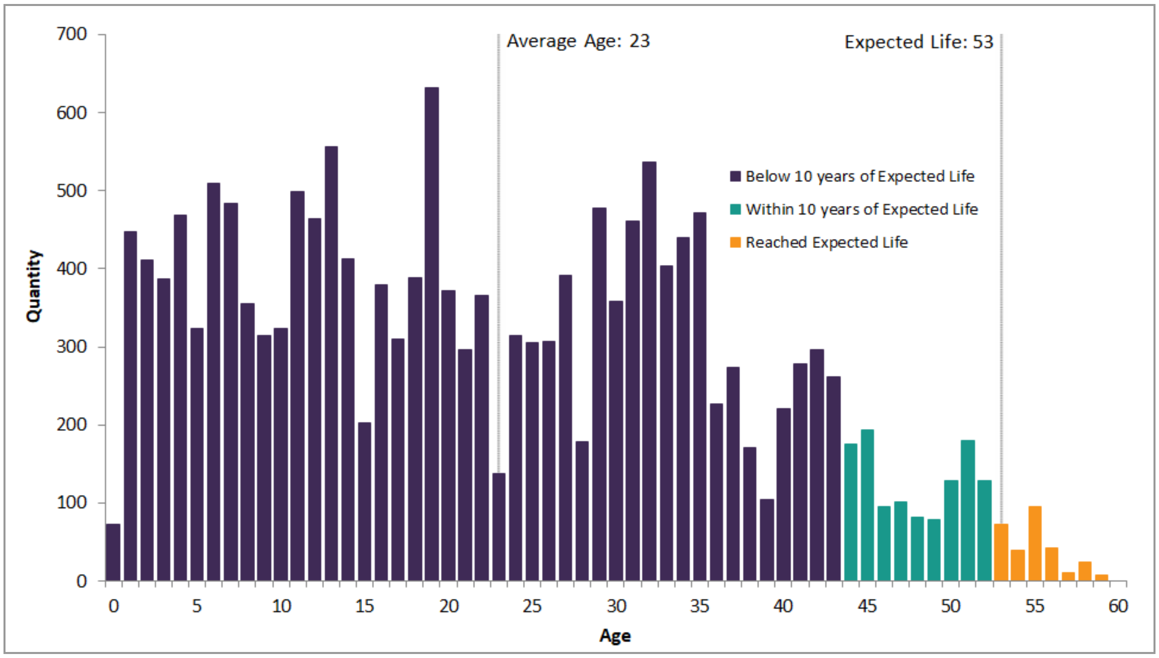
**Table 6.9 – Underground Transformer Components**

| Figure Number | Component | Function |
|---|---|---|
| 1 | Enclosure(s) | Underground transformer enclosure(s) maintain a degree of protection for the medium voltage equipment from the environment while ensuring security from the public for increased safety. Additionally, the enclosure contains the insulating oil and increases system reliability by isolating it from weather, animals and contaminants such as road salt. |
| 2 | Primary Connections | Underground primary connections distribute electricity at medium voltages across the service territory. It also allows for a means of installing fault indicating equipment allowing for expedited fault finding and restoration. |
| 3 | Secondary Connections | Secondary connections allow for underground transformers to supply multiple customers from a single transformer. This provides increased asset value due to effective asset utilization. |
| 4 | Concrete Base | Concrete bases provide support for underground transformers by dispersing the weight over a large area. The base also provides space for cables to be routed to the primary and secondary connections. |
| 5 | Tap Changer | The tap changer is used to regulate the voltage of the underground transformer by changing the transformer's winding ratio. The tap changer can rotate up or down to either increase or decrease the ratio with the transformer isolated. This allows the voltage supplied by the transformer to be locally adjusted within the required range |
| 6 | Core & Windings | An underground transformer's core, primary and secondary windings and oil insulation are sealed within the transformer's enclosure. These elements work together to transform electrical power, stepping down from a distribution voltage to customer supply voltage using an electromagnetic circuit. |
| 7 | Oil Level Gauge | The oil level sight gauge allows visual confirmation of the level of oil insulation within the transformer tank. |
| 8 | Fuses | Fuses disconnect the transformer in response to failed equipment or transformer overloading. The operation of the fuses isolates the failed equipment and minimizes the reliability impact to Hydro Ottawa customers, and protecting equipment from further damage. Underground transformers may contain more than one type of protective fuse. |
| 9 | Insulators | Insulators support electrical conductors and connections, without conducting electricity. |
| 10 | Surge Arrestors | Surge arresters protect the system and equipment by suppressing voltage surges from various causes (e.g. lightning). |

The average age of this asset class is 23 years. Figure 6.39 below illustrates the population demographics. The expected service life of underground transformers is 53 years. There are

290 underground transformers that have already reached the end of their expected service life and an additional 1,165 transformers within 10 years of the end of their expected service life.

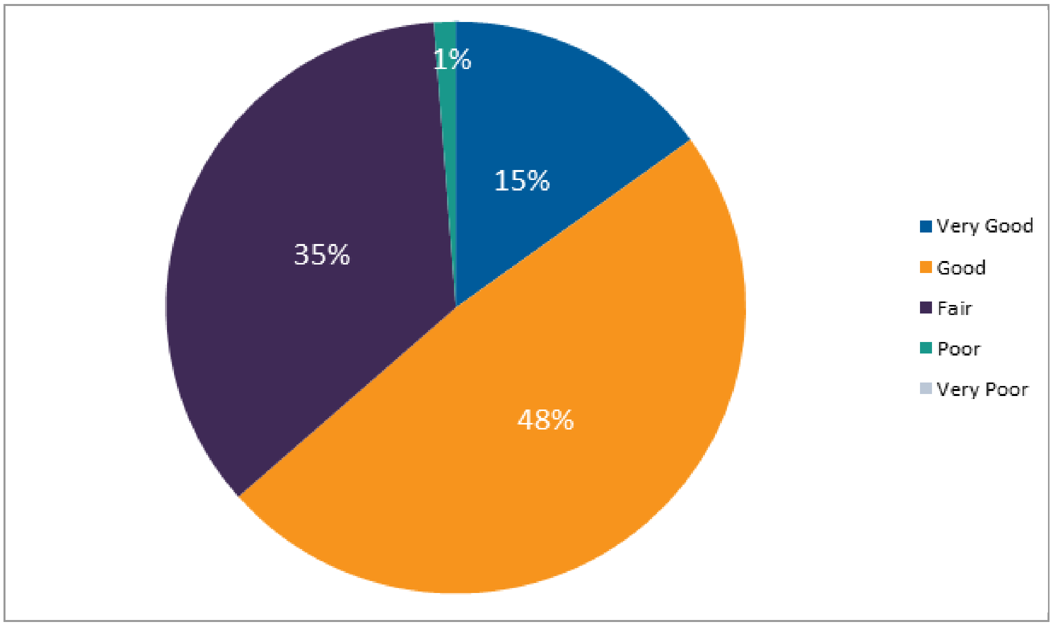
**Figure 6.39 – Underground Transformer Age Demographics**[11]




The health index for underground transformer is largely based on the visual and thermographic inspections. Other factors that influence the health index are the age, peak loading, and condition of the civil structure. A summary of known Hydro Ottawa's underground transformer conditions is shown in Figure 6.40 below.

[11] Datum of August 9, 2019 is used for age demographics.

**Figure 6.40 – Underground Transformer Condition Demographics**

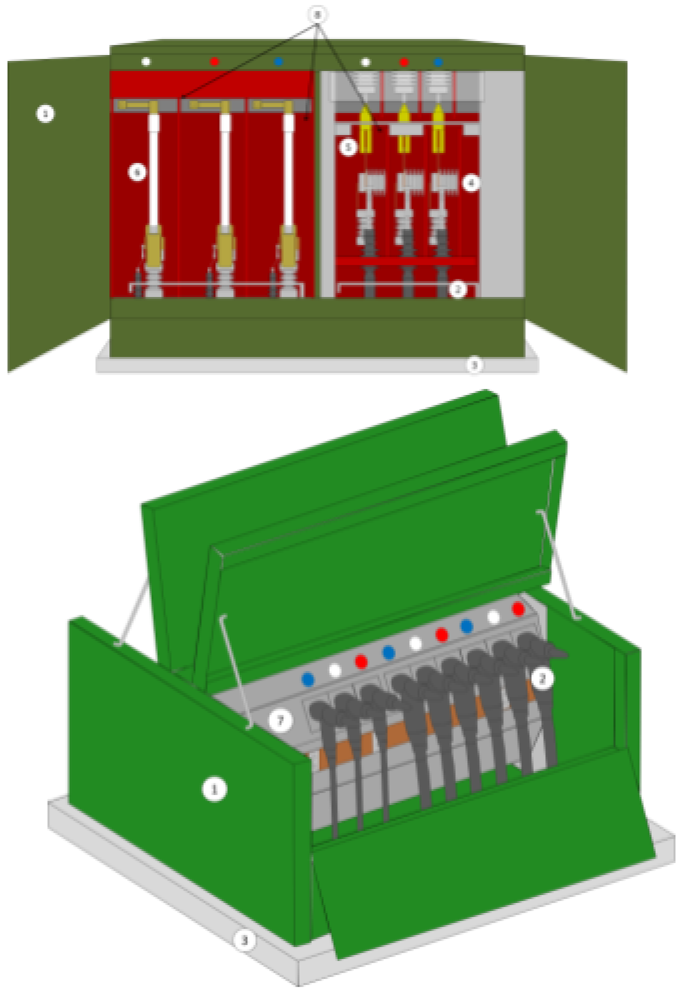



### *6.1.3.4. Underground Switchgear*

Hydro Ottawa owns and operates 527 underground switchgear.[12] There are many different configurations and types of switchgear in service due to the amalgamation of the former utilities and their varying policies for servicing customers. Figure 6.41 below illustrates two common underground switchgear types: air insulated PMH (top) and SF6 insulated (bottom). The components are listed in Table 6.10 below.

[12] Datum of January 31, 2019 is used in this instance.

**Figure 6.41 – PMH (top) and Vista (bottom) Underground Switchgear Types**



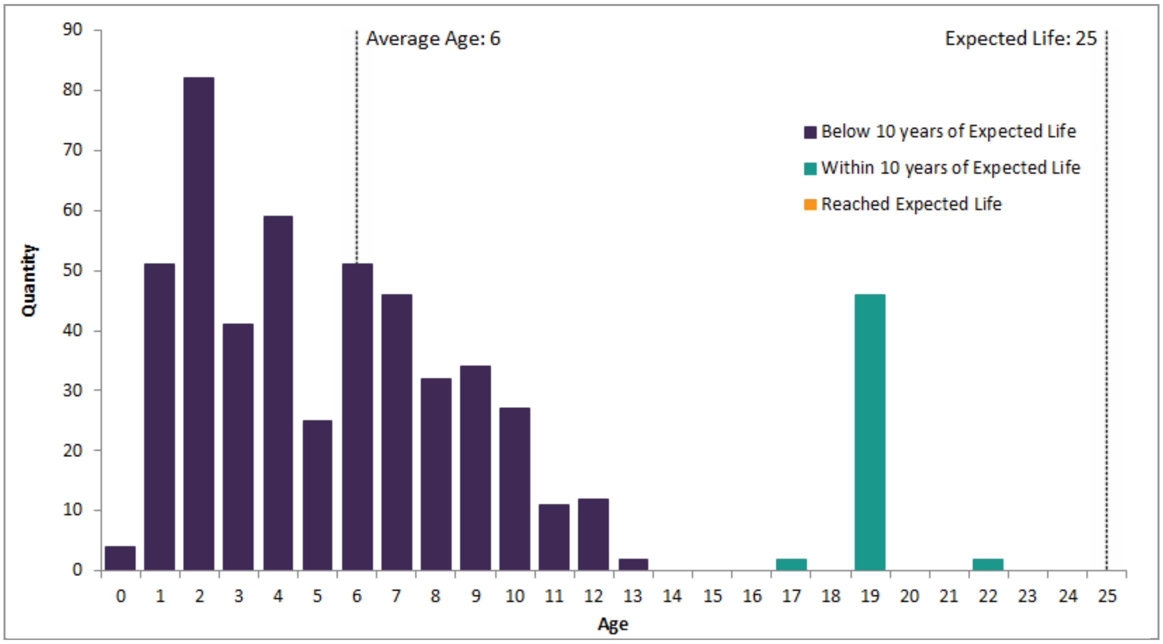
## Table 6.10 – Underground Switchgear Components

| Figure Number | Component | Function |
|---|---|---|
| 1 | Enclosure | Underground switchgear enclosures maintain isolation of the medium voltage equipment from outside sources while ensuring security from the public for increased safety. Additionally, the enclosure protects the inside equipment from damage from external sources and increases system reliability by isolating it from weather, animals and contaminants, such as road salt. |
| 2 | Primary Conductor | Underground primary conductor distributes electricity at medium voltages across the service territory, connecting the supply system to the switchgear. Within an underground switchgear it provides for a contact point for installing fault indicating equipment allowing for expedited fault finding and restoration. |
| 3 | Concrete Base (Pad) | Concrete bases (pads) provide support for underground switchgear by dispersing the weight over a large area. The pad also provides a work area under the switchgear to perform cable work. The pad may also be coupled with a cable chamber (manhole) to allow for increased access to underground cables (described in the Civil Structure AMP). |
| 4 | Insulator | Insulators support electrical connections while protecting equipment from the flow of current. |
| 5 | Switch Blades | Switch blades allow for the continued flow of current while providing the ability to isolate or restore power to customers through switching. The switch blades also allow for isolating the system to enable work (Hydro Ottawa or third party requested). |
| 6 | Switch Fuses | Switch fuses disconnect the circuit in response to high current levels (fault conditions or overloading). Electrical faults result in increased current which can potentially be unsafe for the public, employees and connected equipment. The operation of the fuses isolates the failed equipment and minimizes the safety and reliability impact to Hydro Ottawa customers. |
| 7 | Vista Switchgear | The Vista switchgear is fully enclosed in a hermetically sealed enclosure, containing all of the operational functionality found within other underground switchgear (see 5 and 6 above) while providing a sealed environment for the internal equipment. |
| 8 | Barrier Boards (panels) | Barrier boards (panels) are used to separate the operable equipment within an underground switchgear. While providing additional dielectric insulation, the boards isolate the impact of failure on the adjacent mechanical devices. Additionally, the boards assist in guiding the operation of the specific phase devices. |

**Figure 6.42 – Typical Installation of a Vista Type Underground Switchgear**

The average age of this asset class is six years, Figure 6.43 below illustrates the population demographics. The expected service life of underground switchgear is 25 years. There are 50 underground switchgear that are within 10 years of the end of their expected service life.

**Figure 6.43 – Underground Switchgear Age Demographics**[13]

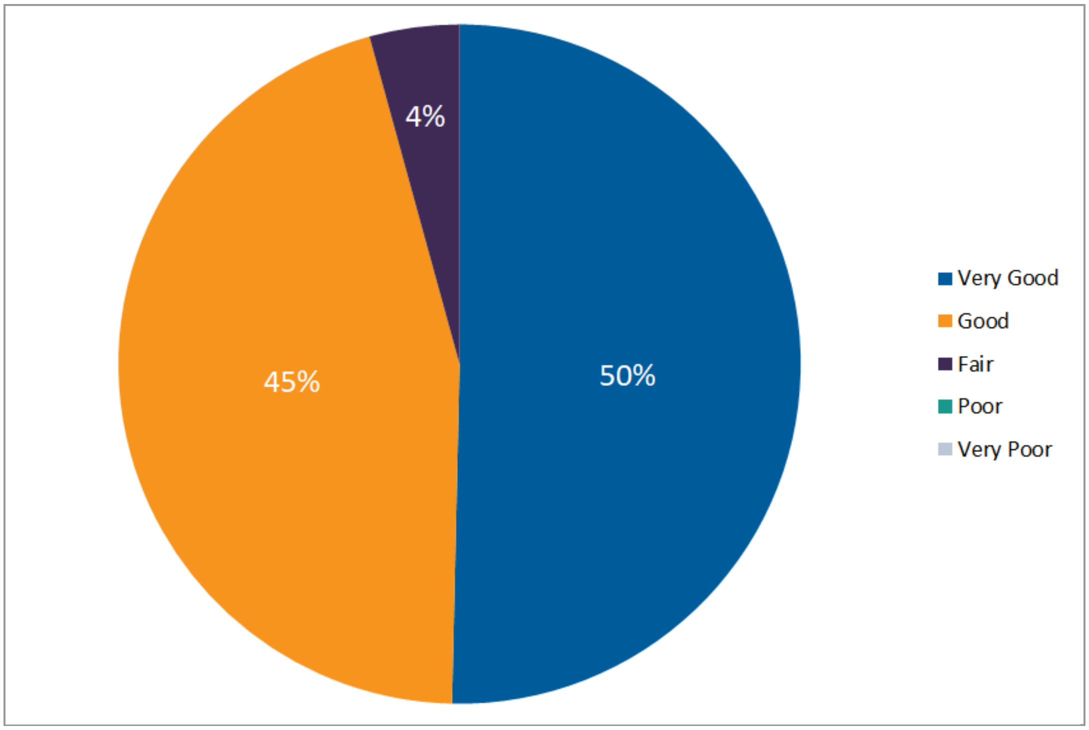



The health index for underground switchgear is largely based on age and the results from visual and thermographic inspections. Switchgear that contain SF6 gas have their health index largely based on the presence of gas leaks.

The condition assessment for underground switchgear is based on data collected from a planned program of inspection as well as installation age. Currently, Hydro Ottawa operates a planned program of inspection and maintenance for its switchgear on a three-year cycle. A summary of known Hydro Ottawa's underground switchgear conditions is shown in Figure 6.44 below.

[13] Datum of January 31, 2019 is used for age demographics.

**Figure 6.44 – Underground Switchgear Condition Demographics**




### 6.1.3.5. Vault Transformers

Hydro Ottawa's vault transformers are located in building vaults and typically service a single large customer. Currently Hydro Ottawa owns 3,652 vault transformers.[14] Figure 6.45 below illustrates a vault transformer and Table 6.11 below details the individual components.

[14] Datum of February 5, 2019 is used in this instance.

## Figure 6.45 – Vault Transformer

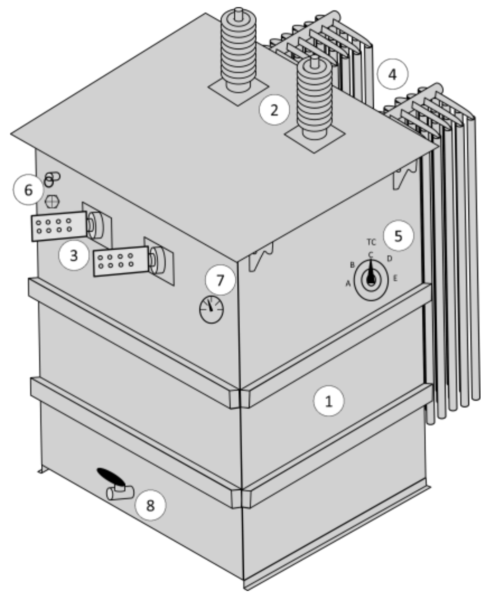
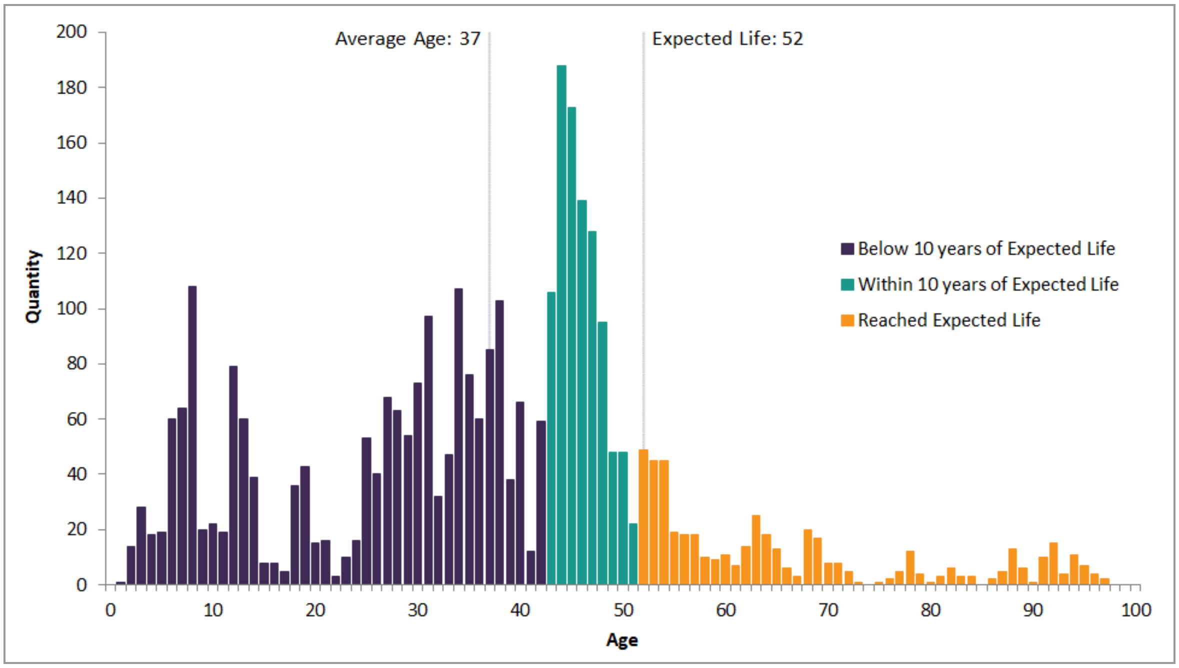


**Table 6.11 – Vault Transformer Components**

| Figure Number | Component | Function |
|---|---|---|
| 1 | Enclosure | Vault transformer enclosures maintain isolation of the medium and low voltage equipment from the environment while providing a degree of personnel protection from the energized internal components. Additionally, the enclosure contains insulating oil. |
| 2 | Primary Bushing | Primary bushings support an insulated flow of current from the connecting primary conductor to the internal transformer connections through the grounded enclosure. |
| 3 | Secondary Bushings | Secondary bushings support an insulated flow of current from the inside connections through the grounded enclosure to the secondary conductor. |
| 4 | Cooling Radiators | Cooling radiators provide convection cooling for the transformer allowing for the efficient dissipation of cool air across the transformer to prevent overheating. |
| 5 | Temperature Gauge | Temperature gauge provides a measurement of the oil temperature of a vault transformer and can be used as an indication of vault transformer operating condition. |
| 6 | Pressure Relief Device | The pressure relief device is used to avoid pressure buildup inside the transformers, and acts as an exit point for oil if the internal pressure exceeds permitted safe level. |
| 7 | Liquid Level Gauge | The liquid level gauge provides a level measurement of oil within the transformer tank to ensure the adequate amount of oil exists to cool and insulate the transformer. |
| 8 | Drain | The drain allows the transformer oil to be removed from the tank for maintenance or in a proactive or reactive manner for testing. |
| Not Shown | Tap Changer | The tap changer is used to regulate the voltage of the distribution vault transformer by changing the transformer's winding ratio. The tap changer can rotate up or down to either increase or decrease the ratio. This ensures that the voltage supplied by transformer is constant, even in cases where the incoming voltage is too high or too low. This results in the distribution of high-quality power. |
| Not Shown | Ground Connection | The ground connection allows for transformer connection to ground electrode which; prevents voltage on transformer enclosure, provides an effective ground-fault current path which is essential for the operation of the overcurrent protection systems, and provides a reference for customer service voltage. |
| Not Shown | Core, Windings, insulating Oil | The transformer's core, primary and secondary windings and oil insulation are sealed within the transformer's enclosure. These elements work together to transformer the electrical power, stepping down from a distribution voltage to customer supply voltage using an electromagnetic circuit. |

The average age of this asset class is 37 years. Figure 6.46 below illustrates the population demographics. The expected service life of vault transformers is 52 years. There are 489 vault transformers that have reached the end of their expected service life and an additional 947 transformers within 10 years of the end of their expected service life.

**Figure 6.46 – Vault Transformer Age Demographics[15]**

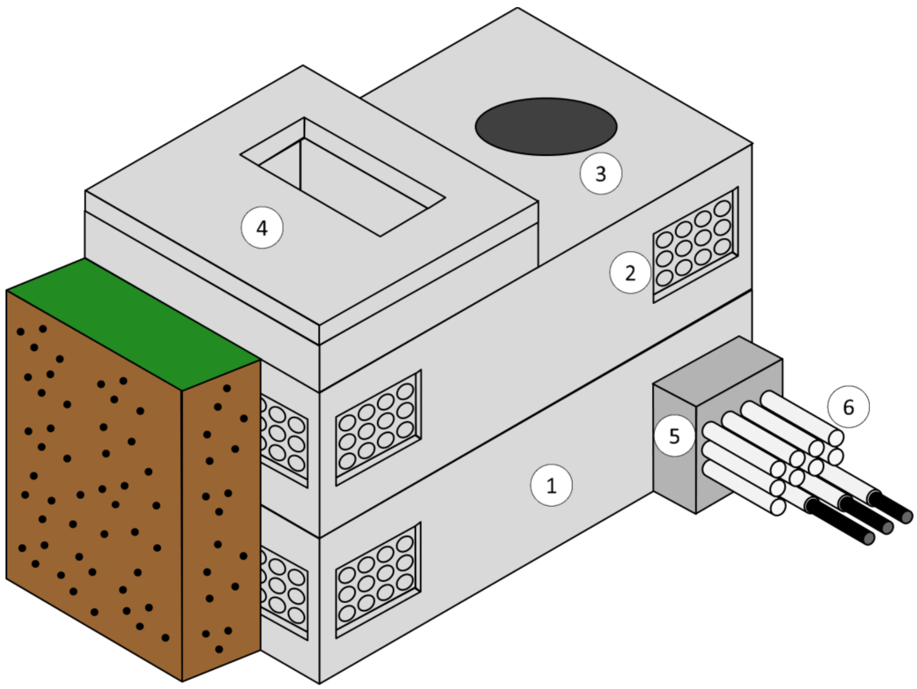



### *6.1.3.6. Underground Civil Structures*

Hydro Ottawa's Underground Civil Structure asset class consists of duct banks, hand holes, and cable chambers forming a network through which cables may be installed. Distribution underground civil structures are used in areas where underground wiring is required which allows for ease of access and protection of electrical equipment. Figure 6.47 below illustrates a cable chamber and Table 6.12 below details the individual components.

[15] Datum of February 1, 2019 is used for age demographics.

## Figure 6.47 – Cable Chamber



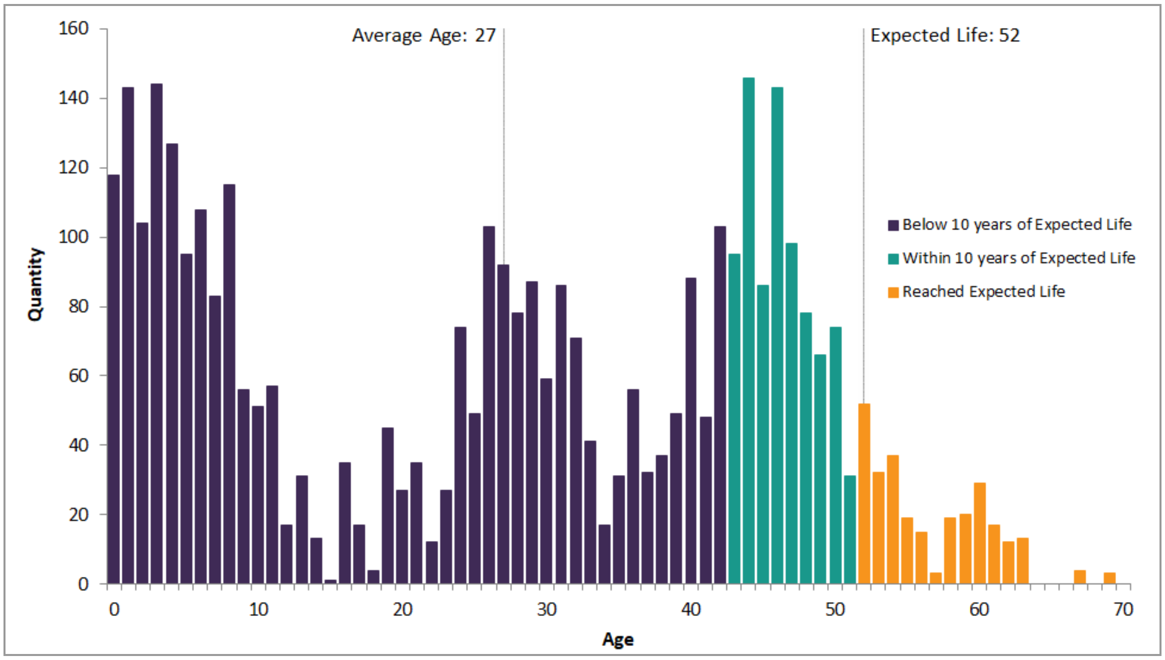

## Table 6.12 – Cable Chamber Components

| Figure Number | Component | Function |
|---|---|---|
| **1** | Cable Chamber | Cable chambers are used to protect other assets such as cable and submersible equipment from external damage and elements. The cable chamber also provides an area for cable splicing, cable pulling, and for replacement and repair without excavation. |
| **2** | Duct Windows | Duct windows are precast concrete structures used for installing new ducts within a cable chamber, while providing a space for future ducts and ease of future core drills. |
| **3** | Cable Chamber Entrance/Lid | The cable chamber entrance/lid allows access to within the cable chamber to gain access to underground assets and connections. |
| **4** | Equipment Pad | Pads support pad-mounted assets including transformers and switchgear. They also allow for bottom entry of equipment and equipment terminations. |
| **5** | Concrete Encased Duct Bank | Concrete encased duct banks support electrical conductors, protect ducts, and therefore the associated cables through a physical barrier preventing damage. |
| **6** | Duct | Duct supports and protects electrical conductors, while allowing for ease of pulling new cable |

**Figure 6.48 – Cable Splicing within a Cable Chamber**

Currently Hydro Ottawa owns 3,878 cable chambers. The average age of this asset class is 27 years. Figure 6.49 below illustrates the population demographics. The expected life of cable chambers is 52 years. There are 275 cable chambers that have already reached the end of their expected life and an additional 817 cable chambers within 10 years of the end of the expected life.

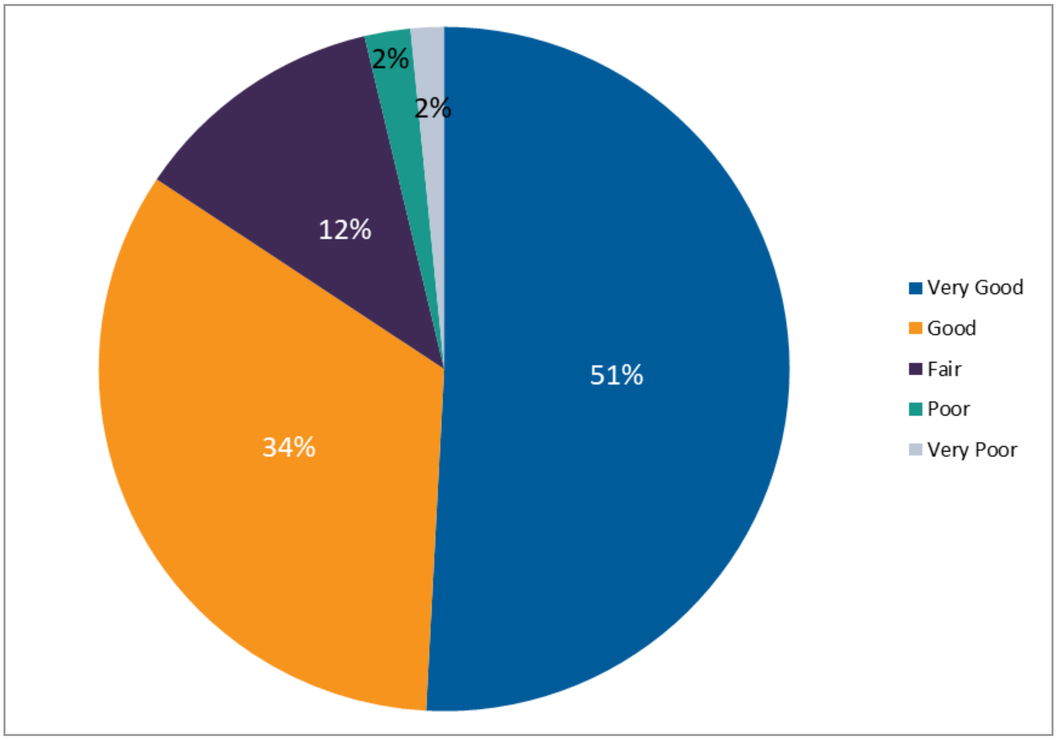
**Figure 6.49 – Cable Chamber Age Demographics[16]**




Hydro Ottawa operates a planned program of inspection for cable chambers based on a 10-year cycle. The health index for cable chambers is primarily based on visual inspections. A summary of known Hydro Ottawa's cable chamber conditions is shown in Figure 6.50 below.

[16] Datum of February 2, 2019 is used for age demographics.

**Figure 6.50 – Cable Chamber Condition Demographics**




## *6.2. ASSET LIFECYCLE OPTIMIZATION POLICIES & PRACTICES*

Hydro Ottawa takes a full lifecycle approach to managing its assets by identifying opportunities to make improvements to the various aspects of the lifecycle. To achieve this, Hydro Ottawa updates design and installation standards, ensures efficient installation and commissioning practices, develops cost effective operation and maintenance, and prioritizes renewal investments.

This section addresses the following:

- Asset Replacement and Refurbishment Policies
- Testing, Inspection, and Maintenance Programs
- Asset Replacement Prioritization and Scheduling

### 6.2.1. Asset Replacement & Refurbishment Policies

Assets identified of needing corrective action are evaluated to determine the appropriate action. Options evaluated are Repair, Refurbish, or Replace. Hydro Ottawa performs a case-by-case analysis to determine the preferred alternative when corrective action is required. Factors such as the age, maintenance history, new standards, and availability of spare parts all influence the decision of whether or not to refurbish, repair, or replace the asset.

Repair actions are corrective interventions that involve the replacement of a minor component which can be obtained from stock materials or through manufacturer sourcing.

Refurbishment is expected to renew the asset and extend the expected service life. These actions are also used to defer the need for replacement to a time where efficiencies can be found by replacing other assets at the same time. Typically, Station assets, such as transformers and breakers, have been more economical to refurbish than Overhead and Underground assets.

Each asset identified for replacement is evaluated for opportunities for efficiencies by assessing the condition of the other assets in proximity that may need to be replaced concurrently; evaluating future growth and demand; and determining if decommissioning is an option.

### 6.2.2. Testing, Inspection & Maintenance Programs

To optimize asset lifecycle and manage risk, Hydro Ottawa uses various programs and activities to evaluate the performance and condition of its assets. The practices used to assess risk include non-destructive testing, and predictive and preventative maintenance which help drive corrective maintenance and capital investments. An overview of this process is available in section 5.1.3 - Testing, Inspection, & Maintenance Programs.

Most of Hydro Ottawa's asset maintenance activities are performed on a predetermined periodic schedule. The cycle period is selected based on various factors to address manufacturers' recommendations, regulatory requirements in the *Distribution System Code*, and/or internal experience and standards. Table 6.13 outlines the inspection and maintenance cycles of each program.

**Table 6.13 – Maintenance Programs**

| | Activity Type | Cycle | Type |
|---|---|---|---|
| **Stations** | Station Inspections | Monthly | Predictive |
| | Thermographic Scans | Annually | Predictive |
| | Transformer Inspection | Annually | Predictive |
| | Transformer Oil Analysis | Annually | Predictive |
| | Transformer Maintenance | Every 3-5 Years | Preventative |
| | Transformer Tap changer Maintenance | Every 1-8 Years | Preventative |
| | Switchgear and Breaker Inspection | Annually | Predictive |
| | Switchgear and Breaker Maintenance | Every 4-6 Years | Preventative |
| | Battery Testing | Annually | Predictive |
| | Relay Maintenance | Every 4-6 Years | Preventative |
| **Underground** | Underground Switchgear Thermographic and Visual | Every 3 Years | Predictive |
| | Underground Distribution Transformer Thermographic and Visual | Every 3 Years | Predictive |
| | Vault Inspections | Every 3 to 6 Years | Predictive |
| | Switchgear $CO_2$ Washing | Every 3 Years | Preventative |
| | XLPE/TRXPLE Cable Testing | 400 segments annually | Predictive |
| | Cable Chamber Inspections | 10 Year | Predictive |
| **Overhead** | Overhead Thermographic Inspection | Every 3 Years | Predictive |
| | Vegetation Management | Every 2 to 3 Years | Preventative |
| | Pole Inspection | Every 10 years | Predictive |
| | Critical Switch Inspection | 8 Years | Preventative |
| | Insulator Washing | Bi-Annual | Preventative |

The following sections detail the testing, inspection, and maintenance practices for each asset type.

### *6.2.2.1. Station Transformers*

Hydro Ottawa performs monthly station inspections where a visual inspection is performed to check for any deficiencies and initiate corrective actions.

Annually, Hydro Ottawa performs transformer inspection on every station transformer, which includes a detailed visual inspection, oil analysis, and infrared scans. The oil analysis includes a dissolved gas and oil quality analysis. Every five years, a furan analysis is performed to assess the degradation of the transformer's paper insulation.

Several major station transformers are also continuously monitored through the SCADA system to provide operational and asset condition related information. Various monitoring technologies have been added to station transformers due the consequences associated with a failure. These include online dissolved gas analysis ("ODGA"), winding and oil temperature, tap changer status, cooling fan status, and loading information. Warnings and alarms from these monitoring units allow Hydro Ottawa to identify the need for corrective actions with real-time data. It also ensures that the transformers are not overloaded or overheating, which causes the insulation to degrade and reduces their lifespans.

**Figure 6.51 – Visual Inspection of a Station Transformer**

Every three to five years, station transformers are isolated for preventive maintenance, which includes electrical testing and mechanical maintenance. Transformer tap changer maintenance intervals vary with the type: oil-filled tap changers with no oil filter are maintained every one to two years; oil-filled tap changers with an oil filter are maintained every two to four years; and vacuum tap changers are maintained every six to eight years.

#### *6.2.2.2. Station Switchgear & Breakers*

Hydro Ottawa performs monthly station inspections where a visual inspection is performed to check for any deficiencies and initiate corrective actions.

Annually, Hydro Ottawa performs switchgear inspection on every station switchgear, which includes a detailed visual inspection and infrared scans.

Every four to six years, preventative maintenance is performed on individual breakers. The breaker maintenance includes electrical, mechanical, and type-specific maintenance tasks to ensure the proper functioning of the breaker.

Every 10 years, detailed preventative maintenance is performed on the entire switchgear assembly. Switchgear maintenance includes detailed internal visual inspections, insulation resistance tests, and ensuring that there are no structural deficiencies, such as cracks, leaks or warped metal in the switchgear.

#### *6.2.2.3. Station Batteries*

Batteries are visually inspected as part of the monthly station inspections to check for any deficiencies and initiate corrective actions.

Annually, detailed predictive maintenance is performed on station battery banks. This includes a detailed visual inspection, infrared scan, as well as electrical and mechanical tests. Battery charger predictive maintenance consists of an annual visual inspection, electrical tests, as well as functional and alarm tests.

#### 6.2.2.4. Relays

Every four to six years, Hydro Ottawa performs relay maintenance at every Hydro Ottawa station. Relay maintenance includes function testing, calibration of electromechanical relays, and protection setting updates, if required.

#### 6.2.2.5. Distribution Poles

Hydro Ottawa inspects all of its distribution poles as part of multiple planned programs of inspection for overhead assets. This planned program of inspection subjects all of its distribution poles and associated attachments to both a visual and thermographic inspection on a rotating three-year cycle identifying candidate assets for corrective actions.

Hydro Ottawa also conducts a predictive maintenance program of detailed inspection of all poles on a 10-year cycle. The data collected from this program is used to assess the pole's condition and estimate remaining strength using the results of non-destructive resistograph drill tests.

#### 6.2.2.6. Overhead Transformers

Hydro Ottawa inspects overhead transformers as part of multiple planned predictive maintenance programs. Transformers are inspected visually as part of the 10-year pole line inspection program and every three years as part of the infrared inspection program.

#### 6.2.2.7. Overhead Switches

Hydro Ottawa inspects all of its overhead switches as part of multiple planned programs of inspection for overhead assets. This planned program of inspection subjects all of its overhead switches to both a visual and thermographic inspection on a rotating three-year cycle identifying candidate assets for corrective actions.

Hydro Ottawa also conducts a separate planned program of detailed inspection and maintenance (Critical Switch Inspection), based on a rotating eight-year cycle, on overhead load break gang operated switches. The detailed inspection is to address switches that have a higher reliability consequence. Inspections are performed in the air, in closer proximity to the switch's components, allowing for a more detailed inspection that could not be performed from the ground. Simultaneously, preventative maintenance is performed on the switch to ensure that it continues to operate as intended.

### *6.2.2.8. Distribution Cables*

Hydro Ottawa annually tests a portion of its polymer cables using non-destructive testing technology to determine the cable's probability of failure resulting from water tree migration. The utility combines this information with feedback from utility staff, reliability data, and the cable segment's age to determine if the cable would be a candidate for replacement.

PILC cables are not subjected to a dedicated planned program of inspection or maintenance and is instead included as part of the inspection of underground civil structures. A visual inspection is performed on a 10-year cycle by qualified outdoor field staff which includes reviewing the cable condition, racking within the cable chamber, and duct allocation.

### *6.2.2.9. Underground Transformers*

Hydro Ottawa inspects its underground distribution transformers annually on a three-year cycle. The inspection process uses a visual inspection to identify transformers with broken components or leaking oil. A thermographic inspection is also performed to identify defective transformer components including elbows, bushings, and fuses. This process identifies candidate transformers for corrective actions including mechanical repair and component replacement. When repair is not economical, the transformer is scheduled for replacement.

### *6.2.2.10. Underground Switchgear*

Hydro Ottawa inspects and maintains all of its underground distribution switchgear on a planned basis. This planned program subjects all of its underground distribution switchgear to a visual and thermographic inspection based on a rotating three-year cycle. The maintenance of air insulated switchgear also includes cleaning of its internal mechanism. The visual inspection records demographic information and the current condition including the enclosure and civil base.

### 6.2.2.11. Vault Transformers

Hydro Ottawa inspects all of its vault transformers on a planned three-year cycle. This planned program subjects its vault transformers to a visual and thermographic inspection in addition to minor cleaning. The visual inspection records demographic information and the current condition.

Hydro Ottawa does not own the electrical supply room within customer-owned buildings. Deficiencies found that would affect the ongoing operations or identified safety risks are identified to the building owner to take corrective actions.

### 6.2.2.12. Underground Civil

Hydro Ottawa performs an inspection of its cable chambers on a 10-year cycle. The cable chamber inspection process involves a visual inspection and sounding test to assess the cable chamber's condition. The inspection includes reviewing the condition of the collar and lid, roof, and walls. Cable chamber components that pose an immediate risk to the public, workers, or reliability of the distribution system are identified for immediate corrective actions. If they pose a reduced risk, they are identified for planned corrective actions at a later date.

Through the use of experienced underground field workers, the electrical components installed within the cable chambers can be inspected and minor corrective actions addressed immediately. The visual inspection includes capturing information about the cable demographics, location of splices, and identification of duct allocation.

Other civil assets, including hand holes, ducts, and duct banks, are not subject to a planned program of inspection. Failures of these assets pose a reduced risk to the public and workers in the event of unforeseen failure.

### 6.2.3. Asset Replacement Prioritization & Scheduling

Hydro Ottawa manages its asset replacement prioritization and scheduling the same way it manages other types of investments. Details about this process can be found in section 5.2 - Capital Expenditure Process.

## *6.3. ASSET LIFECYCLE RISK MANAGEMENT*

Hydro Ottawa identifies risk through its Asset Management Process and seeks to mitigate risk through Expenditure Process as defined in section 5 - Asset Management & Capital Expenditure Process.

In order to understand the long-term impact and risk of decisions, various investment scenarios are used by Hydro Ottawa to prioritize the needed investments to maintain or improve risk to a level that is acceptable to the organization. Details on how the utility has analysed the risk for selecting and prioritizing capital expenditures can be found in Attachment 2-4-3(E): Material Investments for each asset renewal program.

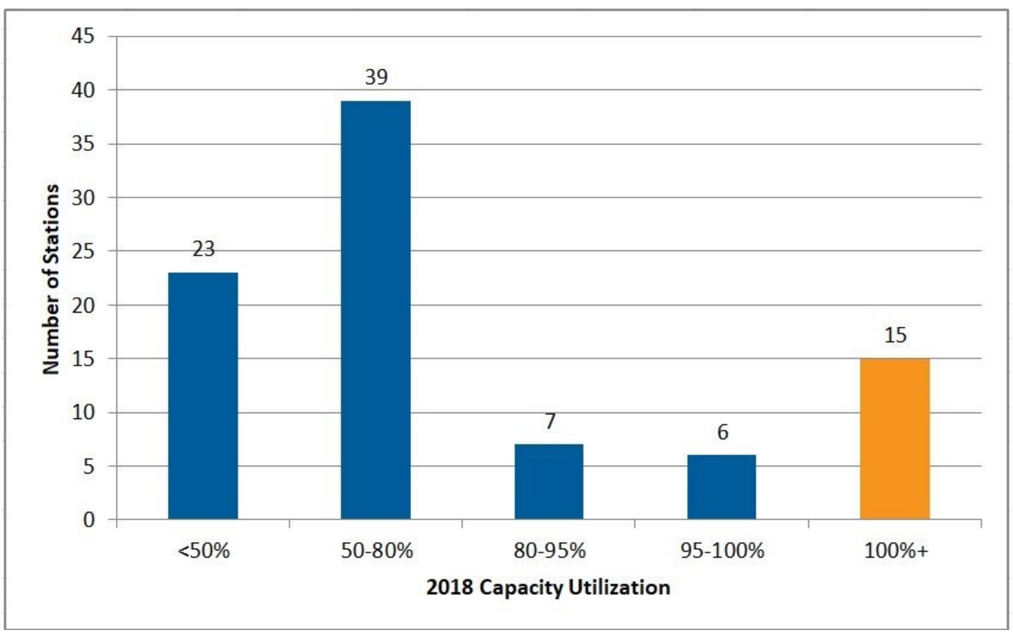
## 7. SYSTEM CAPACITY ASSESSMENT

This section outlines the degree of utilization of existing assets relative to the planning criteria as layout out in section 4.1.4 - System Operations Performance. In addition, it identifies the system capabilities and constraints to accommodate new load and Energy Resource Facility ("ERF") connections, as well as transmission network constraints identified through the Regional Planning Process.

### *7.1 CAPACITY OF THE EXISTING SYSTEM ASSETS*

In 2018, 15 Hydro Ottawa stations were above their planning rating capacity and six were approaching planning capacity limitations as shown in Figure 7.1. None were above normal thermal limits. Stations above 100% of their planning capacity limit the flexibility of the system to manage abnormal system states including planned activities.

**Figure 7.1 – Stations Capacity Utilization in 2018**




#### 7.1.1. Stations Exceeding Planning Capacity

Station planning capacity is defined in section 4.1.4.1 - Station Capacity. Station loading must be maintained within the planning capacity to allow for efficient transfer of load during an N-1 contingency, while respecting equipment ratings. Stations loaded above their planning capacity on the 2018 system peak day are shown in Table 7.1.

**Table 7.1 – Stations Exceeding Planning Capacity**

| | Station | 2018 System Peak Day Load (MVA) | Planning Capacity (MVA) | Planning Factor |
|---|---|---|---|---|
| 1 | Fallowfield MTS | 50 | 25 | 201% |
| 2 | Merivale MTS | 16 | 10 | 160% |
| 3 | Rideau Heights DS | 18 | 12.5 | 143% |
| 4 | Marchwood MTS | 43 | 33 | 129% |
| 5 | Manordale MTS | 13 | 10 | 128% |
| 6 | Centrepointe MTS | 17 | 14 | 119% |
| 7 | Vaughan UG | 8 | 6.7 | 116% |
| 8 | Jockvale DS | 14 | 12.5 | 115% |
| 9 | Hawthorne TS | 123 | 110 | 111% |
| 10 | Bayshore DS | 14 | 12.5 | 111% |
| 11 | Stafford Road DS | 15 | 14 | 109% |
| 12 | King Edward TK | 85 | 80 | 107% |
| 13 | Church AA | 5 | 5 | 105% |
| 14 | Leitrim MS | 25 | 25 | 102% |
| 15 | Kanata MTS | 61 | 60.5 | 101% |

Fallowfield Station in the South Nepean 28kV area continues to be above its planning capacity limitations. The construction of the new Cambrian Municipal Transformer Station ("MTS") will allow offloading of Fallowfield and other stations in the South Nepean area. The new station will be energized in 2022.

Merivale and Rideau Heights Stations in the Nepean Core 8kV area continue to be above their planning capacity limits. A project to increase capacity at Merivale station is currently in progress and expected to be energized by the end of 2019, enabling a decrease of load at Rideau Heights station.

Kanata and Marchwood Stations are slightly above their planning rating. There is substantial growth expected in this area in the short to mid-term. Plans to bring additional capacity to this area are in place for the 2021-2025 period through distribution line extensions, load transfers to adjacent stations, and conservation and demand management ("CDM") demand reductions. Feasibility for a new station in the Kanata North area is being discussed in the current Integrated Regional Resource Planning ("IRRP") cycle. However, there are transmission constraints that will need to be addressed before a new transmission connected station can be built in this area.

Hawthorne Station was a new addition to the list in 2018. Hydro One Networks Inc. ("HONI") is currently replacing the transformers and increasing capacity at this station. The project was set to be completed by Q4 2019.

The other eight stations on the list have minor overloads in 2018 and they will continue to be monitored for future improvements. Plans for addressing the stations above planning capacity ratings are further discussed in section 7.2 - Ability to Connect New Load.

### 7.1.2. Stations Approaching Rated Capacity

Station rated capacity is defined in section 4.1.4.1 - Station Capacity. Transformer loading must be maintained within their thermal rated capacity in order to avoid any accelerated loss of life to the unit.

There were no stations loaded at or above their thermal rated capacity on the 2018 system peak day.

### 7.1.3. Feeders Exceeding Planning Capacity

Feeders planning capacity is defined in section 4.1.4.2 - Feeder Capacity. Feeders must be maintained within the planning capacity to allow for efficient load transfer during N-1 contingency situations, while respecting equipment ratings.

The feeders above 100% of their planning capacity on the 2018 system peak day are listed in Table 7.2. Plans for addressing the feeders above planning capacity ratings are discussed in section 7.2 - Ability to Connect New Load.

**Table 7.2 – Feeders Exceeding Planning Capacity**

| | Station | Feeder | 2018 System Peak Day Load (MVA) | Planning Capacity (MVA) | Planning Factor (%) |
|---|---|---|---|---|---|
| 1 | Russell TB | TB2JP (TB13) | 8.7 | 5.8 | 149% |
| 2 | Fallowfield MTS | FAL02 | 22.9 | 16.3 | 141% |
| 3 | Jockvale DS | 145F1 | 5.9 | 4.3 | 137% |
| 4 | Limebank MS | LMBF7 | 21.5 | 16.7 | 129% |
| 5 | Kanata MTS | 624F1 | 16.4 | 13.1 | 125% |
| 6 | Startop MS | 6F10 | 5.3 | 4.3 | 123% |
| 7 | Uplands MS | Q4801F8 | 18.0 | 14.8 | 122% |
| 8 | Ellwood MTS | ELW11 | 7.0 | 5.8 | 121% |
| 9 | Kanata MTS | 624F5 | 15.0 | 13.1 | 114% |
| 10 | Kanata MTS | 624F2 | 15.0 | 13.1 | 114% |
| 11 | Barrhaven DS | 140F3 | 4.9 | 4.3 | 114% |
| 12 | Slater TS | 630 | 6.6 | 5.8 | 113% |
| 13 | Rideau Heights DS | 180F3 | 4.9 | 4.3 | 113% |
| 14 | Parkwood Hills DS | 190F5 | 4.8 | 4.3 | 112% |
| 15 | Marchwood MS | MWDF4 | 14.4 | 13.1 | 109% |
| 16 | Albion TA | 2206 | 11.8 | 10.7 | 109% |
| 17 | Riverdale TR | 509 | 6.1 | 5.8 | 105% |
| 18 | Riverdale TR | TR2FB | 6.1 | 5.8 | 105% |
| 19 | Janet King DS 28kV | JKGF4 | 16.8 | 16.3 | 103% |
| 20 | Rideau Heights DS | 180F1 | 4.5 | 4.3 | 103% |
| 21 | Stafford Road DS | 200F6 | 4.4 | 4.3 | 103% |
| 22 | Woodroffe TW | TW18 | 5.9 | 5.8 | 101% |

### 7.1.4. Feeders Approaching Rated Capacity

Feeders rated capacity is defined in section 4.1.4.2 - Feeder Capacity. Feeder loading must be maintained within the rated capacity in order to avoid damaging equipment and causing an accelerated loss of life to cables or equipment.

**Table 7.3 – Feeders Approaching Rated Capacity**

| | Station | Feeder | 2018 System Peak Day Load (MVA) | Rated Capacity (MVA) | Capacity Factor (%) |
|---|---|---|---|---|---|
| 1 | Fallowfield MTS | FAL02 | 22.9 | 24.1 | 95% |

There was one feeder loaded at 95% of the rated capacity on the 2018 system peak day. Load on the Fallowfield feeder will decrease once the Cambrian MTS is energized in 2022, enabling the transfer of load to the new Cambrian feeders.

## 7.2. ABILITY TO CONNECT NEW LOAD

Hydro Ottawa regularly assesses the capability and reliability of the distribution system in an effort to maintain adequate and reliable supply to customers. Where gaps are found, appropriate plans for additions and/or modifications are developed consistent with all regulatory requirements and with due consideration for safety, environment, finance, and supply system reliability/security. The factors determining constraints in the system are explained in section 5.1.6 - System Constraints.

In this regard, the supply needs have been assessed to determine if additions and/or modifications are required to maintain an adequate and reliable system capacity. The growth identification process is described in section 5.1.4 - Growth Identification.
Details from City of Ottawa plans used in the forecasting of expenditures are explained below.

**City of Ottawa Growth Projections**

Forecasts for population, household, and employment growth have been obtained from the summary of City of Ottawa Growth Projections for 2006-2031, and are shown in Table 7.4. The

City is in the early stages of updating the Official Plan, which will include updated growth projections. The update to the Official Plan is scheduled for adoption by the City Council in early 2021.

**Table 7.4 – Projected Growth in Population, Households & Employment in the City of Ottawa (2011-2031)**

| Population | | | | |
|---|---|---|---|---|
| **Year** | **2011** | **2016** | **2021** | **2031** |
| **Total** | 923,000 | 976,800 | 1,031,300 | 1,135,800 |

| Households | | | | |
|---|---|---|---|---|
| **Year** | **2011** | **2016** | **2021** | **2031** |
| **Total** | 381,800 | 413,000 | 443,600 | 497,400 |

| Employment | | | | |
|---|---|---|---|---|
| **Year** | **2011** | **2016** | **2021** | **2031** |
| **Total** | 580,200 | 617,000 | 648,400 | 703,100 |

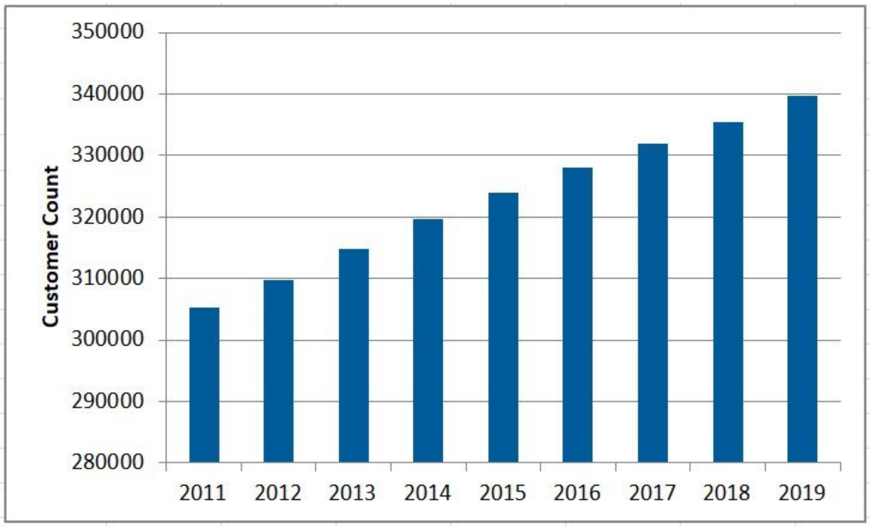
The growth within the City of Ottawa is expected to continue into the future. The total average annual growth rates from 2011-2031 are as follows:

- Population – 1.01%
- Households – 1.25%
- Employment – 0.87%

Hydro Ottawa has been experiencing a steady customer growth for many years. Customer counts from 2011-2018 are in alignment with forecasted population growth in the City of Ottawa Growth Projections for 2006-2031 at an annual growth rate of 1.19%, as shown in Figure 7.2.

Therefore, Hydro Ottawa expects the continuing trend of requests for connection of residential subdivisions and the associated mixed-use centres, along with employment centres.

**Figure 7.2 – Historical Customer Count**

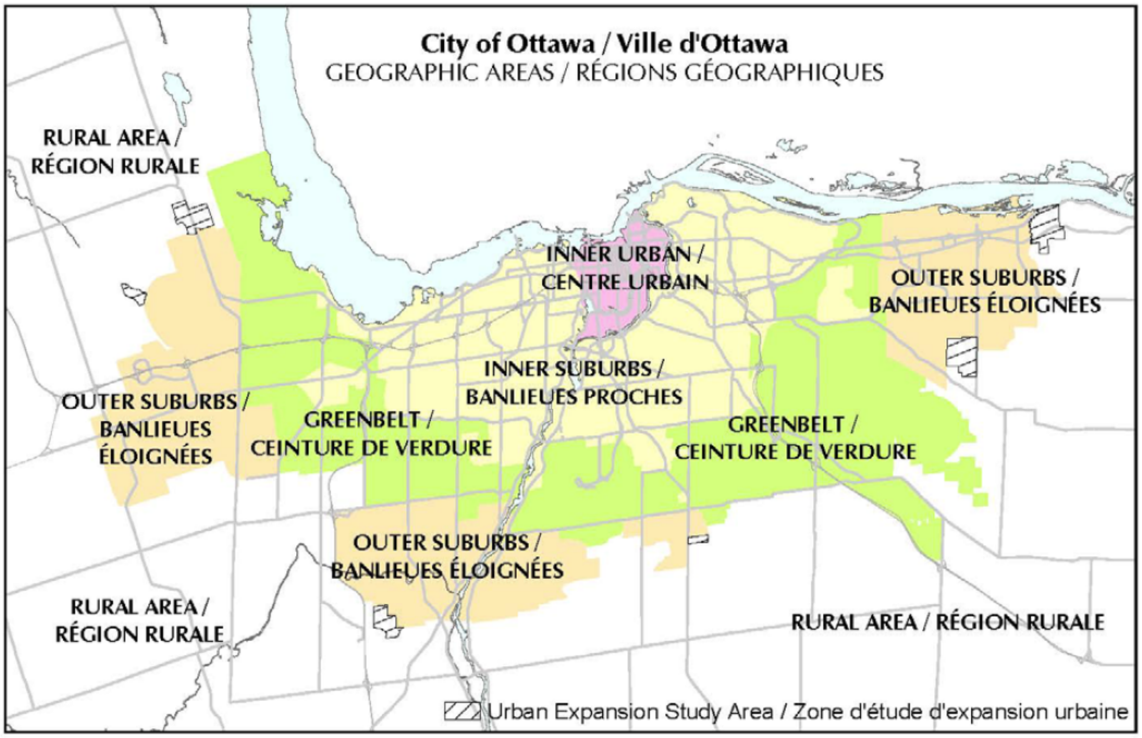



## City of Ottawa Transportation Master Plan

The City of Ottawa's Transportation Master Plan identifies the transportation facilities and services that are required to meet the needs of the growing City. Hydro Ottawa utilizes this information to help forecast customer connection requests and to plan the sustainment of the distribution system. Figure 7.3 and Table 7.5 below depict the increasing requirements by region, within the City of Ottawa out to 2031.

1 **Figure 7.3 – Location of Inner Area, Inner Suburbs & Outer Suburbs (City of Ottawa)**

2




3 *Source: City of Ottawa Transportation Master Plan, 2013

### Table 7.5 – Population & Employment: 2011 Actual & 2031 Projections

| Area | Population | | | Employment | | |
|---|---|---|---|---|---|---|
| | 2011 | 2031 | Growth and Distribution | 2011 | 2031 | Growth & Distribution |
| Inner Area | 97,200 | 116,400 | 19,200<br>9% | 170,600 | 201,800 | 31,200<br>23% |
| Inner Suburbs | 432,500 | 459,300 | 26,800<br>13% | 287,400 | 355,300 | 67,900<br>49% |
| Kanata/ Stittsville | 105,200 | 162,000 | 56,800<br>27% | 51,300 | 62,500 | 11,200<br>8% |
| Barrhaven | 71,200 | 107,400 | 36,200<br>17% | 11,100 | 21,800 | 10,700<br>8% |
| Riverside South/Leitrim | 15,900 | 35,800 | 19,900<br>9% | 4,000 | 7,800 | 3,800<br>3% |
| Orléans | 108,200 | 143,400 | 35,200<br>16% | 20,600 | 33,000 | 12,400<br>9% |
| Rural Ottawa | 91,400 | 111,700 | 20,300<br>9% | 20,000 | 20,900 | 900<br>1% |
| **TOTAL** | **922,000** | **1,135,900** | **213,900** | **564,900** | **703,200** | **138,100** |

*Source: City of Ottawa Transportation Master Plan, 2013

Within the Transportation Master Plan, the City of Ottawa has developed an “Affordable Road Network” planned out to 2031. This “Affordable Road Network” is the prioritized City projects based on the expected funding levels, and as such, is used to forecast Hydro Ottawa’s Plant Relocation, Asset Renewal, and other line upgrades driven by transportation projects.

The “Affordable Road Network” projects have been broken out by phases, and are listed in Table 7.6 below, showing only those projects planned until 2025.

HydroOttawa

**Table 7.6 – City of Ottawa Affordable Road Network - Projects by Phase (*)**

| Phase 1: 2014-2019 | | |
|---|---|---|
| **Sector** | **Project** | **Description** |
| Southeast | Airport Parkway (1) | Widen from two to four lanes between Brookfield Road and Hunt Club Road |
| East | Blackburn Hamlet Bypass Extension (1) | New four-lane road between Orléans Boulevard and Navan Road |
| East | Brian Coburn Boulevard Extension | New two-lane road (ultimately four-lane) between Navan Road and Mer Bleue Road |
| West | Campeau Drive | New four-lane road between Didsbury Road and Huntmar Drive |
| Rural | Country Club Road | New two-lane road between eastern terminus of Golf Club Way and Jenkinson Road |
| West | Earl Grey Drive Underpass | New underpass of Terry Fox Drive |
| Southwest | Greenbank Road Extension | New four-lane road between Cambrian Road and Jockvale Road |
| West | Old Richmond/West Hunt Club | Widen Old Richmond Road/ West Hunt Club Road from two to four lanes between Hope Side and Highway 416 |
| West | Stittsville North-South Arterial (1) | New two-lane road between Fernbank Road and Abbott Street |
| West | Klondike Road | Urbanize existing two-lane rural cross section between March Road and Sandhill Road |
| East | Mer Bleue Road | Widen from two to four lanes between Brian Coburn Boulevard and Renaud Road |
| West | Palladium Drive Realignment | Realign in vicinity of Huntmar Road to new north-south arterial |
| Southwest | Strandherd Drive (1) | Widen from two to four lanes between Fallowfield Road and Maravista Drive |

| Phase 2: 2020-2025 | | |
|---|---|---|
| **Sector** | **Project** | **Description** |
| Southeast | Bank Street | Widen from two to four lanes between Earl Armstrong Road extension and south of Leitrim |
| East | Blackburn Hamlet Bypass Extension (2) | New four-lane road between Innes Road and Orléans Boulevard |
| West | Carp Road | Widen from two to four lanes between Highway 417 and Hazeldean Road |
| Southwest | Chapman Mills Drive | New four-lane road between Strandherd Drive and Longfields Drive |
| West | Eagleson Road | Widen from two to four lanes between Cadence Gate and Hope Side Road |

| Phase 2: 2020-2025 (Cont'd) | | |
|---|---|---|
| **Sector** | **Project** | **Description** |
| Southwest | Jockvale Road | Widen from two to four lanes between Cambrian Road and Prince of Wales Drive |
| West | Kanata Avenue | Widen from two to four lanes between Highway 417 and Campeau Drive |
| West | Stittsville North-South Arterial (2) | New four-lane road between Palladium Drive (at Huntmar) and Abbott Street |
| Southeast | Lester Road | Widen from two to four lanes between Airport Parkway and Bank Street |
| Southwest | Strandherd Drive (2) | Widen from two to four lanes between Maravista Drive and Jockvale Road |
| East | Tenth Line Road | Widen from two to four lanes between Harvest Valley Road and Wall Road |

*Source City of Ottawa Transportation Master Plan, 2013

**City of Ottawa Community Design Plans**

Hydro Ottawa also references published Community Design Plans ("CDPs") from the City of Ottawa to forecast future residential and mixed-use centres.

Currently, there are 35 CDPs published on the City of Ottawa's website which describe a mix of development types. A summary of the CDPs can be found in Table 7.7 below and is based upon information provided within each study plan.

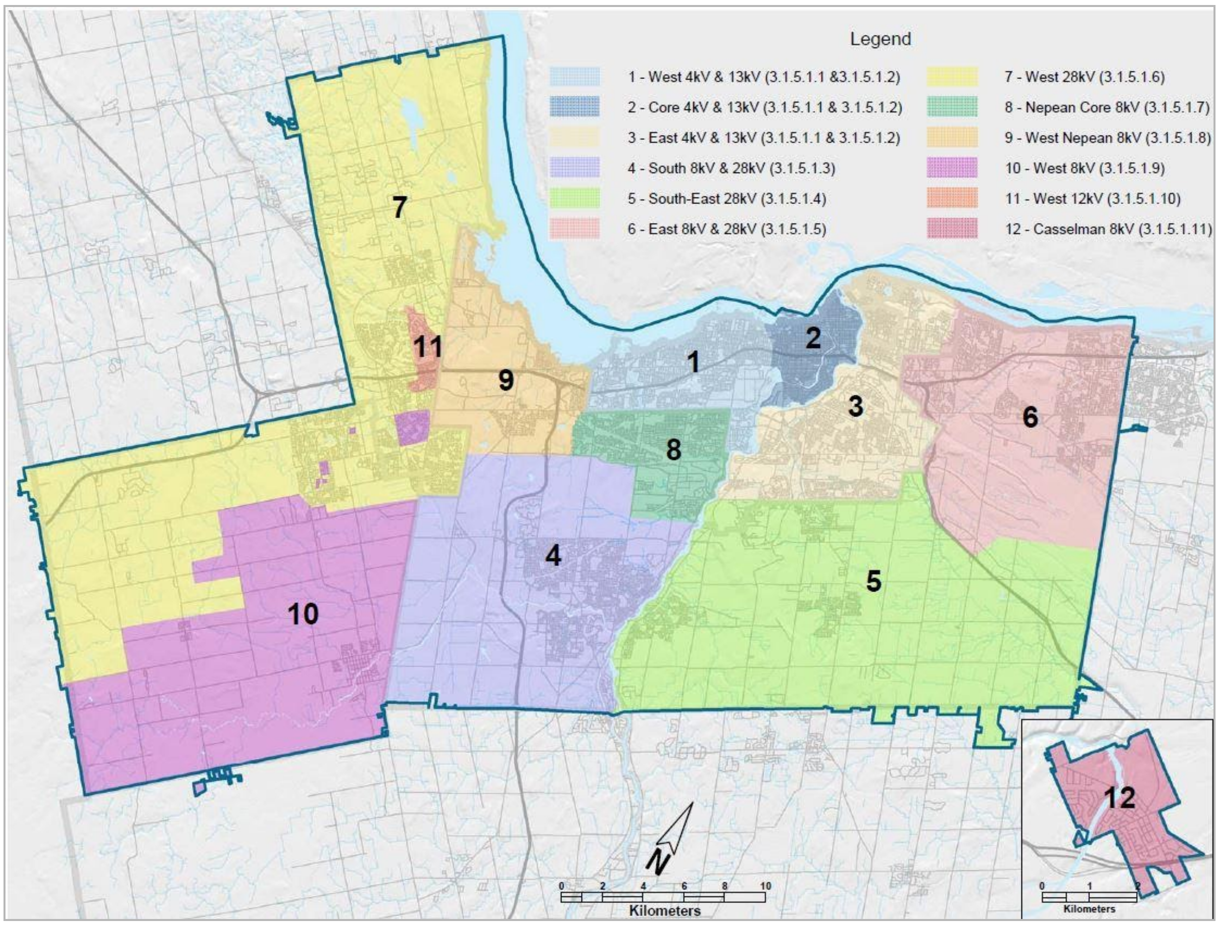
1 **Table 7.7 – City of Ottawa Community Design Plans Summary**

| Study | Study Area (ha) | GFA (ha) | No. Res. Units | Land Use Type |
|---|---|---|---|---|
| Barrhaven South CDP | 500 | 188.9 | 6,862 | Mixed-Use |
| Barrhaven South Expansion CDP | 122 | 48.2 | 1,752 | Mixed-Use |
| Bank Street CDP | 101 | 39.9 | 990 | Mixed-Use |
| Bayview Station District CDP | 29.5 | 55 | 3,594 | Mixed-Use |
| Beechwood CDP | 22 | 6.5 | 819 | Mixed-Use |
| Cardinal Creek Village Concept Plan | 208 | 95 | 3,500 | Mixed-Use |
| Carp Road Corridor CDP | 2475 | Not specified | 0 | Commercial |
| Village of Carp CDP | 49.5 | Not specified | 543 | Mixed-Use |
| Village of Constance Bay Community Plan | 114 | 27.2 | 204 | Mixed-Use |
| East Urban Community (Phase 1 Area) CDP | 570 | Not specified | 3,498 | Mixed-Use |
| East Urban Community (Phase 2 Area) CDP | 240 | Not specified | 1,726 | Mixed-Use |
| Fernbank CDP | 674 | 310 | 11,000 | Mixed-Use |
| Former CFB Rockcliffe CDP | 131 | 45 | 5,350 | Residential |
| Greely CDP | 1276 | 87 | 729 | Mixed-Use |
| Leitrim CDP | 500 | 362.3 | 5,300 | Mixed-Use |
| Mer Bleue CDP | 160 | 113.7 | 3,000 | Mixed-Use |
| Kanata North CDP | 181 | 47.9 | 2,900 | Residential |
| Kanata West Concept Plan | 887 | Not specified | 5,000 | Mixed-Use |
| North Gower CDP | 278 | 208 | 520 | Mixed-Use |
| Old Ottawa East CDP | 158 | Not specified | 2,250 | Mixed-Use |
| Orleans Industrial Park Study | 316 | 18.7 | 0 | Commercial |
| Richmond Road/Westboro CDP | 270 | 111.7 | 2860 | Mixed-Use |
| Riverside South CDP | 1800 | 1450 | 18,300 | Mixed-Use |
| Scott Street CDP | 57.7 | Not specified | 1,500 | Mixed-Use |
| South Nepean Town Centre CDP | 165 | 35 | 11,000 | Mixed-Use |
| Uptown Rideau CDP | 21 | 43.1 | 2,500 | Mixed-Use |
| Transit-Oriented Development (TOD) Plans | 588 | 432 | 16,500 | Mixed-Use |
| Village of Richmond CDP | 879 | 3.5 | 2,700 | Mixed-Use |
| Wellington Street West CDP | 232 | Not specified | 950 | Mixed-Use |

2

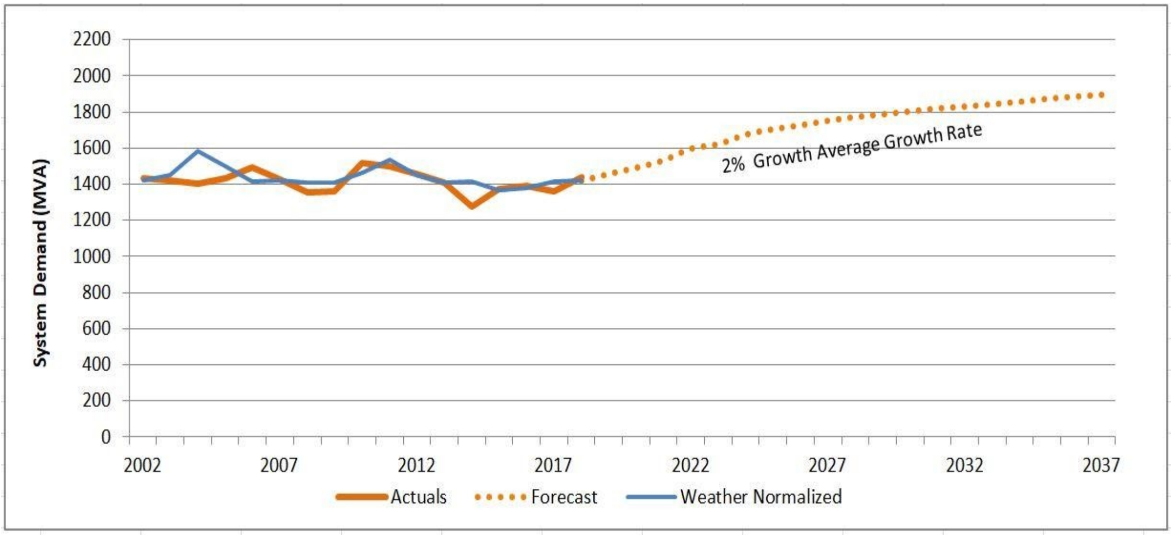
Hydro Ottawa's distribution system is composed of several subsystems, which are segregated by operating voltage, geographical boundaries, and pre-amalgamation utility demarcations, as shown in Figure 7.4. Each of these subsystems undergo an extensive review annually, as part of the capacity planning process, and a forecast is produced over a 20-year horizon.

**Figure 7.4 – Hydro Ottawa Planning Regions**




The forecast from the 2017 assessment was incorporated into the latest IRRP cycle. The expected growth for Hydro Ottawa's service territory included in the latest IRRP is shown in Figure 7.5. Over the next 20 years the system will see an average annual growth of 2%. Five-year and 10-year forecast growth rates are 4% and 3%, respectively.

**Figure 7.5 – System Load Forecast**




Despite steady customer and population growth, overall summer system peak load has remained relatively steady in recent years at approximately 1,400 MW as shown in Figure 7.5 below. However, Ottawa continues to experience high load growth in certain areas of the city primarily due to new residential developments in previously rural areas, infill and intensification in many established areas, as well as major projects like the Ottawa Light Rail Transit ("LRT") system. Rural areas experiencing growth are South Nepean, Kanata North, Leitrim, Riverside South, and Richmond South. Distribution lines and stations in these former rural areas are being pushed to their capacity limitations. Asset renewal and upgrades are required to meet the expected growth and maintain acceptable reliability levels in these growth areas.

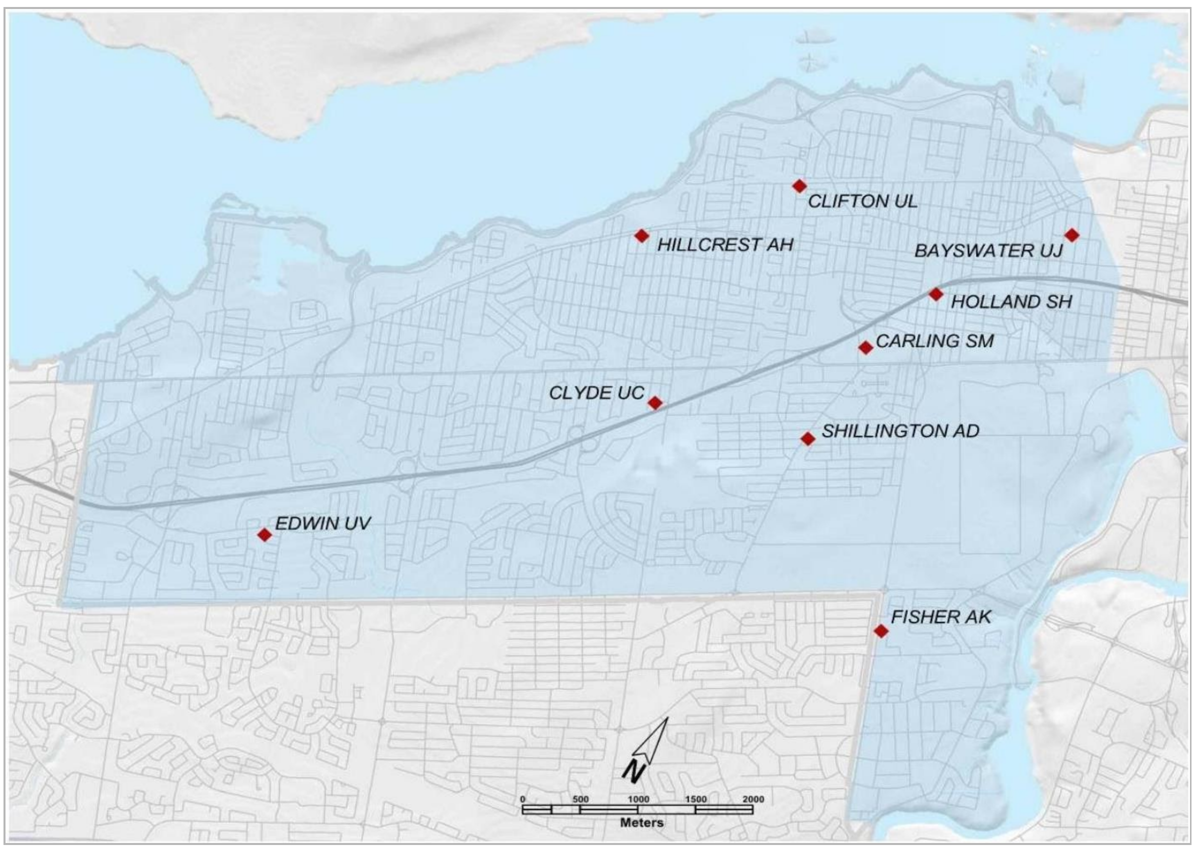
The following sections detail the forecasted subsystem needs.

### 7.2.1. 4 kV System

Hydro Ottawa 4kV supply region is comprised of three main areas: West 4kV, Core 4kV, and East 4kV as shown in Figure 7.6, Figure 7.7 and Figure 7.8 below, respectively.

1) The West 4kV supply region covers West of Rochester Street, East of Bayshore Drive, and North of Baseline Road. This region is supplied by Edwin DS, Shillington DS, Fisher DS, Clyde DS, Carling DS, Hydro Ottawa land DS, Hillcrest DS, Clifton DS, and Bayswater DS.

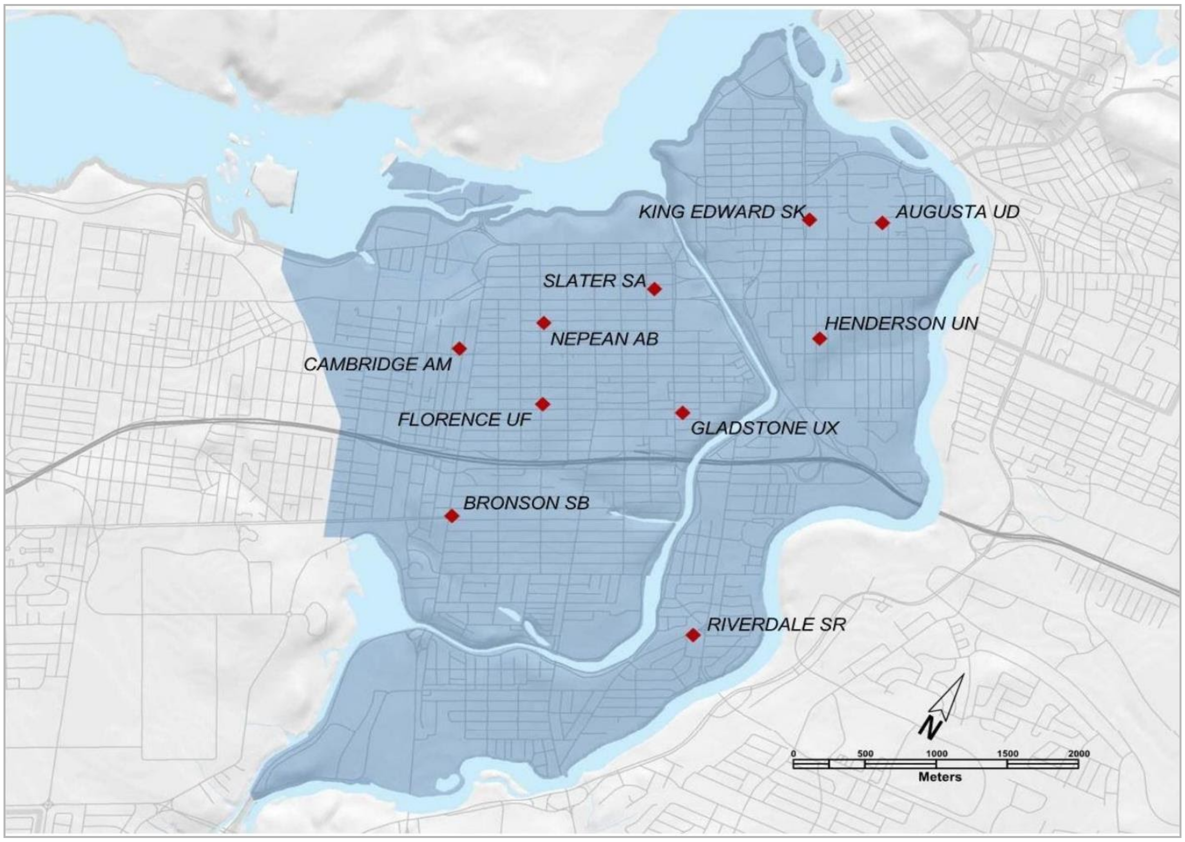
**Figure 7.6 – West 4kV Supply Region**




2) The Core 4kV supply region covers East of Rochester Street and is bounded West and North of the Rideau River. This region is supplied by Bronson DS, Nepean DS,

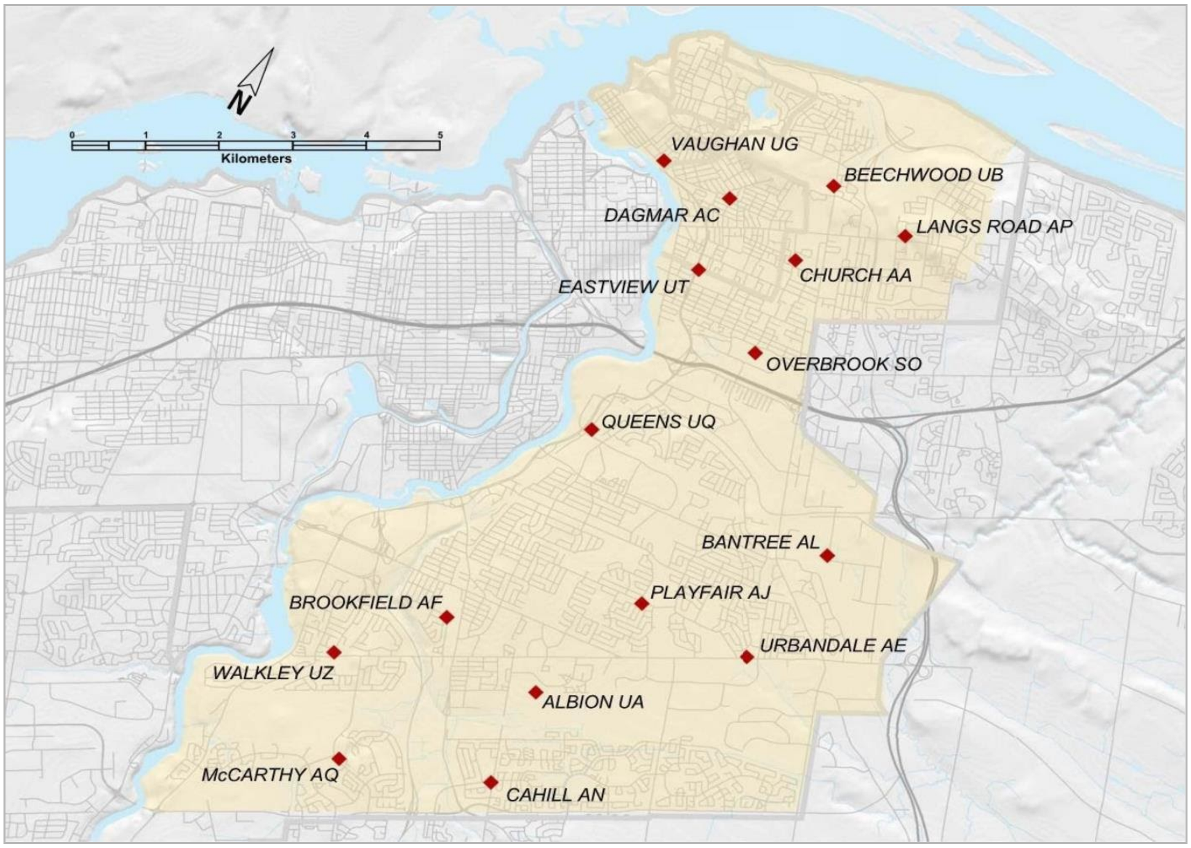
Gladstone DS, Augusta DS, Cambridge DS, Slater DS, Henderson DS, Florence DS, Riverdale DS, and King Edward DS.

**Figure 7.7 – Core 4kV Supply Region**




3) The East 4kV supply region covers West of Blair Road, East of the Rideau River, and North of Hunt Club Road. This region is supplied by Vaughan DS, Bantree DS, Albion DS, Eastview DS, Playfair DS, Cahill DS, Dagmar DS, Urbandale DS, McCarthy DS, Beechwood DS, Brookfield DS, Walkley DS, Queens DS, Langs Road DS, Overbrook DS, and Church DS.

**Figure 7.8 – East 4kV Supply Region**




These 4kV stations are supplied from twelve 13kV stations and provide electricity for the majority of the residential load in the region.

Through the Official Plan, the City of Ottawa is promoting new growth by means of intensification. Many new developments are converting from low-rise apartments to larger high density condos and apartment buildings. As a result, most of the 4kV stations are experiencing decreasing loads as customers upgrade their electrical supply and transfer to being supplied directly from the 13kV system.

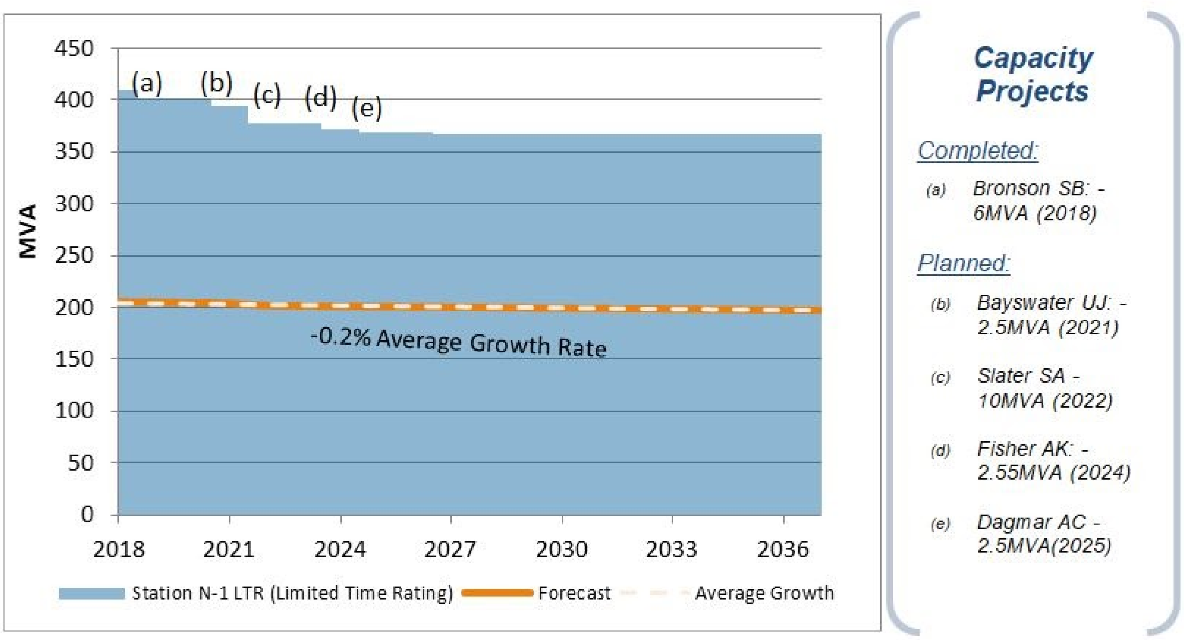
This decrease in load among the stations reduces their financial effectiveness due to the maintenance and replacement costs required that is independent of load. In areas that have seen a large transition of their load being supplied by 13kV stations and where the 4kV stations' equipment is approaching end of life, it may be financially advantageous to convert the existing customers to a 13kV supply while decommissioning the 4kV station.

Hydro Ottawa does not have a formal plan to phase out the 4kV system, but considers voltage conversion when evaluating station renewal options. Voltage conversion is favored over station renewal in cases where the cost to renew station assets exceeds the cost of upgrading the distribution assets to meet 13kV design requirements.

As assets in 4kV stations reach end of life and are identified for renewal, voltage conversion is evaluated on a case-by-case approach as a potential renewal option alongside full station asset replacement.

The forecasted 20-year load growth, along with planned station projects, is shown in Figure 7.9.

**Figure 7.9 – East 4kV Supply Region**



### 7.2.2. 8kV System

Hydro Ottawa 8kV supply system is comprised of five main areas:

1) Nepean Core 8kV System
2) West Nepean 8kV System
3) West 8kV System
4) Casselman 8kV System
5) East 8kV System

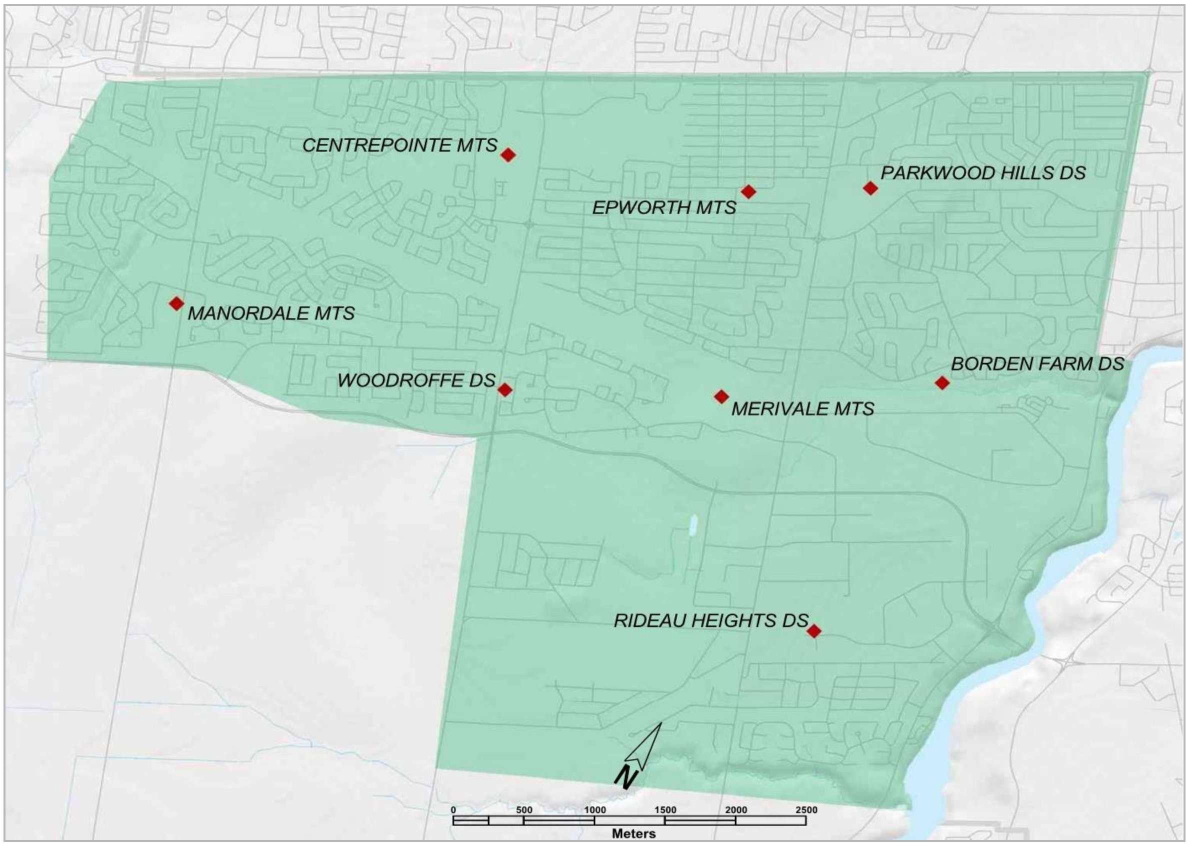
Seven out of the 24 8kV stations are supplied by the 115kV transmission system, one 8kV station is supplied by both 44kV and 115kV supplies, and the remaining 16 are supplied from three 44kV stations.

#### *7.2.2.1. Nepean Core 8kV System*

The Nepean Core 8kV supply region includes the northern portions of Nepean. This region is supplied by the Manordale MTS, Centrepointe MTS, Woodroffe DS, Epworth MTS, Merivale MTS, Parkwood Hills DS, Borden Farms DS, and Rideau Heights DS. Figure 7.10 below shows the supply region of the Nepean Core 8kV System.

Growth in the 8kV Nepean supply region is driven by ongoing commercial developments, which are focused in the Nepean Employment Area (located around Hunt Club Road between Merivale Road and Prince of Wales Drive).

**Figure 7.10 – Nepean Core 8kV Supply Region**



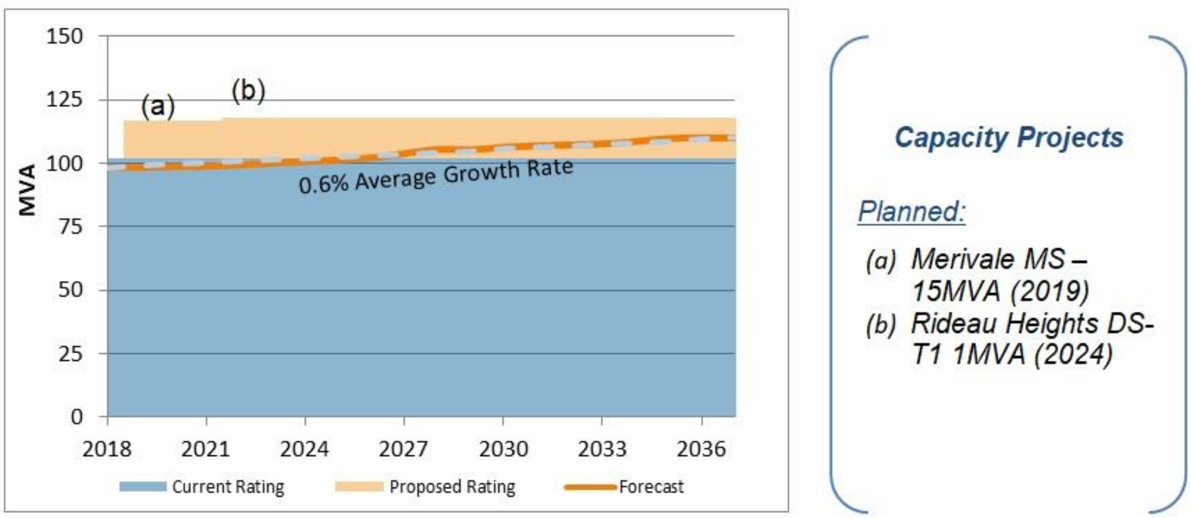

Overall, the existing 8kV Nepean area is operating at the planning capacity limitations with Centrepointe MTS, Merivale MTS, Manordale DS, and Rideau Heights DS operating above their planning capacity rating as shown in Table 7.1 above. The area of main concern is the Nepean employment area in which the trunk feeders are above or approaching their planning capacity limitations and the existing feeder interconnections are limited. Two feeders from Rideau Heights DS and one feeder from Parkwood Hills DS are on the list of feeders exceeding their planning capacity, as shown in Table 7.2 above.

Over the next 20 years, significant growth is expected for the employment area in the Nepean region. The transformers at Borden Farm DS were replaced recently adding 8MVA of additional capacity in this area. The Merivale station is undergoing a major rebuild which will bring 15MVA of additional capacity to this region by 2019. After completion of the Merivale project, the transformers at Rideau Heights will need to be upgraded due to end of life condition adding an additional 1MVA of capacity for future growth.

The additional capacity from Borden Farm DS and Merivale MTS will introduce four new feeders to the area. Plans are in place to reconfigure the feeders in the Merivale employment area to improve feeder load distribution once Merivale MTS is energized.

The forecasted 20-year load growth along with planned capacity upgrade projects is shown in Figure 7.11.

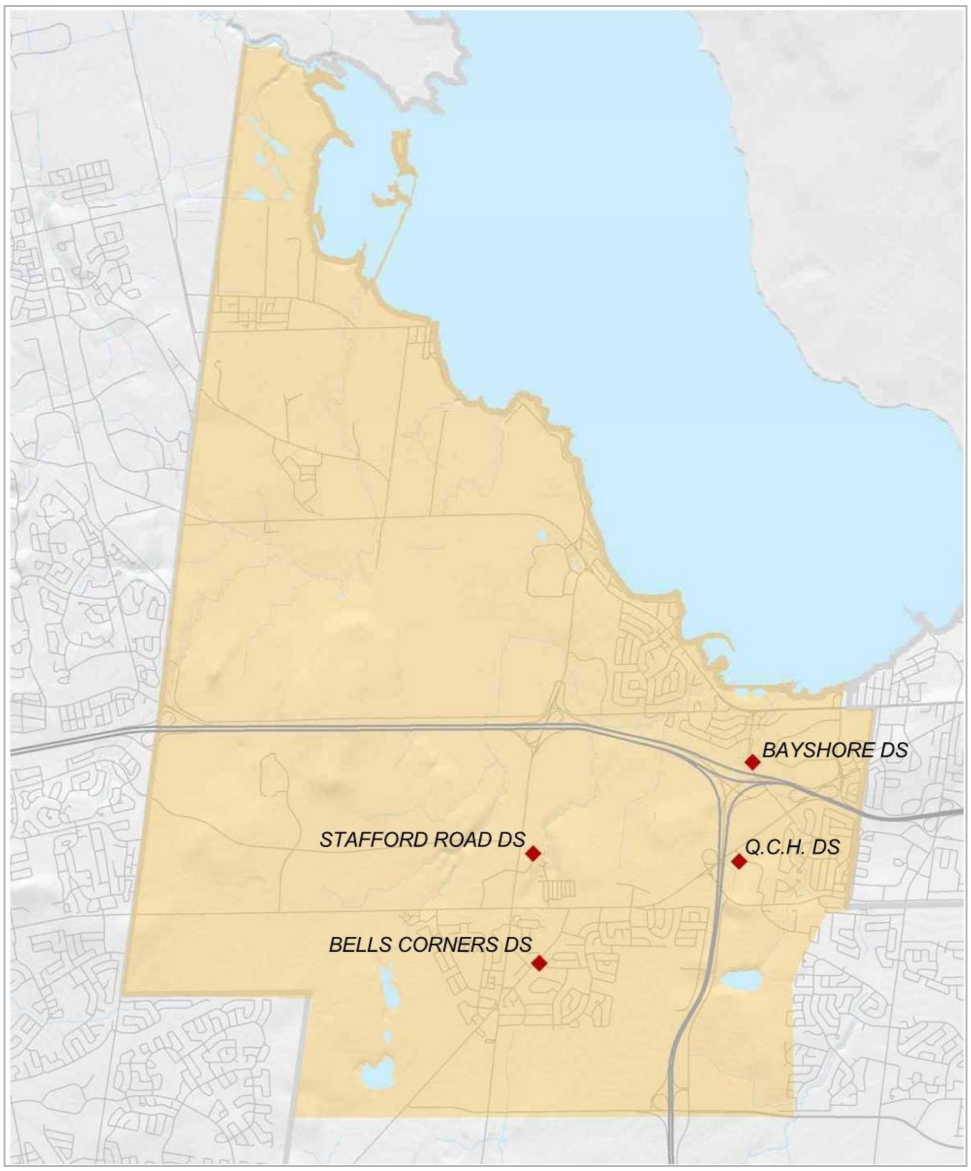
**Figure 7.11 – Core Nepean 8kV Load Growth**



### 7.2.2.2. West Nepean 8kV System

The West Nepean 8kV supply region includes the north-west portions of Nepean. This region is supplied by the Bayshore DS, QCH DS, Stafford Road DS, and Bells Corners DS. Figure 7.12 shows the supply region of the West Nepean 8kV System.

**Figure 7.12 – West Nepean 8kV Supply Region**



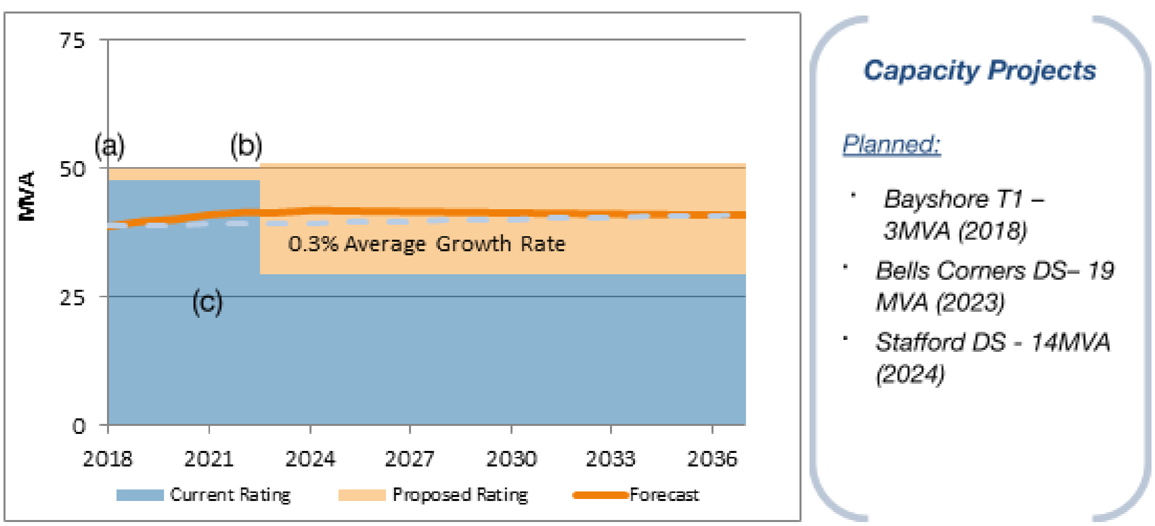
Load in this supply region is expected to remain stable as per historical years since no major projects have been identified or proposed by developers at this time.

Overall, the existing 8kV West Nepean area is operating below the planning capacity limitations; however, Bayshore DS and Stafford DS are operating above their planning capacity rating as shown in Table 7.1 above.

One of the transformers at Bayshore DS was replaced at the end of 2018 increasing the planning capacity rating for this region. The station assets at Bells Corners DS and Stafford DS are approaching end of life and are in need of replacement. The Bells Corners station is planned to be upgraded with three transformers (3x15MVA) facilitating the decommissioning of the nearby station, Stafford DS, by 2024.

The forecasted 20-year load growth, along with planned capacity upgrade projects, is shown in Figure 7.13.

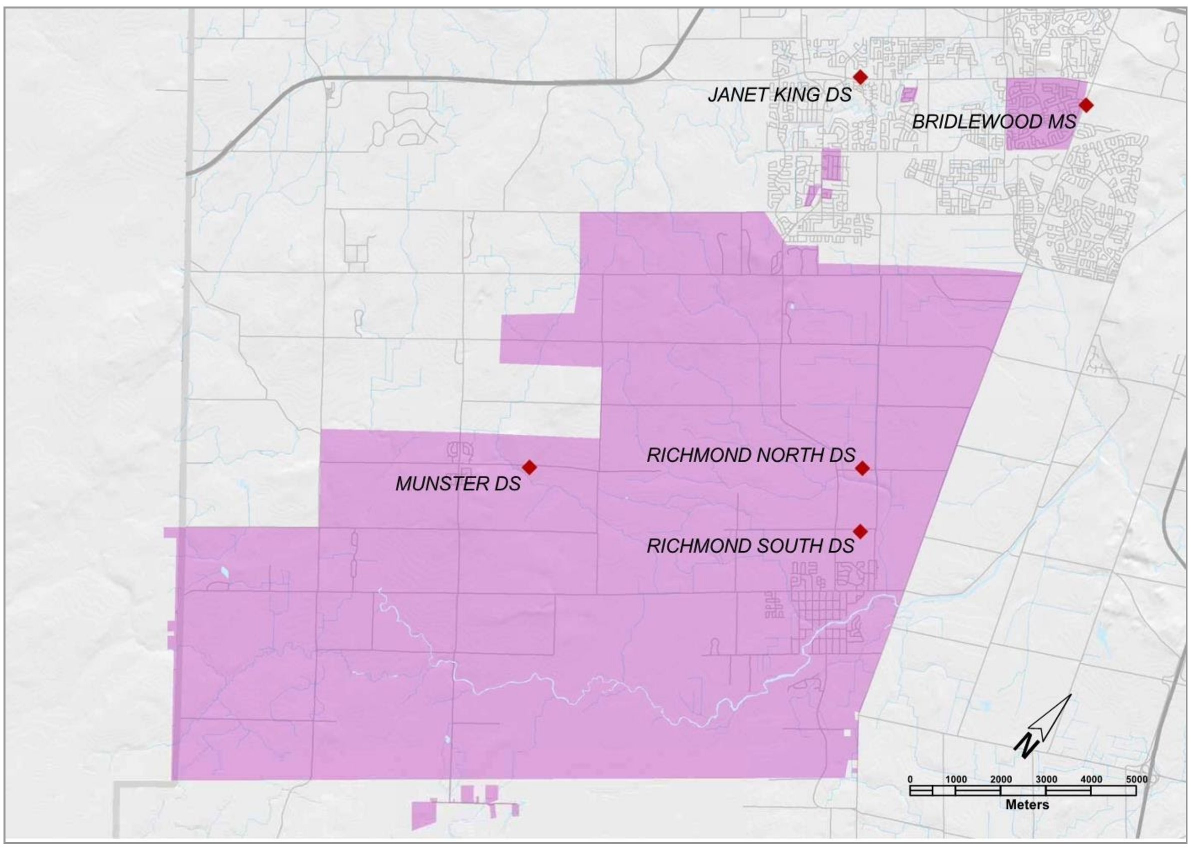
**Figure 7.13 – West Nepean 8kV Load Growth**



#### *7.2.2.3. West 8kV System*

The West 8kV supply region includes the Glen Cairn community, small areas of Stittsville, Richmond Village, Munster and rural Goulbourn. These areas are supplied by Bridlewood DS in Kanata, Janet King DS in Stittsville, Richmond North DS and Richmond South MTS in Richmond Village, and Goulbourn, and Munster DS in Munster. Figure 7.14 shows the supply region of the West 8kV System.

**Figure 7.14 – West 8kV Supply Region**

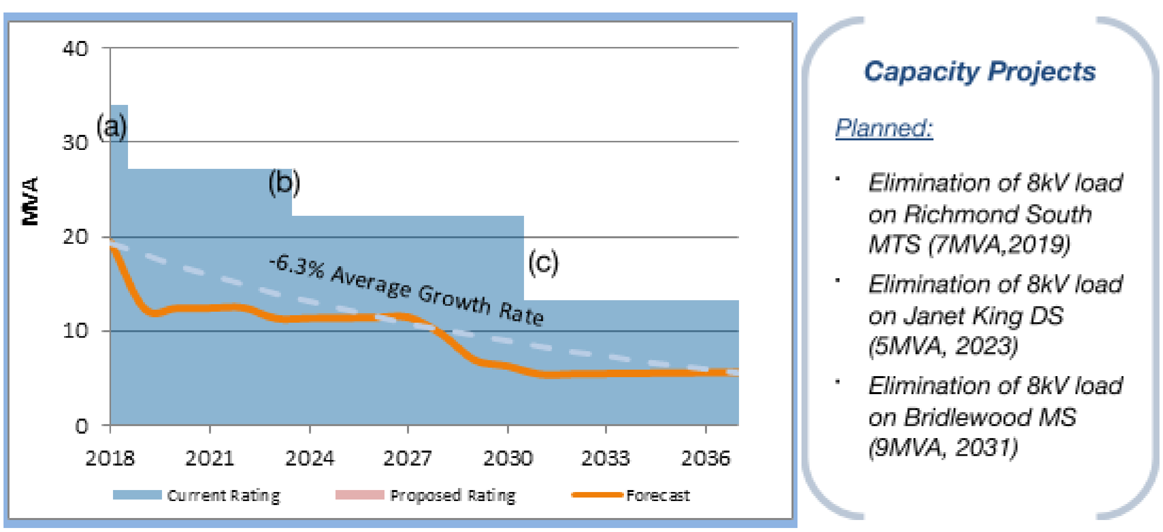



Growth in these areas is limited, due to the rural nature of the supply region. The exception is Richmond Village which required the conversion of Richmond South MTS to 28kV due to planned expansion and growth. The station rebuild is scheduled for completion by late 2019. The main streets of Richmond village are in the process of being converted, with several overhead line upgrades implemented in 2017 to 2019 along main roads. Conversions of minor roads and side streets will continue to be supplied at 8kV, through step-down transformers at the rebuilt Richmond South MTS. New developments will be connected onto the 28kV system. Therefore, the drivers for conversion of the remaining 8kV areas of Richmond Village will be based on asset condition and risks to reliability.

Overall, the existing west 8kV area is spread out over a large geographical area, with few backup feeder options between stations, apart from Richmond North and Richmond South. With the conversion of Richmond South, and the eventual elimination of 8kV load in Stittsville and Glen Cairn, the remaining 8kV region will center on Goulbourn, specifically Munster DS. Contingencies will need to be developed between the two remaining 8kV stations, Munster DS and Richmond North DS. No ties currently exist between these stations, and long-term plans have been put in place to construct ties to facilitate maintenance and outage restoration.

The forecasted 20-year load growth, along with planned capacity upgrade projects, is shown below in Figure 7.15.

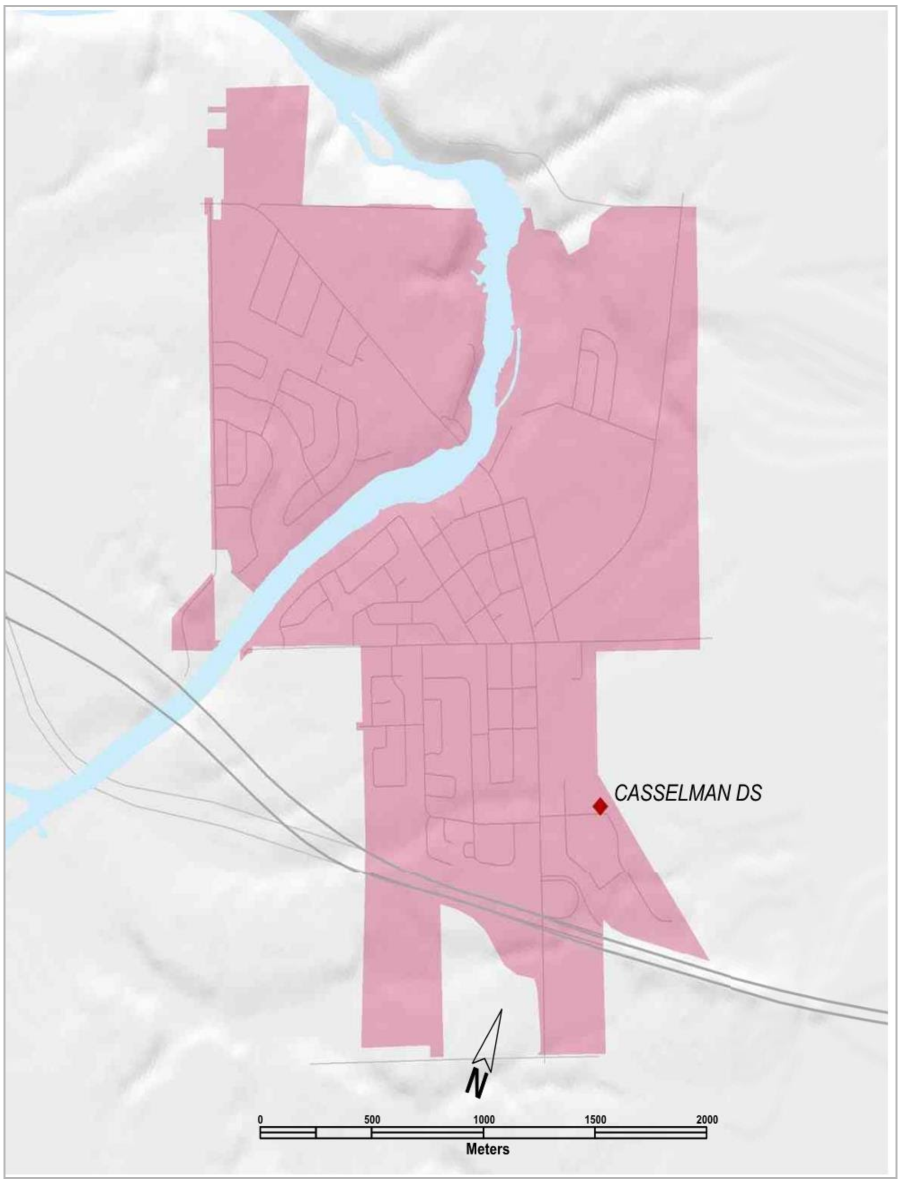
**Figure 7.15 – West 8kV Load Growth**



#### *7.2.2.4. Casselman 8kV System*

The Village of Casselman is supplied from a single Hydro Ottawa station, Casselman DS, and three 8kV feeders. Figure 7.16 shows the Casselman supply area.

**Figure 7.16 – Casselman 8kV Supply Region**

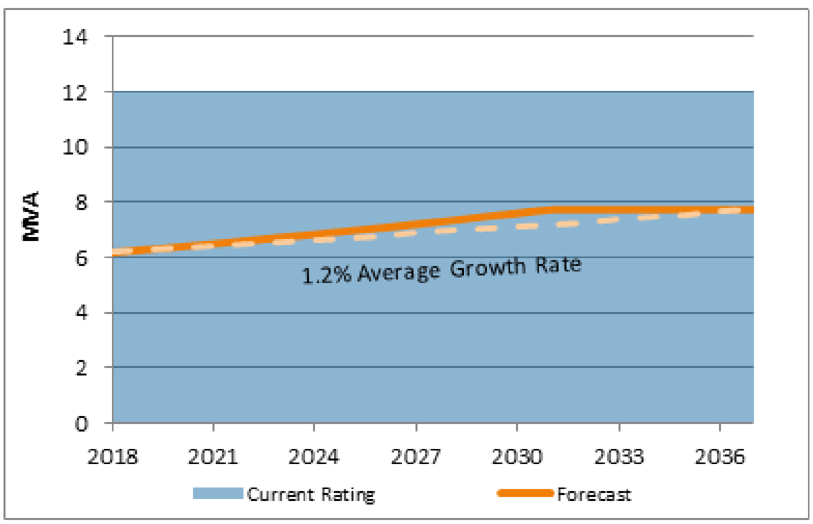


In 2014, a second transformer was installed to provide redundancy for contingency situations and improve reliability to the area. In 2020, a fourth feeder will be added at the station to enable full restoration in an N-1 station bus fault scenario. The additional feeder will improve station reliability.

Growth within the Village of Casselman has been slow and there are no major developments anticipated in the region over the next 20-year forecast period.

The forecasted 20-year load growth is shown in Figure 7.17.

**Figure 7.17 – Casselman 8kV Load Growth**




***Capacity Projects***

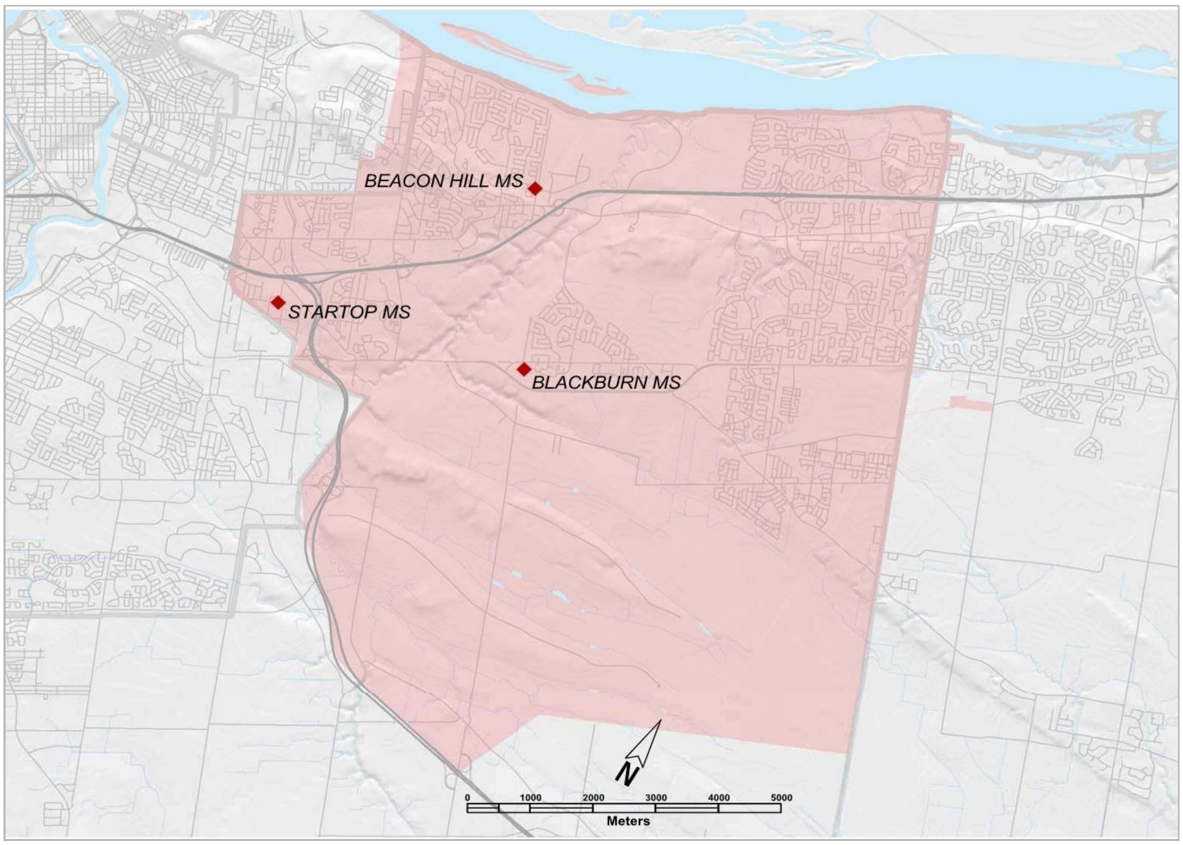
*Planned:*

*none*

### *7.2.2.5. East 8kV System*

The East 8kV supply region is bounded by the old Gloucester and Ottawa municipal boundary and Highway 417 in the south as shown in Figure 7.18. Startop DS, Blackburn DS, and Beaconhill DS supplied this region. These stations are supplied from Hawthorne TS.

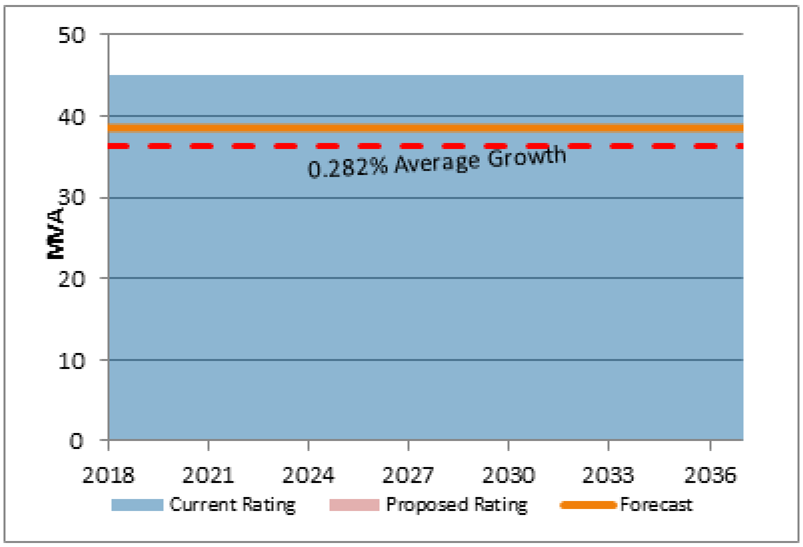
**Figure 7.18 – East 8kV Supply Region**




The East 8kV area is composed of established developments and services mostly residential and small commercial developments. Over the last 10 years, load on the East 8kV system has remained constant. There is no major growth anticipated on this system since large transit oriented developments will be connecting to the East 28kV system to meet their capacity requirements. One feeder from Startop DS is operating slightly above its planning capacity rating as shown on Table 7.2 above. Since there are available options for transferring load and there is no forecasted growth for this region, no plans have been put in place to lower loading levels at this Startop feeder at this point.

The forecasted 20-year load growth is shown in Figure 7.19.

**Figure 7.19 – East 8kV Load Forecast**




***Capacity Projects***

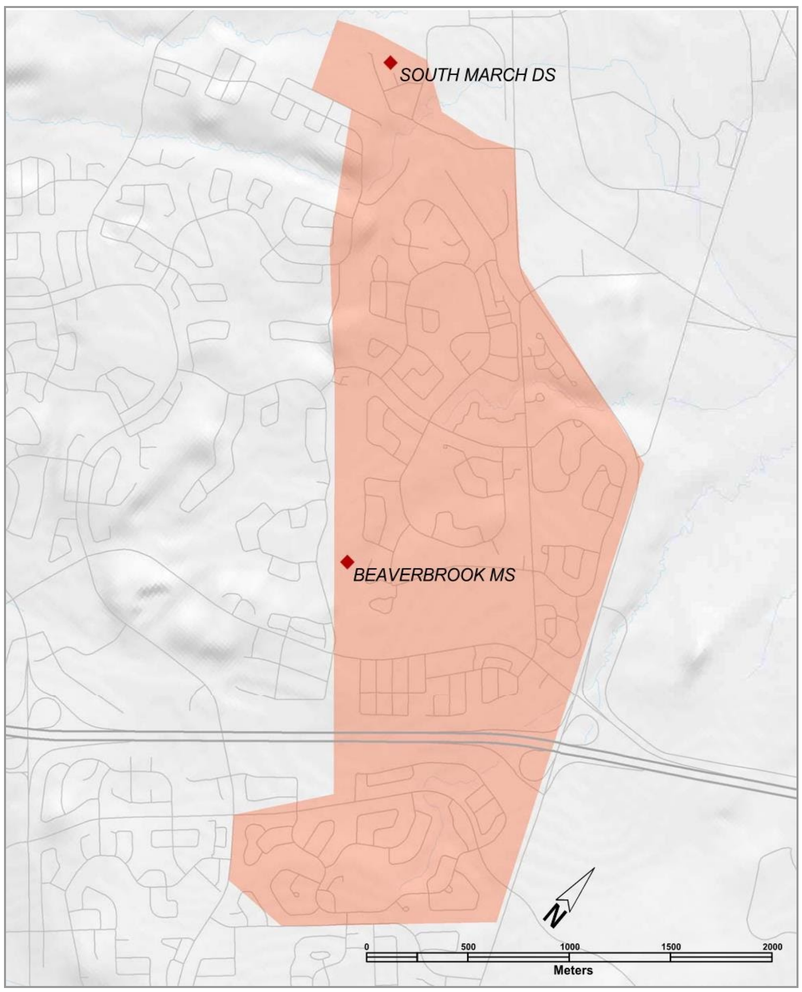
*Planned:*

*None Anticipated*

### 7.2.3. 12 kV System

The West 12kV supply region includes two areas of Kanata, immediately North and South of Highway 417 at Eagleson Road. The communities are supplied by Beaverbrook MS and South March DS, with no distribution capabilities beyond these stations. Figure 7.20 shows the supply region of the West 12kV System.

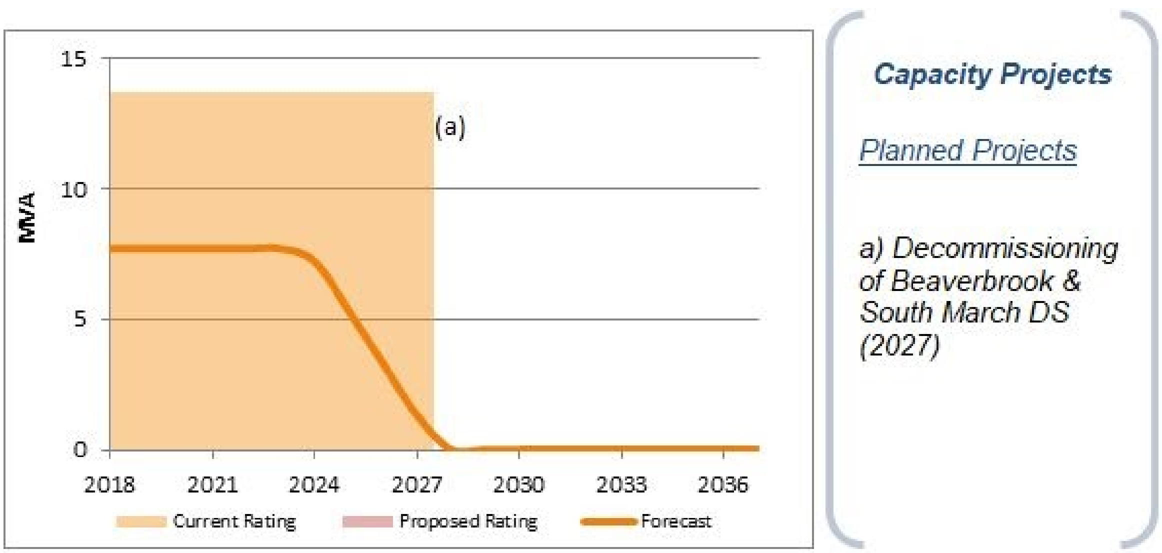
**Figure 7.20 – West 12kV Supply**




The 12kV supply area is mostly residential with a mixture of small to medium commercial, and has experienced very low to no growth over the past several years. There is no significant load growth forecast for the 12kV system, therefore no additional station capacity is required. The area is planned to be converted to 28kV beginning in 2021. Conversion work will last several years due to large areas of end of life cable that require replacement under the cable renewal program. The decommissioning of Beaverbrook and South March stations is tentatively planned for 2027 and needs to be coordinated with the construction of the New Kanata Station due to existing capacity limitations in the 28kV system. In the short-term, strategic locations will be converted to 28kV but energized at 12kV to improve reliability in the 12kV supply area for the next eight years until the stations are decommissioned.

The forecasted 20-year load growth, along with planned capacity upgrade projects, are shown below in Figure 7.21.

**Figure 7.21 – West 12kV Load Forecast**

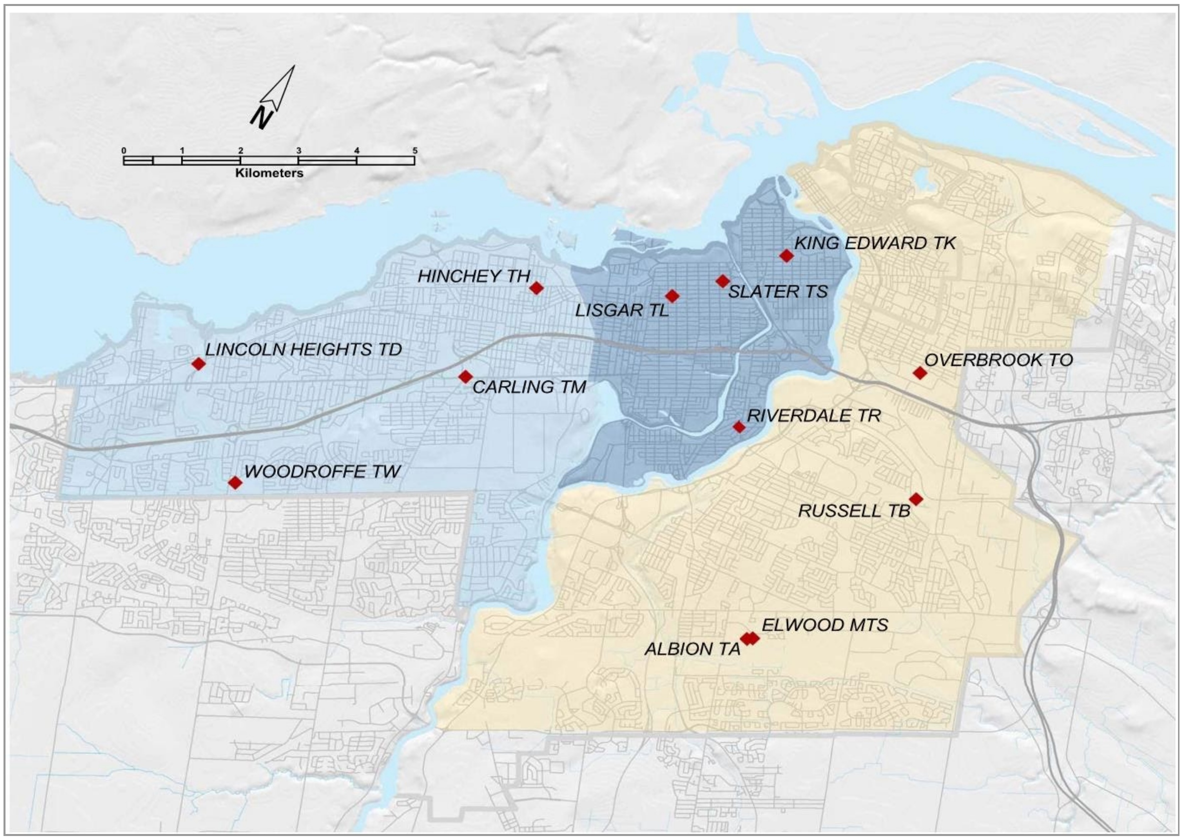


### 7.2.4. 13kV System

The Hydro Ottawa 13kV supply region is composed of three main areas, as shown in Figure 7.22. These zones correspond to the 4kV system mentioned in section 7.2.1 above. The three areas are as follows:

1. The West 13kV supply region covers from Bayview Yards and west of Preston Street to Bayshore Drive, north of Baseline Road. This region is supplied by Hinchey TS, Carling TS, Woodroffe TS, and Lincoln Heights TS. Hinchey TS also supports the Core 13kV supply region.
2. The Core 13kV area follows the Rideau River to the East and covers to LeBreton Flats in the West. This region is supplied by King Edward TS, Slater TS, Lisgar TS, Hinchey TS, and Riverdale TS. Riverdale TS and King Edward TS also support the East 13kV supply region.
3. The East 13kV supply region includes the eastern portion of the Old City of Ottawa. This region is supplied by the Russell TS, Albion TS, Ellwood MTS, Overbrook TS, Riverdale TS, and King Edward TS.

**Figure 7.22 – 13kV Supply**




Much of the residential load in these regions is not directly supplied from the 13kV system, but rather from the thirty-five 4kV stations, which are supplied from the 13kV system.

Through the Official Plan, the City of Ottawa is promoting new growth by means of intensification within central Ottawa. This impacts the 13kV system as it covers mostly established areas. Many new developments are trading in low-rise apartments for larger, high density residential buildings.

The majority of the load growth on the 13kV system is from City driven Community Design Plans, Ottawa LRT, Transit Oriented Development, and new large development plans such as Tunney's Pasture, LeBreton Flats, Greystone Village, Wateridge Village, and Zibi.

In the short-term, there is a requirement for capacity upgrades and the construction of station interconnections to transfer load in order to manage the load within the 13kV system. System expansions will also be required due to system demand. As shown in Table 7.2, there are seven 13kV feeders above their planning capacity ratings: TB2JP, ELW11, 2206, 630, 509, TR2FB, and TW18. Feeder capacity upgrades are in place under the Distribution Capacity Upgrades Program to address the most critical feeders. Feeders with minor overloads and minimal forecasted growth will continue to be monitored for future upgrades.

**Riverdale TS Switchgear Capacity Upgrade**

Riverdale TS transformation capacity exceeds the load forecast at this time; however, the overall station rating is limited due to a lack of unused or unloaded breakers in the secondary lineup. The switchgear is planned to be replaced by 2024 and will include an additional six feeder breakers. The bus's ampacity will also be increased to prevent future limiting factors in case of transformer capacity upgrades.

**Slater TS Transformer Upgrade**

Slater TS station's T1 transformer failed in early 2018, and was subsequently replaced by HONI with a larger unit (100MVA) for future forecast growth and contingency requirements for load transfers within the Core 13kV region**.** The remaining transformers are also approaching end of life, and will be sized to match the capacity of the new T1 unit.

**King Edward TS Transformer Upgrade**

The two transformers at King Edward TS are currently mismatched in capacity, limiting the overall available capacity. This project would see the replacement of the undersized transformer increasing the available LTR of the station transformers from 80MVA to 136MVA; however, the planning rating will be limited to 114MVA due to the switchgear. The increased capacity will relieve Slater TS and support supply of the load growth resulting from the Ottawa LRT project. HONI is currently undertaking the installation of a new transmission line to relieve a thermal overloading issue which is required to increase the load on King Edward TS. The planned in-service date of the King Edward upgrade project is 2020.

The existing East 13kV system is forecasted to be operating above the N-1 rating of its supplying stations due to load growth in the near-term.

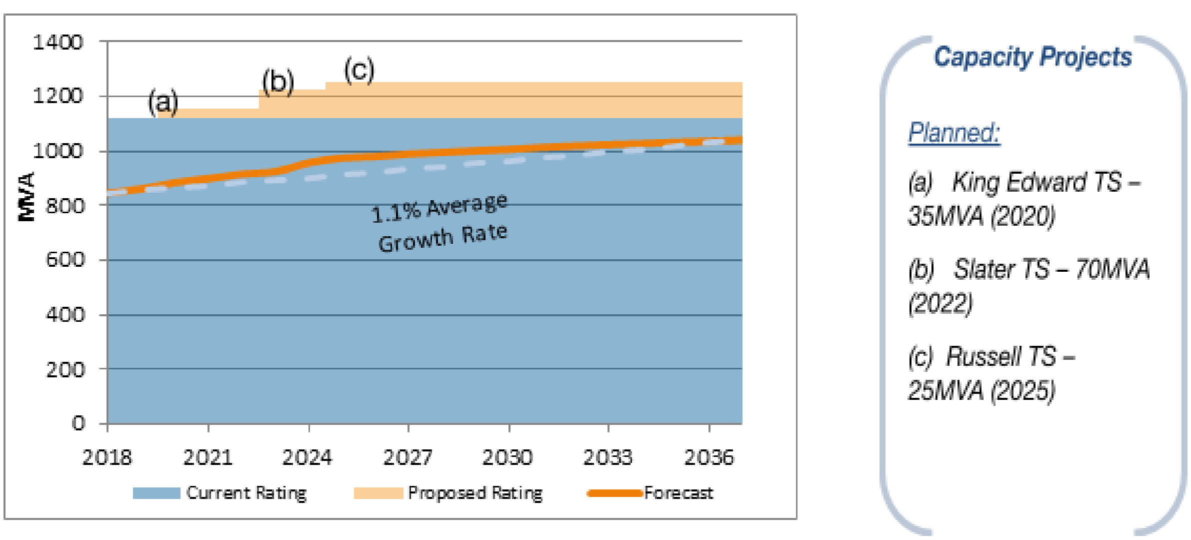
**Russell TS Upgrade**

The planning capacity at Russell TS is currently 77 MVA. The loading has currently reached the station's capacity planning limit and is forecasted to exceed the planning limit in 2019 with the addition of the Ottawa LRT and transit oriented developments. The forecast is expected to approach 100 MVA in 2025. Additional distribution ties will be created to transfer excess load from Russell TS to neighboring stations with spare transformer capacity such as Ellwood MTS, Albion TS, and Overbrook TS.

Load in all areas will continue to be monitored and forecasted to ensure adequate supply to Ottawa's 13kV system.

The forecasted 20-year load growth, along with planned capacity upgrade projects, is shown below in Figure 7.23.

**Figure 7.23 – 13kV Load Forecast**



### 7.2.5. 28kV System

Hydro Ottawa 28kV supply system is comprised of four main areas:

1) South 28kV System
2) South-East 28kV System
3) East 28kV System
4) West 28kV System

#### *7.2.5.1. South 28kV*

The South 28kV supply region covers the areas of Nepean south of the Greenbelt. It is supplied by Fallowfield MTS and Longfields DS and two feeders from Limebank MTS. Despite the physical barrier of the river between Nepean and Gloucester, Limebank station plays an essential role in supplying both sides of the river, making it one integrated supply region.

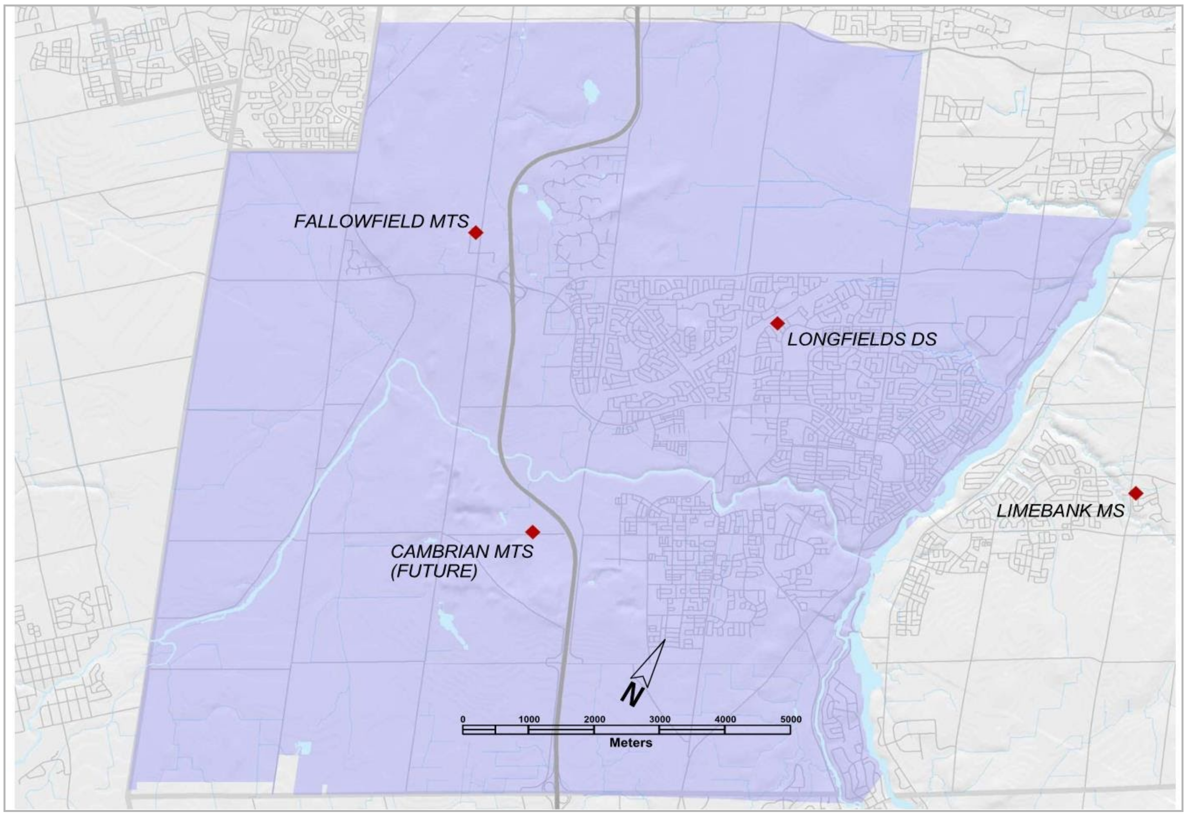
The 2016 IRRP identified the need for an additional station in the South Nepean Region. In May 2016, the IESO provided a letter of recommendation to build a new station to meet the growing electricity demand in the area. The original concept for the station called for a supply from the 230kV transmission system in the area, which would be located within the existing 115kV transmission corridor. In consultation with HONI, it was determined that remaining in the corridor is not feasible due to physical barriers to construction and transmission routing introduced by the Trail Road landfill. Alternative routes and station locations were explored once the limitations of the existing corridor were known, resulting in the proposed site on Cambrian Road, with a 1.5 km transmission extension in a new right-of-way corridor.

This project was approved by the OEB in October 2019. Hydro Ottawa and HONI had submitted a joint Leave to Construct application in May 2019, seeking OEB approval for the station and line scope of work, respectively.[1]

[1] Ontario Energy Board, *Decision and Order*, EB-2019-0077 (October 17, 2019).

Figure 7.24 shows the existing stations in the area as well as the selected location for the new station.

**Figure 7.24 – South 28kV Supply Region**



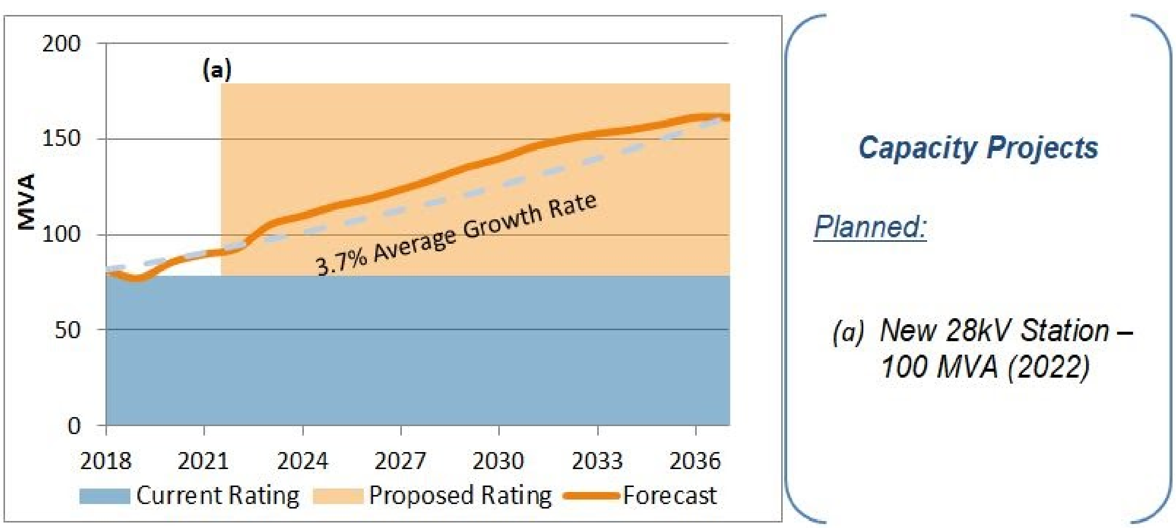

Over the last 10 years, load in the South Nepean region has almost doubled at an average growth rate of 7.6%. Growth in the south supply region is driven by the ongoing expansion of suburban residential developments, the Nepean Town Centre and the Strandherd Business Park. In addition, rural areas south of the Jock River which are currently fed by the 8KV system will be transferred to the 28kV system as 28kV feeders are introduced in the area to supply new suburban developments.

There is a need to expand the system to cover areas seeing growth, as well as strengthen the interconnections to the south of the Jock River. These issues will be addressed by the introduction of a new station that will support the growth in the Fallowfield MTS supply area. Capacity is the main issue affecting restoration and load transfers, as feeders and transformers are at or exceeding planning ratings. As shown in Table 7.1 above, Fallowfield MTS and Longfields DS are currently above their planning capacity ratings. At the feeder level, one feeder from Fallowfield MTS and one feeder from Limebank that supplies the South 28kV region are operating above their planning rating. These issues will also be addressed with the introduction of the new station in this region.

The new station is planned to be built with 2 X 75 MVA (10 day LTR of 100MVA) transformers with a planned energization date of 2022. In addition, investment at the distribution level will be required with the introduction of the new station to bring three of the new feeders across Highway 416 to the east as well as three other feeders west of the station.

The forecasted 20-year load growth, along with planned capacity upgrade projects, is shown in Figure 7.25.

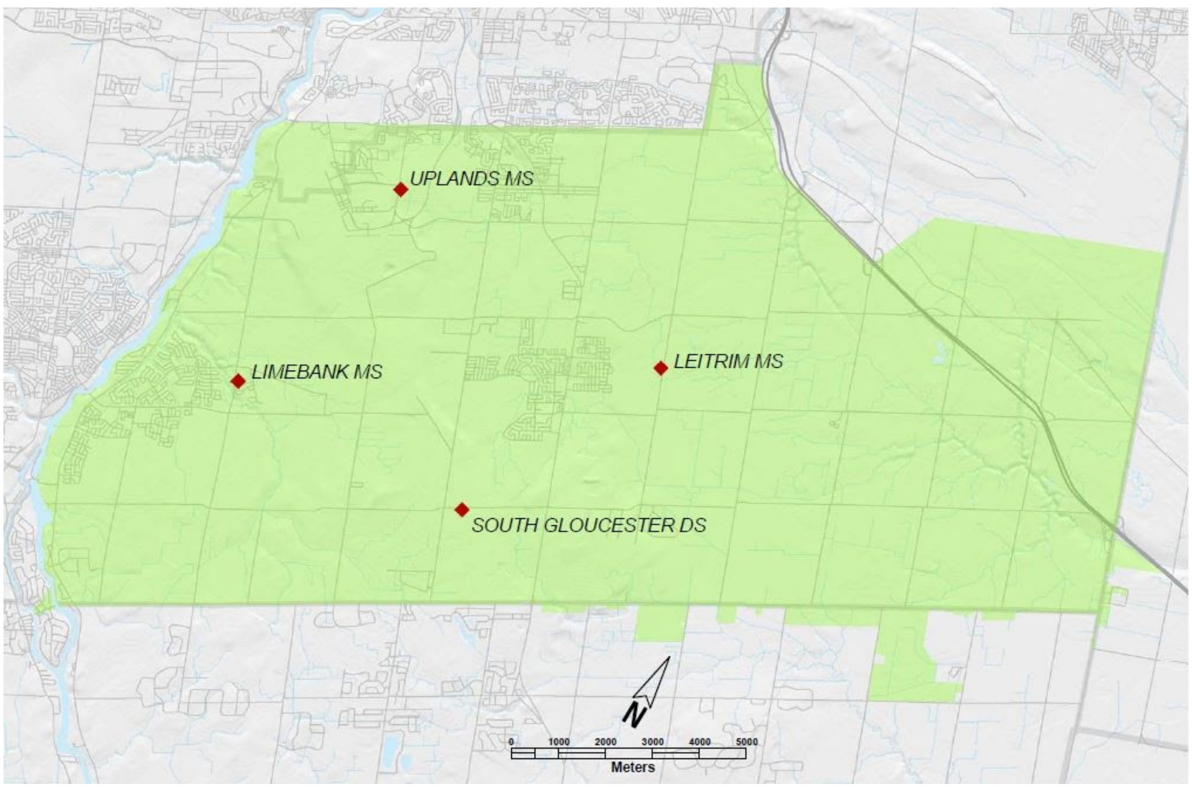
**Figure 7.25 – South 28kV Load Forecast**



### 7.2.5.2. South-East 28kV System

The South-East 28kV supply region includes the southern portions of Gloucester. This region is supplied by Limebank MTS, Uplands MTS, and Leitrim DS, as well as a small pocket supplied by an 8kV feeder from the HONI owned South Gloucester station as shown in Figure 7.26. Despite the physical barrier of the river between Nepean and Gloucester, Limebank station plays an essential role in supplying both sides of the river, creating interdependence between the South 28kV and the South East 28kV systems.

**Figure 7.26 – South East 28kV Supply Region**




Over the past 10 years, demand in the South Gloucester region has been continuously increasing at an average rate of 2.6% per year. Historically, the growth was attributed to the expansion of residential developments in the Riverside South and Leitrim communities.

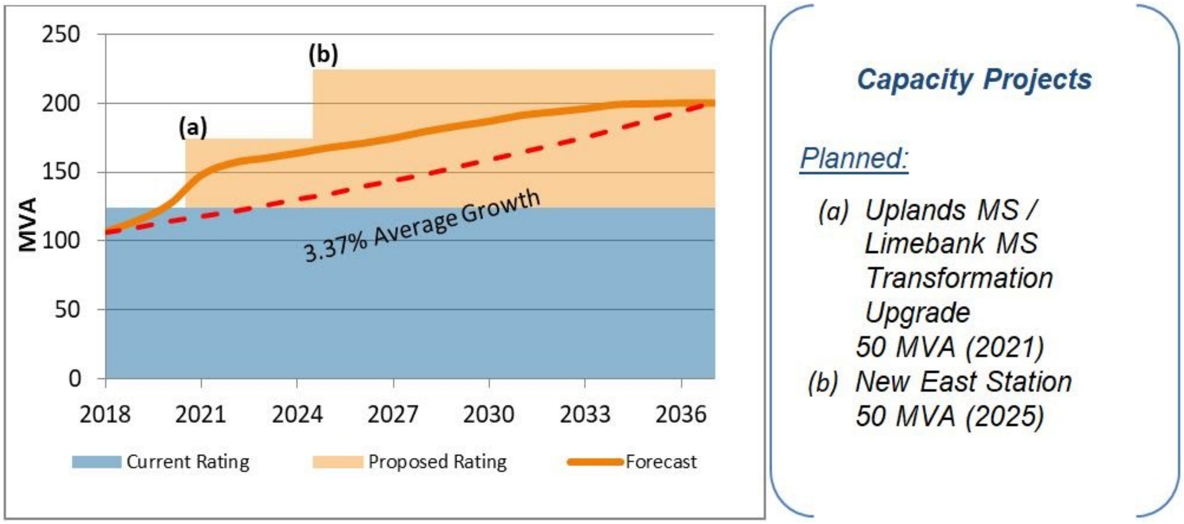
Currently, this region is operating slightly below planning capacity rating; however, Leitrim DS and one feeder from Uplands MTS are operating above its planning capacity ratings. Going forward, the growth rate is expected to increase to an average of 3.4% per year. The increased growth rate is mainly due to the Trillium Line extension of Ottawa LRT, large commercial and light industrial customers. The availability of transit by train is sparking high density residential developments and future business parks in the region. In addition, a new Amazon shipping facility located in the Leitrim supply region will drive future growth in the area due to employment opportunities. Lastly, the South Gloucester region is expected to see an increase in industrial plants in addition to its existing quarries and asphalt plants (i.e. Hawthorne Industrial Park).

Load in the region is forecasted to surpass the region's planning capacity by 2020. Transformation upgrades are currently underway at Uplands MTS and Limebank MTS resulting in a 50 MVA planning limit increase scheduled for 2021. Although, this upgrade may be sufficient to relieve capacity restraints in the western end of the South Gloucester region, the eastern area is currently supplied by a single station, Leitrim DS. Leitrim station is limited by the thermal limitation of the single 44kV supply cable. As such, capacity cannot be increased at the station without adding both redundancy and capacity on the station's supply.

A new station along the 230kV transmission corridor would allow Hydro Ottawa to accommodate the large growth forecasted in the area while maintaining an acceptable level of reliability. Solutions to address the capacity needs in this region are being discussed in the ongoing IRRP. Assessments to date indicate that it is feasible to connect the new station to the existing 230kV transmission line and that non-wire solutions would not be economically feasible to mitigate the capacity needs in this region. Thus, the investment required for building a new station has been included in Hydro Ottawa's capital expenditure plan for 2021-2025 with a planned energization date of 2025.

The forecasted 20-year load growth, along with planned capacity upgrade projects, is shown in Figure 7.27 below.

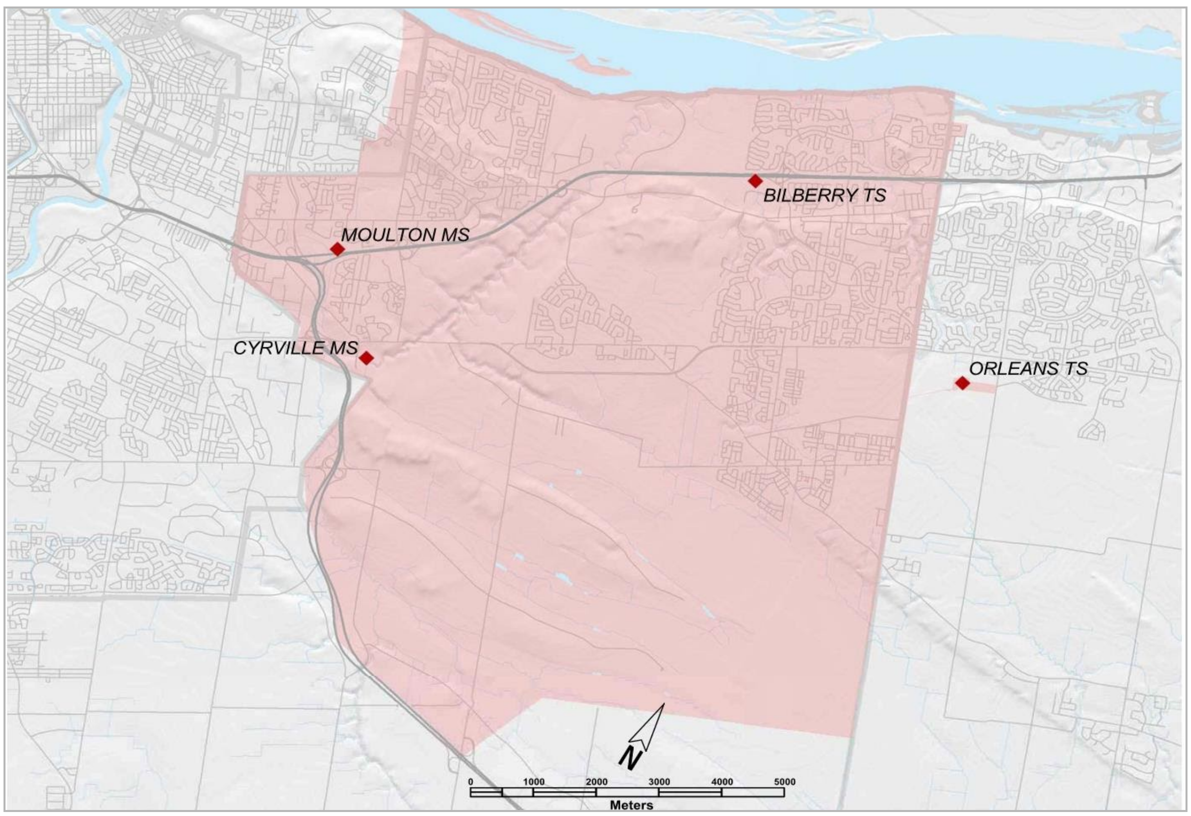
### Figure 7.27 – South East 28kV Load Forecast



#### *7.2.5.3. East 28kV System*

The East 28kV supply is bounded by the old Gloucester and Ottawa municipal boundary and Highway 417 in the south. Supply to the region includes transmission connected 28kV stations Cyrville MTS, Bilberry TS, Orleans TS, and Moulton MTS, as well as 44kV sub transmission supplied 8kV stations Startop DS, Blackburn DS, and Beaconhill DS. Hydro Ottawa owns a single 28kV circuit for HONI's Orleans TS station.

**Figure 7.28 – East 28kV Supply Region**



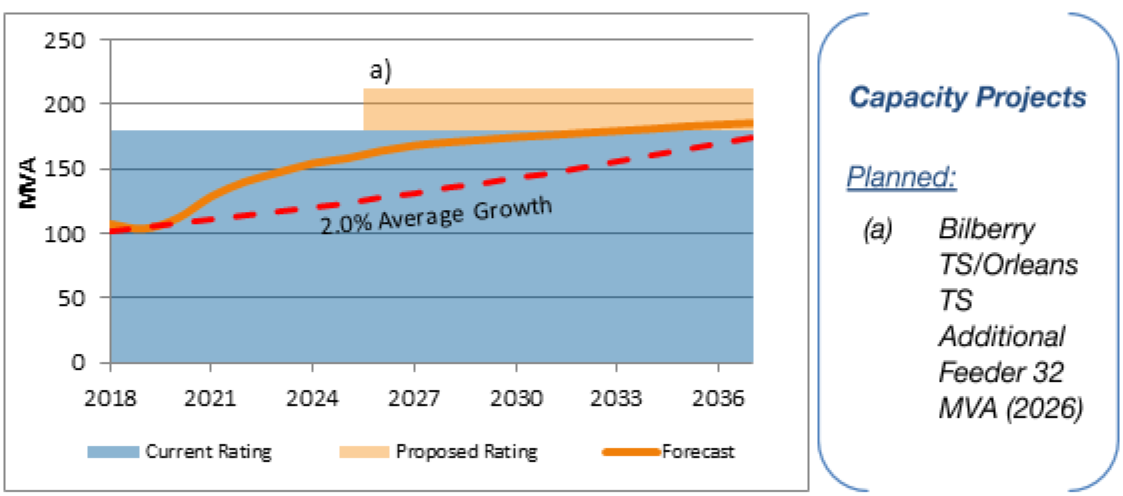

Over the last 10 years, load in the Gloucester and Orleans regions has remained constant. The rate of growth is expected to increase to an average of 2% per year. Growth in this supply region is driven by the ongoing expansion of the East Urban mixed-use community, including the Orleans business park and transit oriented development driven by the introduction of Ottawa

LRT along Highway 174. The existing growth is not expected to exceed the regions planning capacity limit in the region over the forecasted period.

Bilberry TS is a HONI-owned station that supplies Hydro Ottawa's customers and serves as an emergency backup supply to HONI customers currently supplied by Orleans TS. Bilberry TS was built in 1964 and is approaching end-of-life around 2023. Through the ongoing IRRP process, the decommissioning of Bilberry TS, load transfer to Orleans TS, and resulting benefits to the transmission system are being evaluated. Based on completed IRRP assessments for the Bilberry need, it is expected that the working group will recommend the refurbishment of HONI's Bilberry station. Plans for two additional station breakers from Bilberry DS are included under the Distribution Capacity Program for the next rate period. The additional breakers will address growth within the East Urban Community by increasing capacity and addressing reliability concerns on Bilberry feeders by reducing the number of customers per feeder.

The forecasted 20-year load growth along with planned capacity upgrade projects is shown in Figure 7.29.

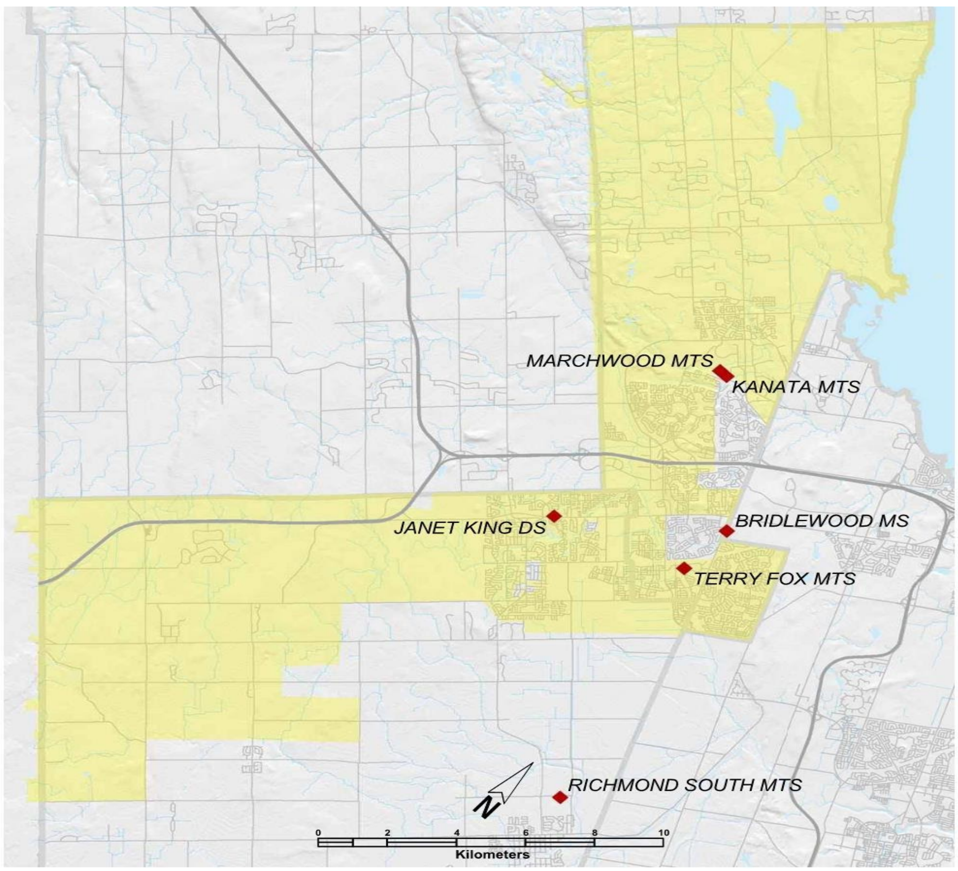
**Figure 7.29 – East 28kV Load Forecast**



#### *7.2.5.4 West 28kV System*

The West 28kV supply region includes the majority of both Kanata North and South, most of the township of Stittsville, and the western region of Goulbourn. These areas are supplied by Kanata MTS and Marchwood MTS in Kanata North (both located at the Station Road site), Bridlewood MTS and Terry Fox MTS in Kanata South, Janet King DS in Stittsville, and the BECKF2 feeder supplied from HONI's Beckwith Station in Goulbourn. When completed, the upgraded Richmond South MTS will also supply the Goulbourn area at 28kV.

**Figure 7.30 – West 28kV Supply Region**




Currently, this supply region is operating slightly below capacity planning ratings. However, Marchwood MTS and Kanata MTS are operating above their capacity planning rating as well as three feeders from Kanata MTS and one from Marchwood MTS, as shown in Table 7.1 and Table 7.2 above.

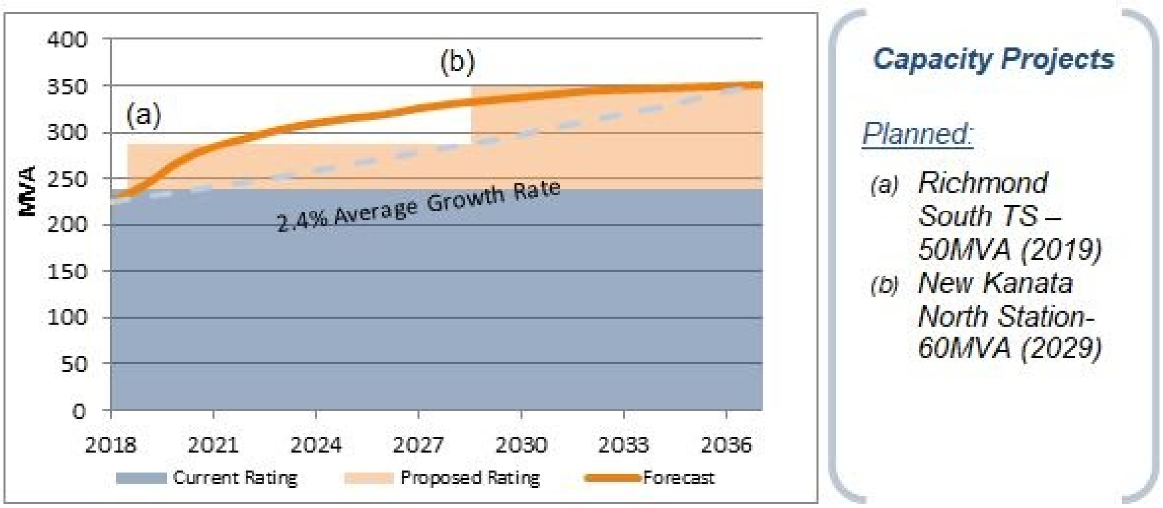
Growth in the West 28kV region is driven by the ongoing expansion of suburban residential developments in the Fernbank and Kanata North areas as well as associated mixed use centres. Additional ties between the primary 28kV area in Kanata and outlying areas, such as Stittsville and Richmond Village, will be required to ensure reliability of supply is maintained. Future medium and long-term planned voltage conversions in Richmond, Glen Cairn, and Beaverbrook will result in large load transfers to the 28kV system. The final result of these conversions will be a consolidation of the Kanata area to 28kV supply, with the 12kV supply area eliminated and 8kV limited to central Goulbourn.

The upcoming voltage conversion of Richmond Village will be supplied by an upgrade of the Richmond South MTS with a 50MVA, 115/28kV transformer, and 2 x 3MVA underground 28kV/8kV step-down transformers. The 8kV system supplied from the step-down transformers allows for conversion of the remaining 8kV system to be planned based on asset condition. The station is planned to be completed in 2019.

Additional capacity is required to supply expected load growth from the Kanata North CDP and offset intensification in the Kanata North high tech area. The solutions to address the capacity needs in Kanata North are being investigated as part of the ongoing IRRP including non-wire solutions, additional transformer capacity and distribution transfers in the area. To date, it has been determined that a new station is required to address the capacity requirements by the end of the study period. The IESO is conducting a parallel network assessment of the 230kV system in western Ottawa to be completed in 2020. Results from that assessment will affect the connection requirements for the new Kanata North station. Thus, short-term solutions have been put in place to address immediate capacity and reliability needs including load transfers to adjacent stations, distribution line extensions, voltage reduction projects in long rural feeders and area-specific CDM demand reduction programs.

The forecasted 20-year load growth, along with planned capacity upgrade projects, are shown in Figure 7.31.

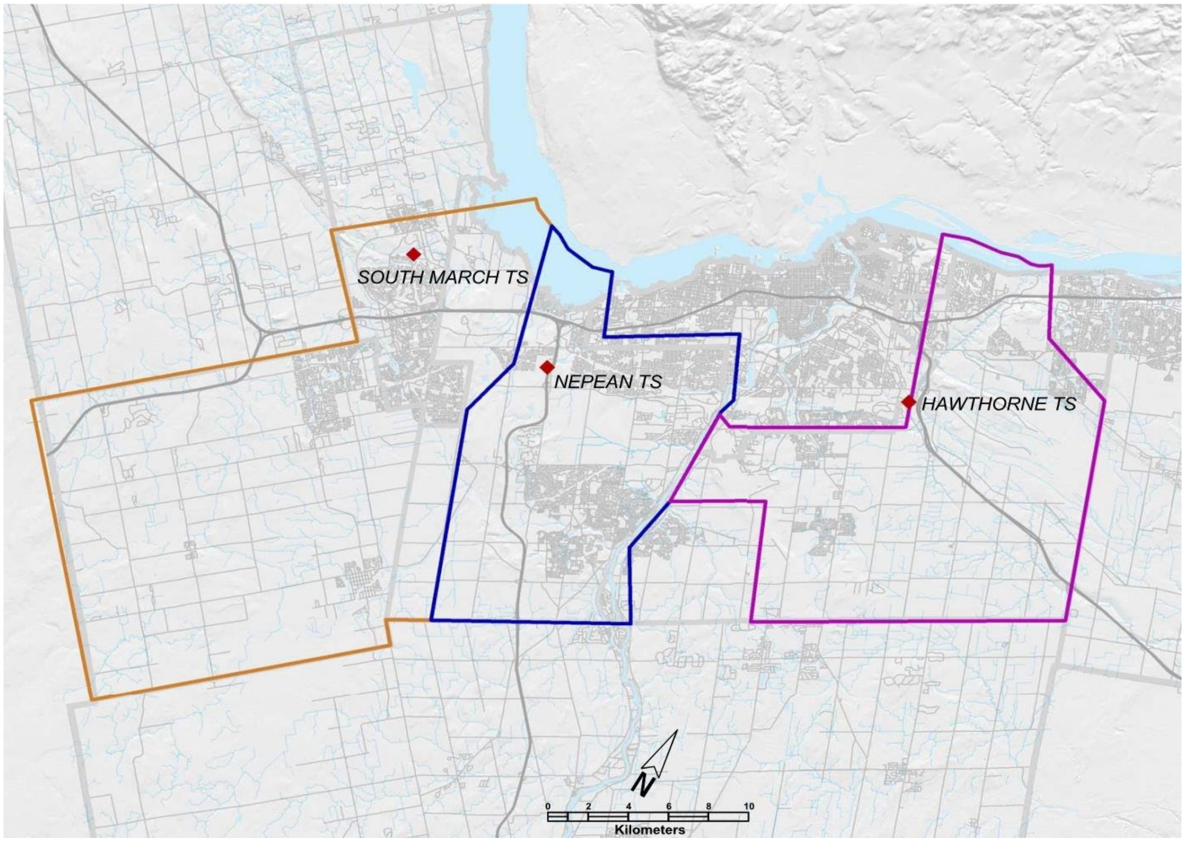
**Figure 7.31 – West 28kV Load Growth**




### 7.2.6. 44kV System

The 44kV system spans the entire service area and is supplied from three stations: Hawthorne TS, Nepean TS, and South March TS. This system supplies a number of large commercial and industrial customers as well as 44kV to 28kV and 44kV to 8kV Hydro Ottawa distribution stations. The location of these stations and supply areas are shown in Figure 7.32 below.

**Figure 7.32 – 44kV Supply Region**




South March TS supplies the west, Nepean TS supplies the south, and Hawthorne TS supplies the east. There are distribution ties between South March TS and Nepean TS feeders, as well as between Nepean TS and Hawthorne TS feeders.

Expansions at Hawthorne TS, in terms of capacity and feeder coverage, will reduce load at Nepean TS, which is at or near planning capacity. A combination of transformer upgrades, from 99MVA to 150MVA (expected in 2019) and a new feeder out of Hawthorne, 48M6, (recently completed and in service) will allow for distribution stations from the Nepean TS system to be transferred to Hawthorne TS.

South March TS demand is forecasted to decrease significantly past 2024. This is due to a combination of projects which eliminate the need for 44kV high-side supply, the planned conversion of the 12kV supply region to 28kV stations supplied by the 115/230kV transmission, reduced load on Richmond North DS due to the upgrade at Richmond South MTS, and the long-term plan to relocate Janet King DS to take advantage of the 230kV corridor in Stittsville.

Based on the large area that these stations cover and limited interconnections between them, they have been studied as separate stations as opposed to as a single region. The 20-year load forecast for each of the stations has been developed (see Figures 7.33 through 7.35 below).

**Figure 7.33 – Hawthorne TS Load Growth**

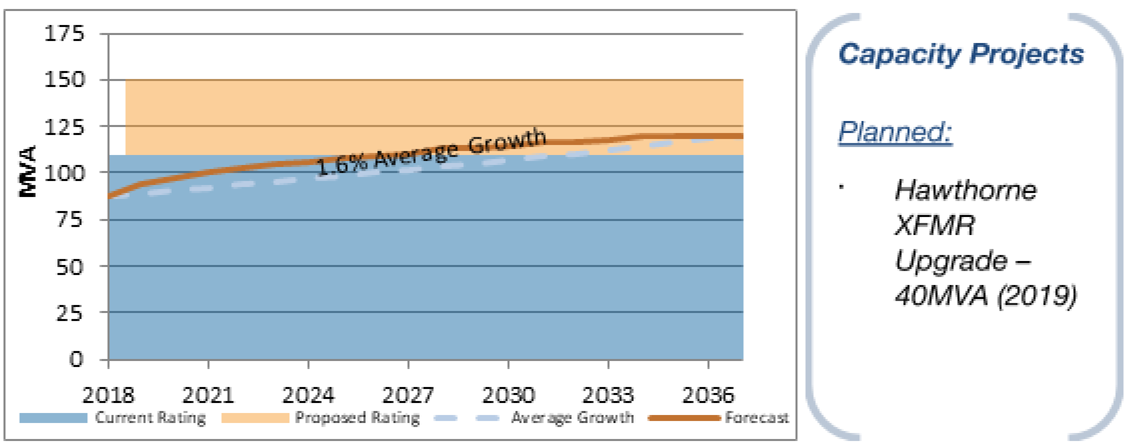


**Figure 7.34 – Nepean TS Load Growth**

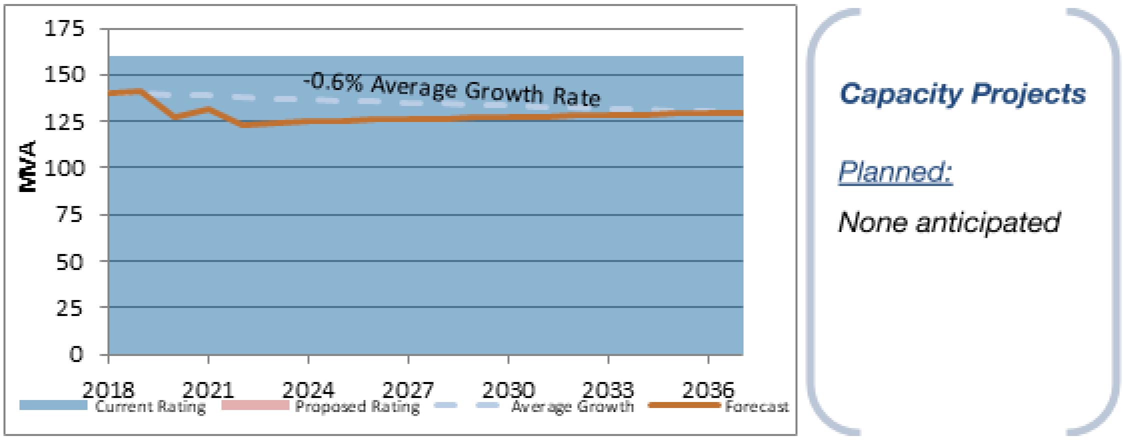
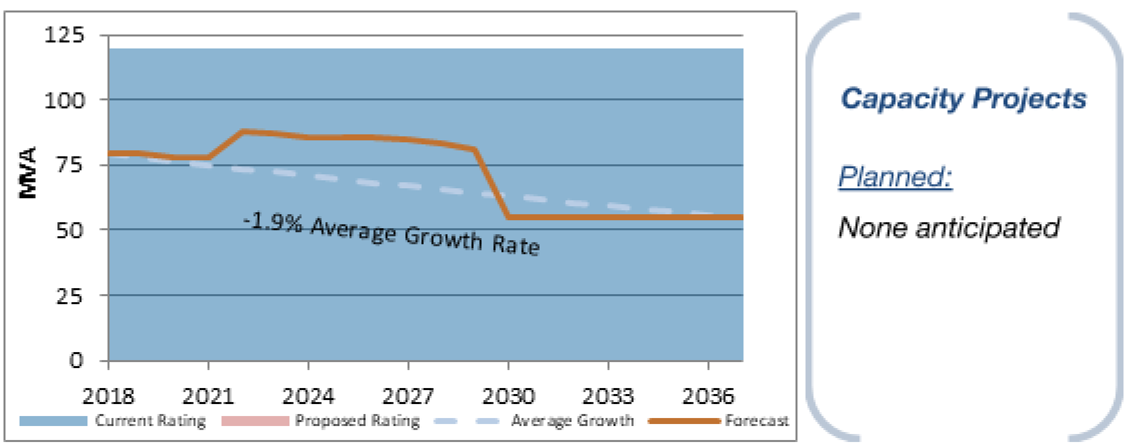



**Figure 7.35 – South March TS Load Growth**

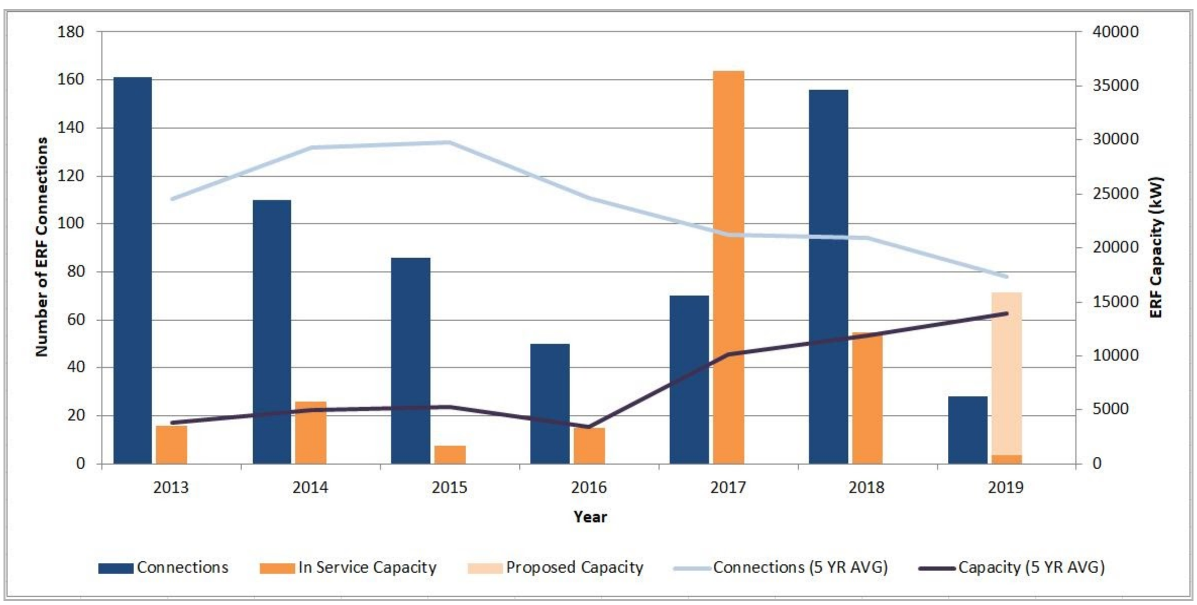


## 7.3. ABILITY TO CONNECT NEW ENERGY RESOURCE FACILITIES

### 7.3.1. System Capability Assessment for Energy Resource Facilities

There is a mix of both renewable and non-renewable ERFs (electricity generation or storage facilities) within Hydro Ottawa's service area and there continues to be customer and stakeholder interest in both types. These ERFs have been connected and continue to be connected under various programs, such as IESO-administered programs (FIT, HCI, PSUI-CDM, RESOP, HESOP), as well as Net-Metering and Load Displacement. See Figure 7.36 for the annual number of ERF connections and associated capacity.

**Figure 7.36 – Historical ERF Connections by Year**




Hydro Ottawa has a significant number of renewable energy generators within its service area, with the majority of existing installations being solar energy FIT or MicroFIT contracts. Interest in solar generation is expected to continue in the form of Net Metering or Load Displacement applications. Additionally, there have been a number of initial inquiries into battery storage technology, although only the 4 MW Ellwood Battery storage project has been formalized to date. In 2017, the connected capacity was the largest over the historical period mainly driven by the 29 MW Chaudiere hydroelectric generation connection. In 2018, the most significant ERF connections were the Ellwood Battery Storage connection (4 MW) and the Algonquin College natural gas generation connection (2 x 2 MW).

**Figure 7.37 – Solar Installation at Hydro Ottawa's Bank Street Facility**

In addition, there were approximately 140 small generation connections, which were impacted by the ending of the microFIT program. In 2019 and 2020, the most significant connections will be the Hull 1 and Hull 2 (43 MW) hydroelectric generation connections.

The existing renewable and non-renewable ERF connections within Hydro Ottawa's service area are shown in Figure 7.38 below.

**Figure 7.38 – ERF Connections**

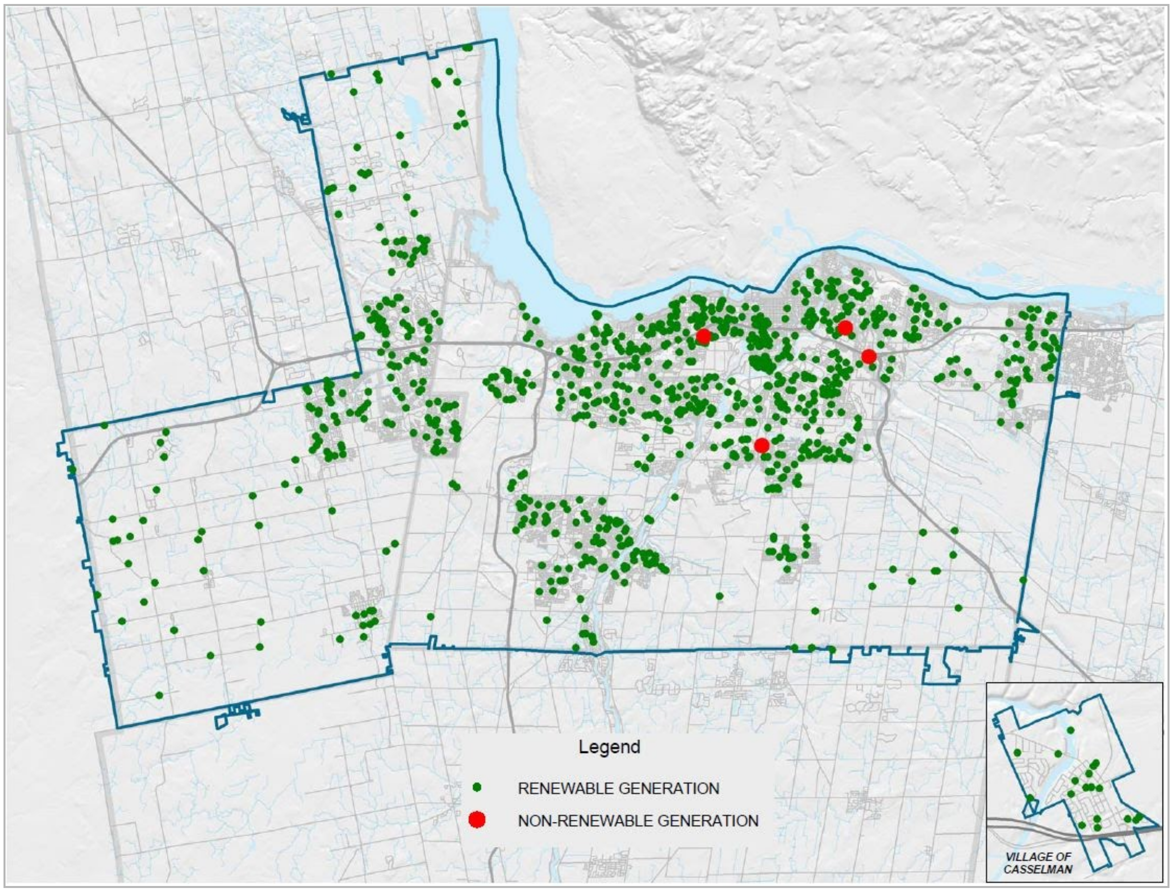


**Table 7.8 – 2018 ERF Facility Connections**

| Program / DSC Category | Large | | Medium | | Small | | Micro | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | kW | Qty | kW | Qty | kW | Qty | kW | Qty | kW | Qty |
| **Non-Renewable** | | | | | | | | | | |
| Battery-IESO | | | 4,000 | 1 | | | | | 4,000 | 1 |
| HOEP | | | | | | | | | | |
| Standby | | | 999 | 1 | | | | | 999 | 1 |
| Load Displacement | | | 21,578 | 8 | 500 | 1 | | | 22,075 | 9 |
| **Renewable** | | | | | | | | | | |
| FIT | | | | | 15,017 | 107 | | | 15,017 | 107 |
| HCI | | | 18,780 | 5 | 465 | 1 | | | 19,245 | 6 |
| HESOP | 29,352 | 1 | | | | | | | 29,352 | 1 |
| Load Displacement | | | | | 997 | 6 | 5.5 | 1 | 1003 | 7 |
| HOEP | | | | | 28 | 1 | | | 28 | 1 |
| RES | | | 8,378 | 2 | | | | | 8,378 | 2 |
| RESOP | | | 10,000 | 1 | | | | | 10,000 | 1 |
| MicroFIT | | | | | | | 7,348 | 880 | 7,348 | 880 |
| Net-Meter | | | | | | | 183 | 27 | 183 | 27 |
| **TOTAL** | **29,352** | **1** | **63,735** | **18** | **17,007** | **116** | **7,536** | **908** | **117,630** | **1043** |

By the end of 2018, Hydro Ottawa had 1,043 ERF connections of various sizes. The details on the number and total kilowatts of ERFs connected by size and program are provided in Table 7.8, where the generation categories are defined in accordance with section 1.2 of the DSC, as follows:

- **Micro-embedded generation facility**: Facilities with a name-plate rated capacity of 10kW or less
- **Small embedded generation facility**: Facilities with a name-plate rated capacity of 500kW or less in the case of a facility connected to a less than 15kV line or 1 MW or less in the case of a facility connected to a 15kV or greater line
- **Medium embedded generation facility**: Facilities with a name-plate rated capacity above 500kW but less than 10 MW in the case of a facility connected to a less than

15kV line, or above 1 MW but less than 10 MW in the case of a facility connected to a 15kV or greater line

- **Large embedded generation facility**: Facilities with a name-plate rated capacity of more than 10MW

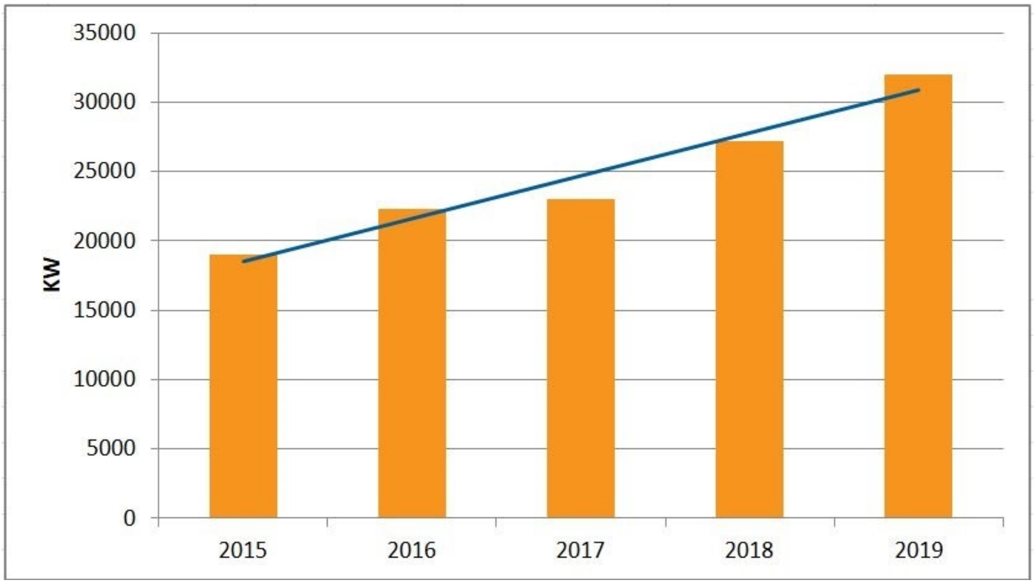
#### *7.3.1.1. Existing Facilities over 10kW*

As of the end of 2018, Hydro Ottawa had a total of 135 connected ERFs greater than 10kW, totalling 110 MW peak nameplate capacity. Out of that total, 124 facilities featured renewable ERFs representing 83 MW of renewable generation.

### 7.3.2. Energy Resource Facilities Forecast

Interest in generation projects within Hydro Ottawa's service area has fluctuated over the historical years driven by external factors. Removing connections larger than 1 MW results in a historical increasing trend in connected capacity for 2016-2019, as shown in Figure 7.39 below. This increasing trend is expected to continue. Thus, an ERF annual growth rate of 11% has been applied to the forecast for the next five years.

**Figure 7.39 – ERF Connected Capacity (kW) (Excluding Large Connections)**




Among other factors driving the ERF forecast, the City of Ottawa, through its official renewable energy strategy known as "Energy Evolution," is seeking ways to promote greater deployment of distributed and renewable resources.

With the Government of Ontario's cancellation of various renewable energy contracts, future generation connections will predominantly take the form of Net Metering and Load Displacement projects of various fuel types.

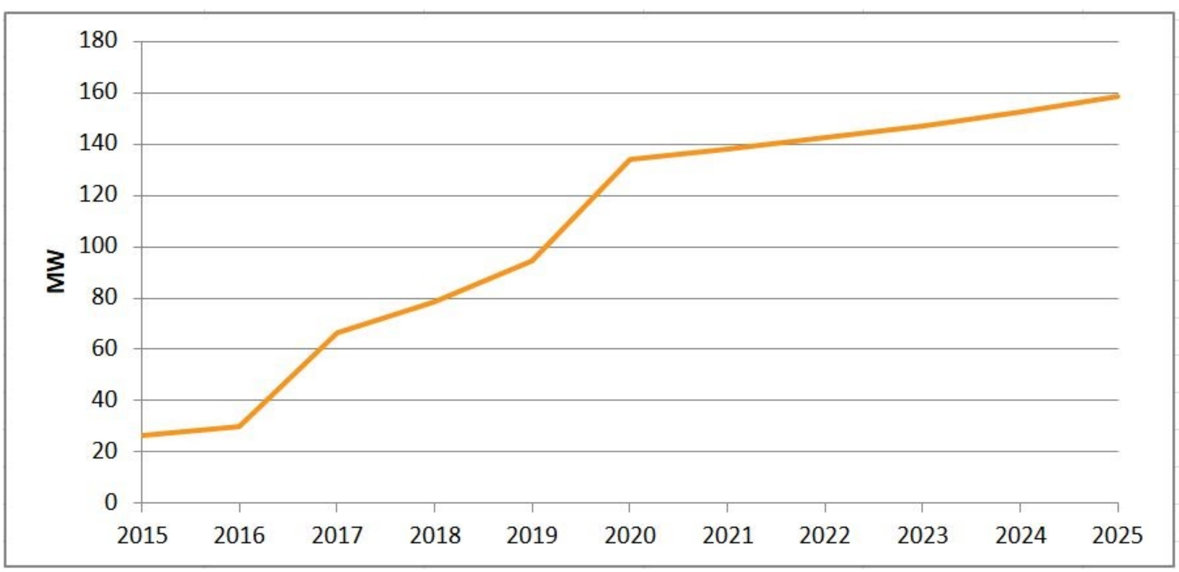
Forecasts for ERF connections are provided in Table 7.9 below and are based on initial consultations and executed Connection Impact Assessments ("CIAs") received and completed as of February 2019. The initial consultations include projects applicable to either the Net Metering, Load-Displacement, or Energy Storage programs.

Between 2019 and 2025, Hydro Ottawa forecasts that approximately 64 MW of additional ERF capacity will be connected to its distribution system, as shown in Figure 7.40 below, by applying the historical trend identified in Figure 7.38 above, in addition to accounting for known upcoming projects of all sizes.

**Table 7.9 – Forecasted ERF Connections**

| Type | Number of Applications | Total Nameplate Capacity (kW) |
|---|---|---|
| Solar PV | 21 | 5,223 |
| Natural Gas | 5 | 6,098 |
| Hydro-Electric | 2 | 42,880 |
| Battery | 2 | 6,110 |
| Biogas | 1 | 5,700 |
| Wind | 0 | 0 |
| Co-Generation | 0 | 0 |
| Diesel | 0 | 0 |
| **TOTAL** | **31** | **66,011** |

**Figure 7.40 – Forecasted ERF Capacity**



### 7.3.3. Factors Affecting Ability to Connect New Energy Resource Facilities

The ability of the distribution system to connect distributed ERFs may be limited by the following factors:

1. **Station Loading** – Some station transformers have limited or no capability for reverse power flow. At these stations, the total connected generation cannot exceed either:
    a. 60% of the top transformer rating plus the minimum station loading; or
    b. The minimum station loading when the station transformers do not have reverse flow capability. This limit has been adopted from HONI's evaluation tool for generation connection assessment.

2. **Feeder Thermal Rating** – Exceeding the feeder ampacity rating will result in overheating the conductors and connected equipment thereby reducing their effective life. For distributed ERFs, the available thermal capacity is the full feeder ampacity rating less contingency loading.

3. **Short Circuit Rating** – Connection of distributed ERFs will increase the available current that flows through the system during faults. The total available current during faults cannot exceed the equipment ratings.

4. **Power Quality** – The following power quality concerns arise when connecting distributed generation:
    a. harmonics caused by inverter based generation
    b. phase imbalance caused by single-phase generators
    c. voltage instability caused by generators connected at various points along a feeder, or by induction generators requiring reactive power
    d. flicker caused by generators intermittently turning on and off which can affect the voltage on the circuit, thus impacting the quality of supply to Hydro Ottawa customers

5. **Anti-Islanding** – Distributed ERFs may introduce safety and power quality issues in the event of continued un-sanctioned generation after the loss of distribution supply. The installation of transfer trip functionality and alternate anti-islanding methods may be used to mitigate the potential for the un-sanctioned islanding of a generator. Currently, transfer trip is only required for generation connections equal to or larger than 500kW.

The ERFs connected to both feeders and stations must be managed to prevent adverse impacts to existing Hydro Ottawa load and customers.

### 7.3.4. System Constraints for Connecting New Energy Resource Facilities

Hydro Ottawa currently owns/co-owns three stations which have restrictions on generation connection of any size. Slater TS and Ellwood MTS are due to short circuit limitations while Lisgar TS is on the restricted list due to reverse power flow concerns. The following sections identify any potential system constraints categorized regionally and by voltage level.

**Core 13kV**

Currently, there are connection restrictions at Slater TS and Lisgar TS. Slater TS is limited due to the available short circuit levels at the station, whereas Lisgar TS is limited by minimum normal loading on the station bus, thus raising reverse power flow concerns should additional generation be installed.

Hydro Ottawa has had discussions with a few proponents interested in large size district heating and cooling, hydro-generation, or energy storage within this region. With the coming load growth and planned station upgrades, capacity may become available to accommodate these requests on more stations in the future.

**East 13kV**

There is a connection restriction at Ellwood MTS due to the available short circuit levels at the station potentially exceeding the bus ratings.

**West 13kV**

A recent HONI transformer and Hydro Ottawa switchgear upgrade at Hinchey TS has provided additional capacity for ERF connections. A large hydro generation facility connecting to Carling TS with 29.35 MW of generation was commissioned early in 2018.

**South 28kV**

There are currently no station restrictions for the connection of distributed generation at the South 28kV stations.

**South-East 28kV**

There are currently no station restrictions for the connection of distributed generation at the South-East 28kV stations.

**East 8kV & 28kV**

There are currently no station restrictions for the connection of distributed generation at the East 28kV and 8kV stations.

**West 28kV**

There are currently no station restrictions for the connection of distributed generation at the West 28kV stations.

**Nepean Core 8kV**

There are currently no station restrictions for the connection of distributed generation at the Nepean Core 8kV stations.

**West Nepean 8kV**

There are currently no station restrictions for the connection of distributed generation at the West Nepean 8kV stations. All these stations are supplied from HONI High Voltage Distribution Stations ("HVDS"), either South March TS or Nepean TS.

**West 8kV**

There are currently no station restrictions for the connection of distributed generation at the West 8kV stations.

**West 12kV**

There are currently no station restrictions for the connection of distributed generation at the West 12kV stations.

**City Wide 44kV**

There are currently no station restrictions for the connection of distributed generation at the 44kV Stations.

### 7.3.5. Energy Resource Facility Connection Capacity

The available station capacity of the system to connect ERFs, as of September 2019, is shown in Table 7.10 below and illustrates the capacity availability to connect ERFs at each Hydro Ottawa-owned HVDS. If an HVDS has an open bus-tie switch, capacity is provided per bus. Where the bus-tie is normally closed, it is provided by the bus pair.

Overall, where Hydro Ottawa station limitations exist, they are limited by thermal capacity and not short circuit capacity, with the exception of Ellwood MTS and Epworth MTS. When transformers are identified as having reverse flow capability as per manufacturer specification, the limiting factor is the transformer capacity plus minimum station load. Otherwise, the limiting factor is simply the station minimum load.

### Table 7.10 – Capacity for Generation at Hydro Ottawa HVDS

| Station | Bus | Connected & Committed (kW) | Remaining Generation Capacity | | Limiting Factor |
|---|---|---|---|---|---|
| | | | Equivalent Inverter Based Generation (kW) | Equivalent Spinning Generation (kW) | |
| BRIDLEWOOD MTS | B1 | 35 | 3,562 | 2,125 | Thermal Capacity |
| | Q | 209 | 2,247 | 1,464 | Thermal Capacity |
| CENTREPOINTE MTS | B1 | 61 | 15,097 | 14,921 | Thermal Capacity |
| | B2 | 30 | 8,694 | 8,337 | Thermal Capacity |
| CYRVILLE MTS | JQ | 566 | 32,800 | 34,035 | Thermal Capacity |
| ELLWOOD MTS | JQ | 4546 | 1,694 | 457 | Short Circuit |
| FALLOWFIELD MTS | J | 8175 | 3,910 | - | Thermal Capacity |
| | Q | 120 | 3,021 | 2,562 | Thermal Capacity |
| KANATA MTS | B1B2 | 1451 | 73,630 | 39,200 | Thermal Capacity |
| LIMEBANK MTS | B1 | | 21,544 | 21,070 | Thermal Capacity |
| | B2 | 130 | 23,952 | 23,129 | Thermal Capacity |
| | JQ | 619 | 21,359 | 20,565 | Thermal Capacity |
| MANORDALE MTS | B1 | 52 | 8,850 | 8,358 | Thermal Capacity |
| | B2 | 532 | 6,974 | 6,676 | Thermal Capacity |
| MARCHWOOD MTS | JQ | 551 | 16,026 | 12,605 | Thermal Capacity |
| MERIVALE MTS | B1 | | 2,348 | 1,575 | Thermal Capacity |
| | B2 | | 2,269 | 1,815 | Thermal Capacity |
| MOULTON MTS | B1 | 145 | 25,066 | 22,569 | Thermal Capacity |
| | B2 | 999 | 21,791 | 19,961 | Thermal Capacity |
| NEPEAN EPWORTH MTS | B | 39 | 1,162 | 288 | Short Circuit |
| | Q | 42 | 10,203 | 9,730 | Thermal Capacity |
| RICHMOND SOUTH MTS | B | 318 | 1,831 | 1,356 | Thermal Capacity |
| TERRY FOX MTS | J | 822 | 43,398 | 43,087 | Thermal Capacity |
| | Q | 677 | 42,873 | 43,644 | Thermal Capacity |
| UPLANDS MTS | Z | 244 | 39,874 | 38,336 | Thermal Capacity |

Typically, more capacity at the stations is available for inverter based generation as opposed to spinning generation for two reasons:

- When reverse flow is the limiting factor, the minimum station load is higher between 10AM to 3PM (the same period the solar generation nameplate capacity will likely be reached and the facility nameplate in capacity calculation is considered); and
- Short circuit contribution of inverter based generators is by rule of thumb 1.2 times the full load current and for spinning generation is considered to be five to 10 times the full load current.

The column label Connected & Committed represents all non-standby ERF (renewable and non-renewable) that is already connected to the grid, committed for connection due to having an IESO contract, or Hydro Ottawa has issued a CIA and tentatively allocated or reserved capacity.

### 7.3.6. Constraints for Embedded Distributors

Hydro Ottawa does not have any embedded distributors within its service territory. As such, any current or future ERF connections will not have an impact in regards to embedded distributor constraints.

Hydro Ottawa is classified as an embedded distributor to HONI. As a result, there is potential for Hydro Ottawa to be impacted by HONI's generation connections upstream of the respective HONI-owned HVDS stations, as identified in Appendix B.

# 8. CAPITAL EXPENDITURE PLAN

## *8.1. CAPITAL INVESTMENTS OVERVIEW*

The capital expenditure plan details the system investments made through the asset management and capital expenditure planning processes described in section 5. Investments are detailed by investment category, and are organized around a Capital Program and Budget Program for the Historical Years of 2016-2018, Bridge Years of 2019-2020 and Test Years of 2021-2025.

Hydro Ottawa's Capital Expenditures are broken into four Investment Categories which are summarized in Table 8.1.

**Table 8.1 – Capital Investment Categories**

| Investment Category | Description |
|---|---|
| System Access | Modifications (including asset relocation) to a distributor's system a distributor is obligated to perform to provide a customer (including a generator customer) or group of customers with access to electricity services via the distribution system. |
| System Renewal | Replacing and/or refurbishing system assets to extend their original service life and thereby maintain the ability of the distributor's distribution system to provide customers with reliable and safe electricity services. |
| System Service | Modifications to a distributor's distribution system to ensure the distribution system continues to meet distributor operational objectives while addressing anticipated future customer electricity demand and service requirements. |
| General Plant | Modifications, replacements or additions to a distributor's assets that are not part of its distribution power delivery system; including land and buildings; tools and equipment; rolling stock and electronic devices and software used to support day to day business and operations activities. |

Capital Expenditures for Historical and Bridge Years are outlined in Table 8.2, which shows actual spending for the years 2016-2018 and committed spending for 2019 and 2020, including variance from OEB approved budgets for the 2016-2020 period. The forecast spending levels for the test years of 2021-2025 are outlined in Table 8.3. Hydro Ottawa's capital expenditures over the 10-year period (2016-2025) can be found in Attachment 2-4-3(B): OEB Appendix 2-AB - Capital Expenditure Summary.

**Table 8.2 – Capital Expenditure Historical Summary ($'000s)**

| Investment Category | Historical | | | | | | Bridge | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2016 | | 2017 | | 2018 | | 2019 | | 2020 | |
| | Act. | Var. | Act. | Var. | Act. | Var. | Act. | Var. | Act. | Var. |
| System Access | $37,805 | (3%) | $30,908 | (12%) | $40,849 | 16% | $44,775 | 25% | $53,331 | 46% |
| System Renewal | $42,639 | 12% | $43,816 | 46% | $54,942 | 59% | $29,446 | (14%) | $32,288 | (4%) |
| System Service | $17,783 | (21%) | $24,844 | (30%) | $29,801 | (5%) | $27,509 | (15%) | $32,621 | (7%) |
| General Plant | $20,323 | (56%) | $38,300 | (20%) | $56,738 | 210% | $35,239 | 88% | $42,580 | 205% |
| **Total Capital Expenditures** | **$118,550** | **(18%)** | **$137,867** | **(8%)** | **$182,349** | **53%** | **$136,969** | **13%** | **$160,820** | **35%** |
| Capital Contributions | $(19,491) | (18%) | $(17,315) | (25%) | $(16,742) | (27%) | $(27,580) | 18% | $(34,532) | 45% |
| **Net Capital Expenditures** | **$99,058** | **(19%)** | **$120,552** | **(4%)** | **$165,607** | **72%** | **$109,388** | **12%** | **$126,288** | **32%** |

Overall spending has fluctuated over the last five years of the 2016-2020 period due to variances that typically arise during the planning and execution of large capital programs. Significant increases in 2018, 2019 and 2020 are mainly due to:

- Underspending in the Facilities Renewal Program ("FRP") over the first three years with the majority of spend happening in 2018;

- Delays in some station projects (i.e. Merivale Station, Richmond South Station and New South Station) over the first three years with increased spending in 2018; and
- Increased spending in the Corrective Renewal Program from 2015-2020 due to:
    - An increase in the required interventions identified through the distribution inspection programs; and
    - Significant weather events which occurred in 2018.

Through the course of the 2016-2020 period, Hydro Ottawa has reprioritized projects and adjusted programs pacing as necessary while continuing to meet the objectives outlined in the 2016-2020 DSP. Detailed descriptions of these variances by Capital Program for each Investment Category are provided in sections 8.2 through section 8.5.

**Table 8.3 – Capital Expenditure Forecasted Summary ($'000s)**

| Investment Category / Capital Program | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|
| System Access | $56,693 | $41,032 | $37,434 | $34,462 | $34,039 |
| System Renewal | $43,296 | $44,012 | $40,191 | $39,436 | $40,474 |
| System Service | $31,001 | $27,415 | $24,337 | $25,155 | $23,899 |
| General Plant | $32,047 | $11,681 | $7,556 | $17,354 | $16,884 |
| **Total Capital Expenditures** | **$163,037** | **$124,140** | **$109,518** | **$116,407** | **$115,296** |
| Capital Contributions | $(41,254) | $(25,217) | $(19,943) | $(19,226) | $(19,264) |
| **Net Capital Expenditures** | **$121,783** | **$98,923** | **$89,574** | **$97,181** | **$96,032** |

Over the 2021-2025 period, overall annual average spending will be slightly lower than the 2016-2020 rate period (excluding the FRP). This spending plan is a continuation of the objectives outlined in the 2016-2020 DSP, which focused on the enhancement of system capacity to keep pace with growth and shifts in loads within the service territory, and the renewal of aged and aging infrastructure that are at greatest risk of failure.

Changes by Investment Category are described below for 2021-2025:

- Spending in System Access programs will see a slight decrease since large projects requiring significant system expansion such as the Chaudière and Hull generation projects as well as Ottawa LRT will be complete before or during the early years of the next rate period. Spending in commercial and residential connection projects are expected to remain at the same as historical level.
- Spending in System Renewal programs will see a slight increase in order to continue replacement of the critical assets as outlined in Section 6 Asset Lifecycle Optimization.
- Spending in System Service programs will remain at the same levels, mainly driven by the construction of new stations in the south and east regions. The new station in the south region is expected to be energized by 2022 and the new station in the east is planned for energization by 2025. In addition, there are associated distribution projects to deliver additional capacity from the new stations to the growth areas. Also, there are follow up enhancements to the SCADA upgrade project included in Hydro Ottawa's 2016-2020 rate application, such as the upgrade to the existing OMS and implementation of DMS functionality.
- Spending in General Plant will return to historical levels with the completion of the FRP.

### 8.1.1. Historical and Forecasted Expenditure Comparison

Figure 8.1 and Table 8.4 depict the expenditures by Investment Category over the historical period of 2016-2020 and the projected expenditures for the 2021-2025 period.

The 2016-2020 period had an average annual expenditure of $147M and the 2021-2025 period is set to have an average annual expenditure of $126M, a decrease of almost 15%. The reduction in spending is mostly in two spending categories: General Plant, where the FRP will be completed, and in System Access, due to the completion of large generation projects. System Renewal will remain mostly at historical levels, with reductions in some lower risk asset replacement programs used to fund increased expenditures for other higher priority replacement programs such as Cable Renewal. System Service expenditures will remain at historical levels to fund large capacity upgrade projects planned over the forecast period, such as the Cambrian MTS station project. The cost for Cambrian MTS includes HONI CCRAs $50M in General Plant and $27M for station construction and equipment in System Service. (See Attachment 2-4-3(E) for more details on the project).

**Figure 8.1 – Expenditure by Investment Category**

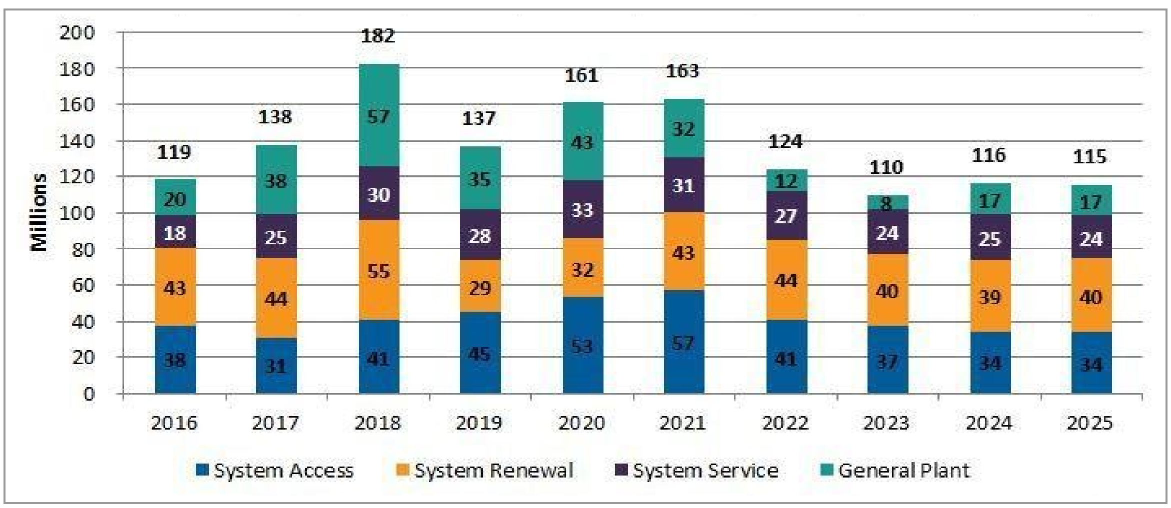


**Table 8.4 – Expenditures by Investment Category ($'000s)**
**Part One – Historical and Bridge Years**

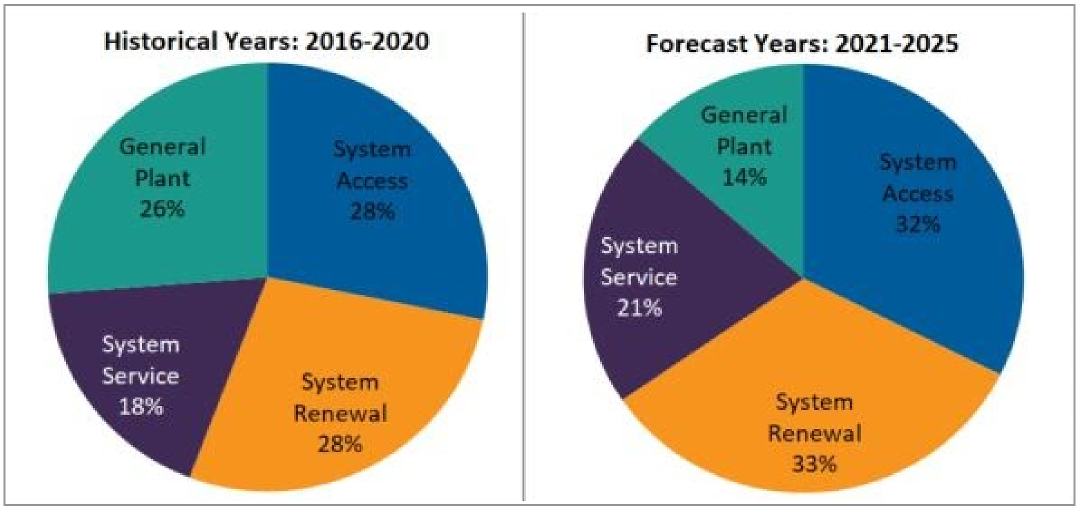
| Investment Category | Historical | | | Bridge | | Avg |
|---|---|---|---|---|---|---|
| | 2016 | 2017 | 2018 | 2019 | 2020 | |
| System Access | $37,805 | $30,908 | $40,849 | $44,775 | $53,331 | $41,533 |
| System Renewal | $42,639 | $43,816 | $54,942 | $29,446 | $32,288 | $40,626 |
| System Service | $17,783 | $24,844 | $29,801 | $27,509 | $32,621 | $26,512 |
| General Plant | $20,323 | $38,300 | $56,738 | $35,239 | $42,580 | $38,636 |
| **Total Capital Expenditures** | **$118,550** | **$137,867** | **$182,330** | **$136,969** | **$160,820** | **$147,307** |
| Capital Contributions | $(19,491) | $(17,315) | $(16,742) | $(27,580) | $(34,532) | $(23,132) |
| **Net Capital Expenditures** | **$99,058** | **$120,552** | **$165,587** | **$109,388** | **$126,288** | **$124,175** |

**Part Two – Test Years**

| Investment Category | Test | | | | | Avg |
|---|---|---|---|---|---|---|
| | 2021 | 2022 | 2023 | 2024 | 2025 | |
| System Access | $56,693 | $41,032 | $37,434 | $34,462 | $34,039 | $40,732 |
| System Renewal | $43,296 | $44,012 | $40,191 | $39,436 | $40,474 | $41,482 |
| System Service | $31,001 | $27,415 | $24,337 | $25,155 | $23,899 | $26,361 |
| General Plant | $32,047 | $11,681 | $7,556 | $17,354 | $16,884 | $17,105 |
| **Total Capital Expenditures** | **$163,037** | **$124,140** | **$109,518** | **$116,407** | **$115,296** | **$125,680** |
| Capital Contributions | $(41,254) | $(25,217) | $(19,943) | $(19,226) | $(19,264) | $(24,981) |
| **Net Capital Expenditures** | **$121,783** | **$98,923** | **$89,574** | **$97,181** | **$96,032** | **$100,699** |

Figure 8.2 shows the average percent contribution of annual expenditures to each of the Investment Categories over the 2016-2020 period compared to the forecast period of 2021-2025. System Renewal and System Access Investment Categories continue to be the top contributors, with significant reductions in General Plant due to the completion of the new facilities project.

**Figure 8.2 – Percentage Contribution of Investment Categories to Total Expenditures**




### 8.1.2. Impact on O&M Costs

Impacts to operation and maintenance costs vary by Investment Category, as described below.

**System Access**

System Access projects can introduce new assets to the system, resulting in an increasing quantity of equipment requiring maintenance, and additional potential failure points within the grid.

**System Renewal**

System Renewal investments target the replacement of ageing infrastructure. As certain assets age, the required maintenance and associated costs increase. Assets which have deteriorated to the point of failure result in high O&M costs associated with the emergency work required to respond and restore power. When an asset is replaced, maintenance is still required, but typically involves less time and resources resulting in lower O&M expenses in comparison. Through proactive replacement, additional O&M costs can be avoided.

As Hydro Ottawa replaces assets, new technologies are introduced. There are benefits to such improvements, such as reduced crew travel time, but other added costs such as software licencing, increased communication infrastructure and the need for device specific training can increase O&M costs.

**System Service**

System Service investments represent the costs associated with growing the distribution system, thereby increasing the number of assets to maintain and introducing additional potential failure points within the system.

### 8.1.3. Drivers by Investment Categories

The drivers by investment category have been described in section 5.2.1 - Project Concept Definition. Table 8.6 shows the average historical and forecast expenditures by driver and Figure 8.3 shows the distribution by driver of the total expenditure over the forecast period.

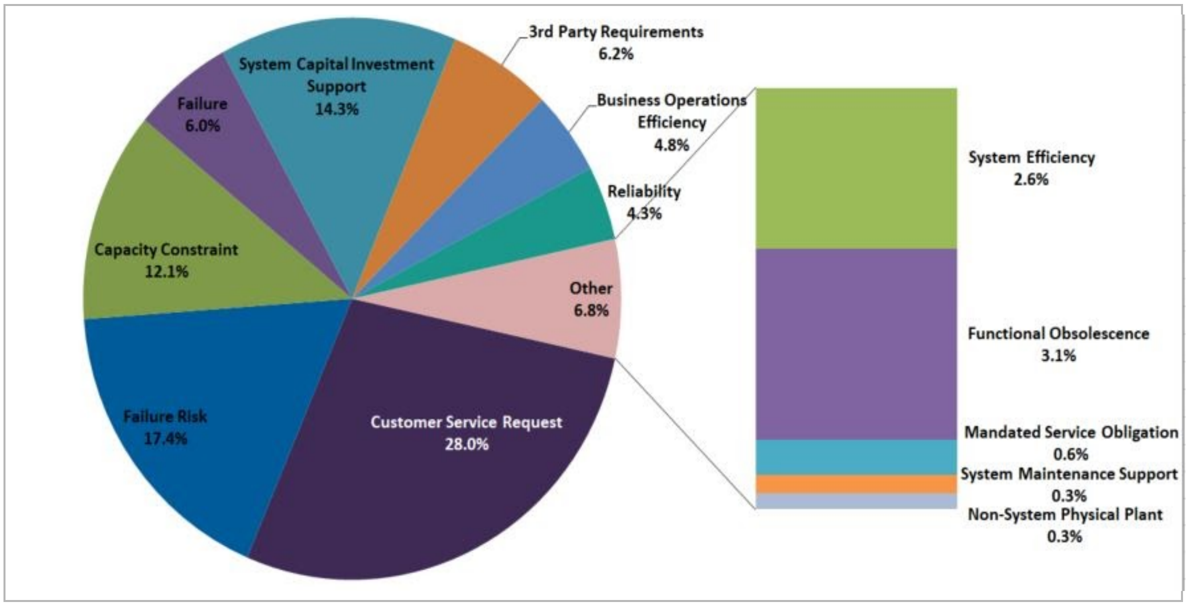
Customer Service Request, Failure Risk, System Capital Investment Support, and Capacity Constraints are the top four drivers in the proposed forecast expenditure for the 2021-2025 rate period. Many programs under the System Access investment category are driven by Customer Service Requests, including expansion of the distribution system, residential connections, commercial connections and generation connections. Assets that are being replaced due to Failure Risk in the System Renewal investment category include the following: station transformers, station switchgear, P&C equipment, batteries, poles, OH switches, cables, civil structures and UG switchgear. Projects driven by System Capital Investment Support include capital contributions to intangible assets purchased from HONI in conjunction with Hydro Ottawa's major station projects such as the new Cambrian MTS and the New East Stations. Projects driven by Capacity Constraints include construction of new stations such as the Cambrian MTS and the New East Station as well as associated distribution work to bring additional capacity to growth pockets.

1 **Table 8.6 – Expenditures by Driver ($'000s)**

| Investment Category | Driver | 2016-2020 Avg | 2016-2020 Total | 2021-2025 Avg | 2021-2025 Total |
|---|---|---|---|---|---|
| SA - System Access | Third Party Requirements | $8,156 | $40,781 | $7,581 | $37,905 |
| | Customer Service Request | $31,839 | $159,194 | $32,197 | $160,987 |
| | Mandated Service Obligation | $1,539 | $7,693 | $953 | $4,767 |
| SR - System Renewal | Failure | $10,051 | $50,254 | $9,819 | $49,095 |
| | Failure Risk | $29,574 | $147,869 | $28,734 | $143,670 |
| | High Performance Risk | $529 | $2,644 | $0 | $0 |
| | Substandard Performance | $90 | $450 | $0 | $0 |
| | Functional Obsolescence | $383 | $1,913 | $2,929 | $14,644 |
| SS - System Service | Capacity Constraint | $14,643 | $73,216 | $16,342 | $81,712 |
| | Reliability | $6,545 | $32,725 | $5,840 | $29,199 |
| | System Efficiency | $5,323 | $26,616 | $4,179 | $20,895 |
| GP - General Plant | Business Operations Efficiency | $8,926 | $44,630 | $7,535 | $37,676 |
| | Non-System Physical Plant | $17,570 | $87,849 | $413 | $2,066 |
| | System Capital Investment Support | $11,575 | $57,877 | $8,688 | $43,438 |
| | System Maintenance Support | $565 | $2,824 | $469 | $2,343 |
| **GRAND TOTAL** | | **$147,307** | **$736,536** | **$125,680** | **$628,398** |

2

**Figure 8.3 – Contribution to Total Forecast Expenditures by Drivers (2021-2025)**




## 8.1.4. Non-distribution Activities

At the end of 2018, Hydro Ottawa received funding from the IESO to complete a "Local Achievable Potential ("LAP") study" in the Kanata North area (see Attachment 2-4-3(K): Local Achievable Potential Study).

The objective of this study was to evaluate non-wires options potential to offset load growth in the Kanata North area to defer or eliminate the need for new infrastructure. The non-wire options considered in the study include Conservation and Demand Management ("CDM") programs, distributed generation, and energy storage.

The study concluded that the desired peak demand reductions cannot be achievable from CDM programs. The higher achievable potential is reachable with the consideration of utility-scale energy storage. The budgetary cost for implementing this project is estimated at $9.6M and $22.7M to introduce peak reduction ranging from 3.75 MW-7.5 MW.

Short-term solutions have been put in place to address immediate capacity and reliability needs in the Kanata North area, including load transfers to adjacent stations, distribution line extensions, VAR control projects in long rural feeders and area-specific CDM demand reduction programs through IESO funding opportunities.

Hydro Ottawa has submitted two CDM program funding applications to the IESO strategically targeting capacity constrained areas in Kanata North. These programs are the Thermostat Program and the Kanata North Retrofit T&T Program (Top-Up and Targeted Outreach) for a total of $3.25M in funding requirements. The Thermostat Program leverages Enbridge Gas Distribution's existing smart thermostat rebate program and offers more beneficial incentives to Hydro Ottawa customers in the Kanata North region. Potential demand reduction from the Smart Thermostat program is 0.76 MW. The Kanata North Retrofit T&T Program offers top-up incentives at 100% or double the incentive amounts with a targeted outreach strategy. The potential demand impact from the Retrofit Top-up is expected to be 1.8 MW. The total demand reduction in the Kanata North area from these programs is expected to be 2.6 MW. Obtaining funding from IESO for CDM programs minimizes the impact to customer rates and provides short-term capacity relief in the Kanata North area.

Based on the results from the Kanata North LAP study, Hydro Ottawa did not include expenditures for non-distribution activities in the forecast expenditure plan.

### 8.1.5. System Capability Assessment

Over the 2021-2025 period, Hydro Ottawa will not specifically address stations that have restrictions for the connection of ERFs (including REGs) within the capital expenditure plan. However, as station transformers are identified for replacement through the Asset Management Process (section 5.1) due to either reaching their end of life or capacity constraints, the new units will have-reverse flow capabilities specified to eliminate potential restrictions to the connection of ERFs. Also, the addition of new station transformers in the east and south regions of Hydro Ottawa's service area allows for additional capacity for ERF connections.

### 8.1.6. System Development Expectations

This section describes how Hydro Ottawa anticipates the system to develop over the next five years in relation to load and customer growth, changing climate patterns, Smart Grid development and the accommodation of forecasted renewable energy generation projects.

#### *8.1.6.1. Load and Customer Growth*

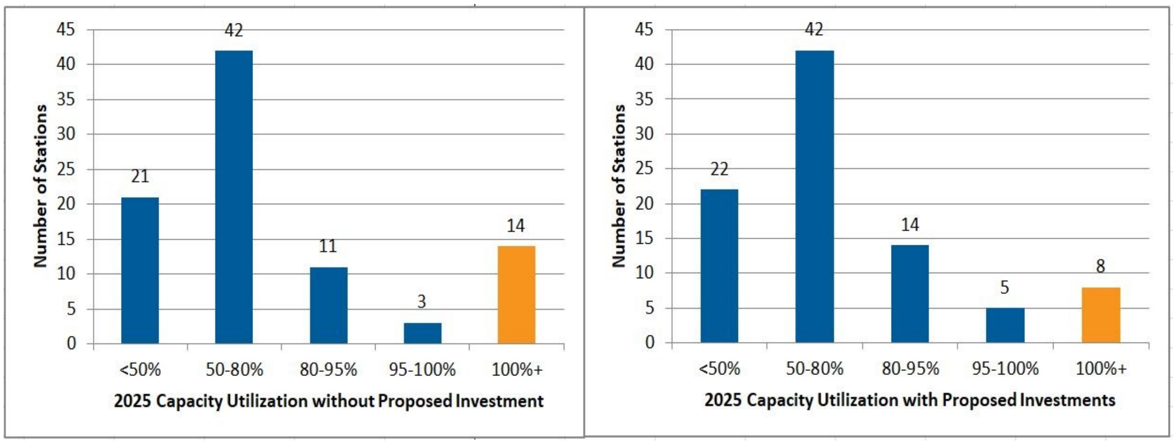
Hydro Ottawa's system capacity is lagging behind load growth. At present, 16% of stations are above their specified planning rating. Over the next five years, Hydro Ottawa is expecting growth to continue as previous rural areas are changed to urban areas and the City's plan for intensification continues.

Overall, the City of Ottawa is seeing continued growth, primarily focused in five regions: the downtown core, Nepean and Riverside South, Leitrim, South Kanata and Stittsville, and Orleans. This growth is being seen through the development of new mixed retail/residential communities as well as intensification of existing communities and the Ottawa LRT developments. Moving forward, significant investment in capacity for the system, at both the station and distribution level, will be required to catch up to and maintain pace with the demand. These capacity upgrade projects are identified through the Capacity Planning process. In addition, there are a number of distribution expansions which will be required to deliver power from the stations to the customer site. Customer-driven distribution expansions go through an economic evaluation to determine customer contribution for the project.

With the proposed Capacity Upgrades projects, the number of stations above the specified planning rating is expected to decrease to 9%, as per Figure 8.4. With the exception of Marchwood station, the other seven stations above their planning rating will be between 100% and 115%. All stations above their planning capacity have feeder contingency plans in place in case of a single transformer failure at any of the seven stations.

Without the proposed Capacity Upgrades projects, the number of stations above the specified planning rating is expected to be at 15% by 2025, as per Figure 8.4 (assuming that on-going projects are completed). Fallowfield station would be above its station rating and five out of the 14 stations would be between 115% and 185% of their planning rating.

**Figure 8.4 – Stations above Planning Rating by 2025**




There are several upgrades of transmission interties within the City which may be necessary over the next 20 years to maintain adequate and reliable supply from the bulk system. Hydro Ottawa is involved in an IRRP that is evaluating the transmission capacity and infrastructure requirements in the Ottawa region. The final report is expected to be completed in the first quarter of 2020. However, Hydro Ottawa's proposed five-year investment plan incorporates preliminary needs identified for the short term through this study. These are summarized in Table 8.7 below.

### Table 8.7 – IRRP Results

| Need | Description | Preliminary Solution |
|---|---|---|
| Supply to Kanata | Several stations in the area are operating at or near their planning capacity. Large commercial and residential developments are driving significant growth in electricity demand in the near and medium term. | Limitations on the existing transmission system in the area cannot accommodate expansion of the existing stations.<br>A new station is likely required to provide reliable long term supply in the area. The IESO is currently developing a bulk transmission plan in parallel to the Greater Ottawa IRRP that might impact requirements for connecting the new station. Bulk transmission plan will be finalized in 2020.<br>Hydro Ottawa is planning to implement distribution system upgrades to distribute forecast growth between stations in the area. |
| Supply to South East Ottawa | Several stations in the area are operating at or near their planning capacity. Demand is expected to increase driven by large residential, mixed and industrial developments. | Hydro Ottawa will proceed with a plan to build a new 230 kV connected supply station in the south east part of the City. The new station is planned for energization in 2025. HONI will evaluate the options for this upgrade in the Regional Infrastructure Plan (RIP). |
| Supply to East Ottawa | Bilberry Creek TS came into service in 1976 and is approaching end of life; options to decommission or refurbish the station were evaluated including the impact to the bulk system. Large industrial and residential mixed use developments are forecasted to increase demand over the near and medium term. | HONI will refurbish Bilberry Creek TS, including like for like transformer replacement.<br>HONI will expand the station to provide two additional breaker positions to supply Hydro Ottawa customers. |
| Supply to the Regional 115kV System | Several of the 230/115 kV transformers at Merivale and Hawthorne are operating at or near their capability | HONI will replace the more limiting of the 230/115 kV transformers at Merivale TS in the near term so that the two Merivale transformers have similar capability.<br>Subsequent to the release of the IRRP, the Working Group will undertake an IRRP Addendum Study, this will include an evaluation of potential benefit of non-wires options to manage future demand growth on the 115kV system. |

#### *8.1.6.2. Accommodation of Forecasted ERF Projects*

Hydro Ottawa is predicting a continued interest in the installation of ERF within the service territory, over the five-year forecast period. Among the factors pointing towards sustained public and consumer interest in this regard are the objectives set forth in the City of Ottawa's "Energy Evolution" strategy in support of increased deployment of renewable resources. Based on the current ability of the system to connect new ERF, there are no constraints at the anticipated connecting stations for the forecasted connections. For more detailed information on accommodation of forecasted renewable energy projects in the next five years, refer to section 7 - System Capacity Assessment.

#### *8.1.6.3. Climate Adaptation*

Extreme weather events include, but are not limited to, high wind events, freezing rain, temperature and precipitation extremes, as well as complex events such as tornadoes. Such extreme weather has had an increasing impact on Hydro Ottawa's assets and operations over the past decade. In response to these events, and forecasted changes in weather patterns attributed to climate change, Hydro Ottawa has undertaken a Climate Vulnerability Risk Assessment ("CVRA"), and subsequent development of an adaptation plan as part of its distribution planning activities. Please see Attachment 2-4-3(H): Distribution System Climate Risk and Vulnerability Assessment for further details.

The CVRA was used to evaluate potential impacts and risks to the Hydro Ottawa electrical distribution system and supporting infrastructure as a result of changing climate and extreme weather events. This assessment process followed the Canadian Electricity Association's ("CEA") guide on adaptation to climate change, and Engineers Canada's Public Infrastructure Engineering Vulnerability Committee ("PIEVC") Protocol. This assessment methodology conforms to the International Organization for Standardization ("ISO") 31000:2018 Risk Management Standard, to identify relevant climate parameters and infrastructure responses, and assign risk ratings to each response to relevant climate considerations. The process involved the systematic review of historical climate information and the projection of the nature, severity and probability of future climate changes and events. The assessment of climatic changes was used to establish the exposure of infrastructure systems to these climate events. The impact of a particular damaging or disruptive climate event was then quantified and used to calculate the risk for a particular climate-infrastructure interaction. This process was repeated for all applicable infrastructure elements to produce an electrical distribution infrastructure climate risk profile.

The CRVA utilized the following methodology:

1. Identification of climate events (e.g. temperature, precipitation, winds) and their threshold values above which infrastructure performance would be affected and projecting the probability of occurrence of the climate hazards in the future (i.e. 2050s).

2. Assignment of a probability score for each climate event based on climate data. This involved converting the projected probability of occurrence of future climate parameters into the five-point rating scale used in Hydro Ottawa's Asset Management System Risk Procedures.

3. Assignment of a severity rating for the impact of climate events on each element of the distribution system considered in the assessment. Impacts on the infrastructure were assessed for various performance criteria. This part of the assessment was completed through a staff workshop.

4. Calculation of the risk for each infrastructure element was performed.

5. Using Hydro Ottawa's Asset Management System Risk Table, medium, high and very high risks to infrastructure and operations were identified.

The adaptive capacity – the ability of a system to respond which takes into consideration factors like, age, design setting, etc.– of the infrastructure elements were taken into account during the risk assessment stage.

Further information on the forecasted climate parameters used in the CVRA can be found in section 2.4.1. The analyses in this study use projections for the “business-as-usual” Representative Concentration Pathway emissions scenario – RCP8.5 – and for the 2050s (2041-2070).

This study identified a number of risks, which will be considered in the management of Hydro Ottawa’s assets moving forward. In current climate conditions, very high risks were identified to power distribution lines and poles under extreme (>120 km/h) wind conditions; these risks remain very high in future projected climate. Projected changes to climate in the Hydro Ottawa service area, are expected to increase risks to very high as follows:

- Daily maximum temperatures of 40°C or higher are expected to occur annually, impacting field staff; and,
- Freezing rain storms resulting in 40mm or more of ice accumulation are projected to occur more frequently in a 30-year period, resulting potentially in damage to a wide range of Hydro Ottawa’s assets, disruptions in service, and impacts on staff.

Key adaptations which are incorporated into this DSP include planning for climate, increased system resilience, and increased operational capability.

- Planning for climate: in response to a changing climate Hydro Ottawa will formalize the incorporation of climate into its planning systems, to ensure risks and adaptation remain current as climate trends and science evolve. Hydro Ottawa will continue to perform post-event analysis to identify lessons learned. Further, the utility will ensure future climate resilience is considered in all decision making practices, and establish recurring process to evaluate vulnerability risks to ensure long term sustainability of its current investments.
- Increased system resilience: the company will focus on sustaining and introducing practices to mitigate damage during severe wind and ice events. Hydro Ottawa will evaluate and, where feasible, implement augmentations to its vegetation management

practices to mitigate the impact of extreme weather, building on the success of storm hardening, and revised vegetation management practices implemented in 2014/2015. Hydro Ottawa will work with the City of Ottawa and the Village of Casselman to explore feasibility to expand trimming to include heritage trees, and trees in the fall zone outside of the utility's right-of-way if condition assessment indicates vulnerability.

- Renewal of aged, and decayed overhead infrastructure to withstand climatic forces from storm events is key to resilience over the long term for the system. Most notably, Pole Renewal programs support the development of this resilience. Hydro Ottawa will augment the impact of these renewal investments over the 2021-2025 period through the development of new anti-cascade standards and risk based application guides to further mitigate damage in high risk installations when damage does occur.
- Increased operational capability: Hydro Ottawa will continue to invest in appropriate technologies to augment its response to outages when weather events do cause interruption. These include system capacity investments to maintain sufficient operational capacity and redundancy, as well as, automation investments, to enable remote and automatic, isolation and restoration of faulted system components.

#### *8.1.6.4. Electric Vehicles*

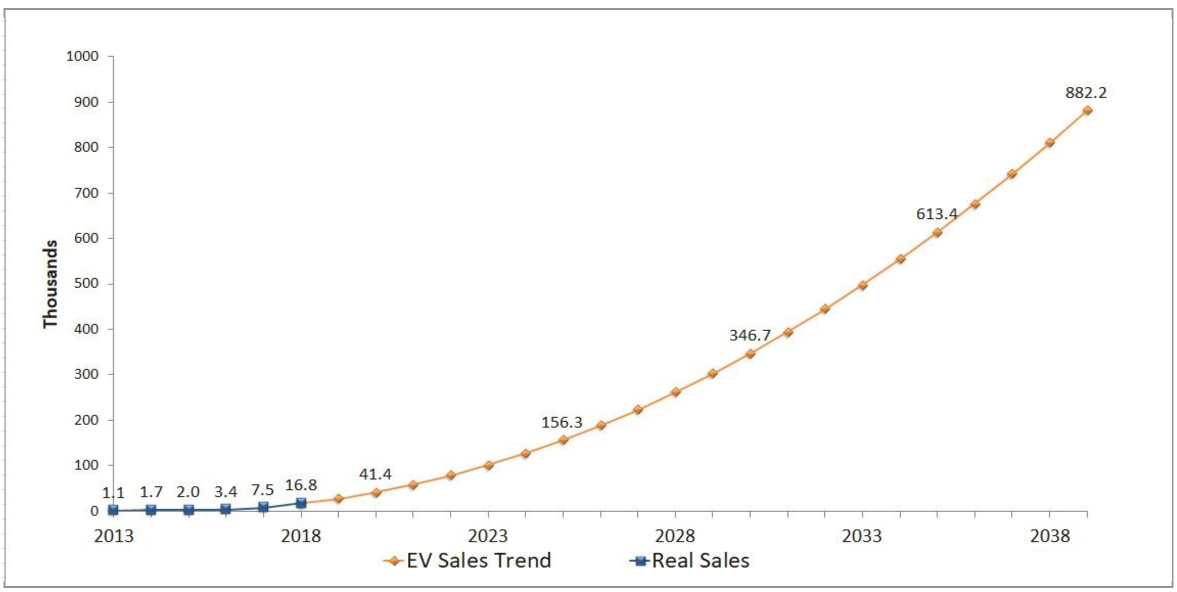
In response to the increasing growth of electric vehicles ("EVs"), Hydro Ottawa seeks to remain vigilant and adaptive to the impact EVs may have on the distribution system. Over the course of five years, EV yearly sales in the Province of Ontario have increased from 1,092 in 2013 to 16,814 in 2018, representing a compound annual growth rate of 11.56%. A breakdown of yearly EV sales can be found in Table 8.8. Using these sales data, a growth projection can be modelled further into the future, as shown in Figure 8.5. Comparing the 2018 trend, modelled sales of 2018 to the real EV sales of the same year yields a percent deviation of 2.57%.

### Table 8.8 – Historical Ontario EV Sales[1]

| Year | EV Sales |
|---|---|
| 2013 | 1,092 |
| 2014 | 1,736 |
| 2015 | 2,049 |
| 2016 | 3,400 |
| 2017 | 7,477 |
| 2018 | 16,814 |

Extrapolating from the sales results in Table 8.8, the compound annual growth rate from 2013 real sales to 2039 projection sales was determined to be 31%. This extrapolated growth is shown in Figure 8.5.

### Figure 8.5 – Ontario EV Sales Forecast




[1] Sources: "Electric Vehicle Sales In Canada, 2017," FleetCarma, 08-May-2019. Available: https://www.fleetcarma.com/electric-vehicle-sales-canada-2017/ and "Electric Vehicle Sales in Canada in 2018," Electric Mobility Canada - Mobilité Electrique Canada, Feb-2019. Available: https://emc-mec.ca/new/electric-vehicle-sales-in-canada-in-2018/.

Based on provincial EV per capita rates, it was estimated that Ottawa will have 2,959 EVs, as of 2018. By the end of 2019, this number is projected to rise to 4,832, a 63% increase. By 2039, the number of EVs within Ottawa is forecasted to grow to 511,332. In comparison to the total light vehicles ("LV") population, EVs will make up 66% by 2039 of all LVs in the City of Ottawa if trends continue.

**Charging Technologies**

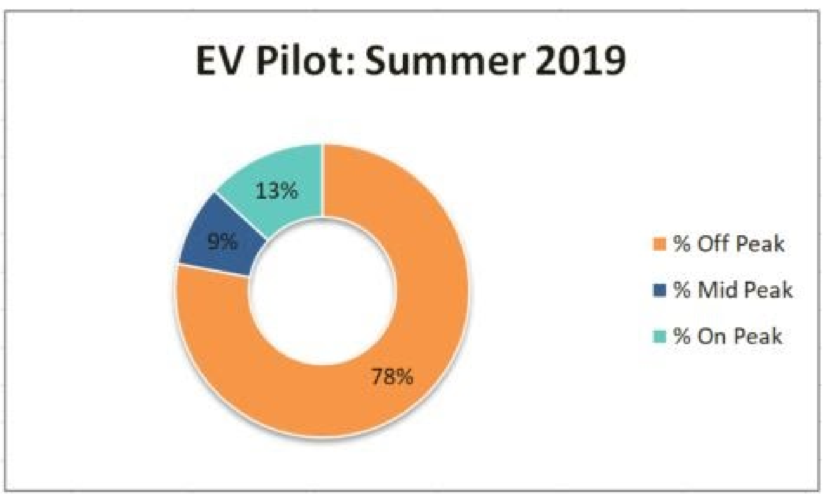
Modern day EV chargers can be categorized into three levels: level 1 (L1), level 2 (L2), and level 3 (L3) chargers. L1 chargers are very basic chargers that draw power in the range of 1.44 kW and 1.92 kW. L2 charger rated power ranges from 3.1 kW to 19.2 kW. L3 chargers range between 50 kW to 150 kW. DC fast chargers are typically what would be found in public installations.

At present, going by market trends, the 7.7 kW L2 charger is the preference for EV onboard chargers. In particular, the Tesla Model 3 has an onboard charger of 7.7 kW. Tesla is currently the major market leader in EVs for North America. Accordingly, this analysis will be focused on their leading market technology.

### Hydro Ottawa EV Charger Program

In 2018, Hydro Ottawa began a pilot study gathering EV charging data from select participants to better understand charging patterns. The participants were chosen on a first come/first served volunteer basis with each characterized as using the FLO X5 charging station. As of August 2019, there were 67 charging station installations that Hydro Ottawa has the capability to collect data from across the City of Ottawa. The data collected from each active installation includes the following: total kWh consumption, date of use, time of use (broken down into off-peak, mid-peak, and on-peak), consumption per charge session, and km driven per week. The most valuable of these data points is the time of use (specifically, the on-peak periods). It allows Hydro Ottawa to analyze and understand the behavioural trends of consumers as it relates to charging for each month and season. The summer demand of EVs from the pilot study showed that 13% was on-peak, as shown in Figure 8.6.

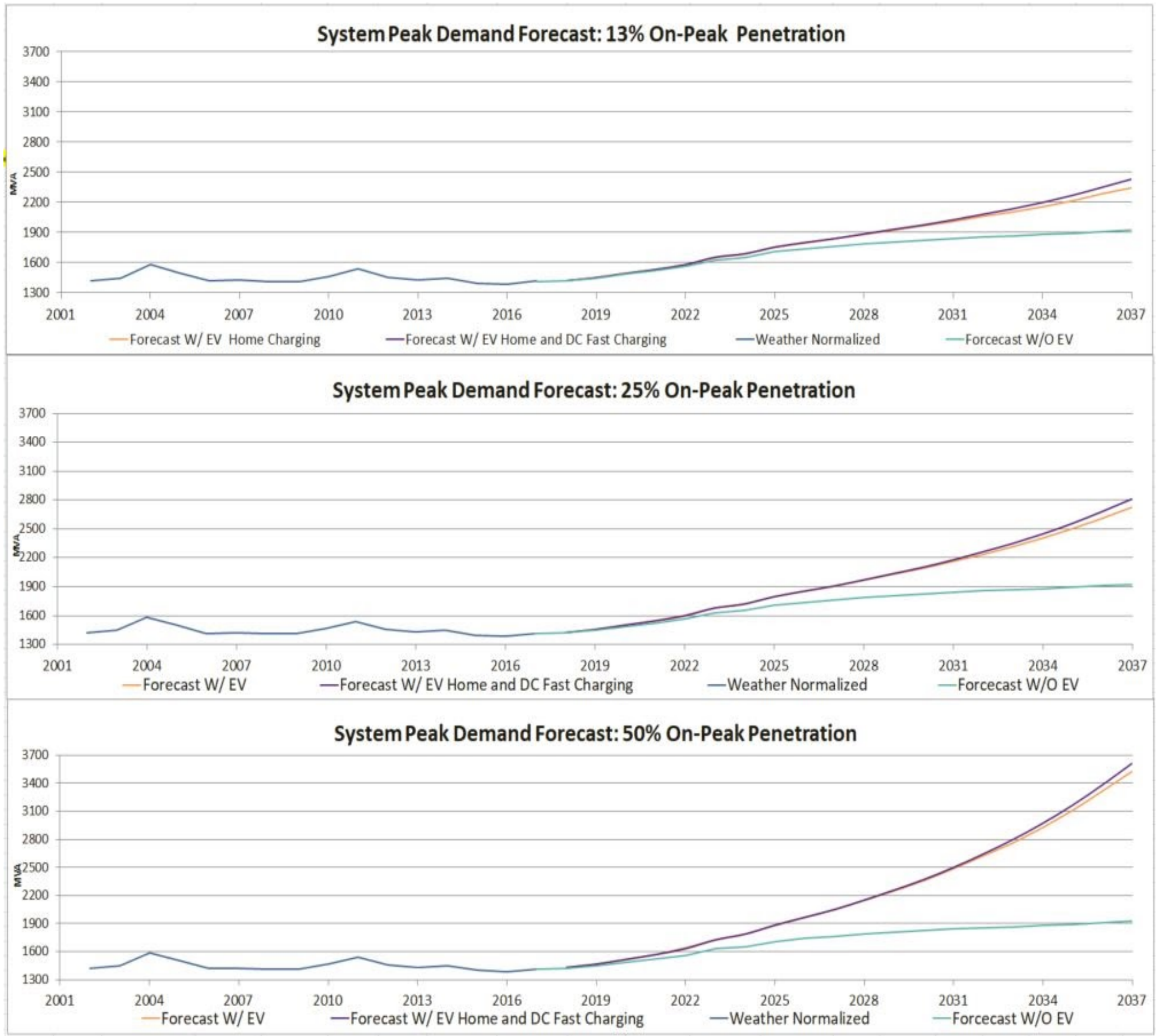
**Figure 8.6 – EV Charging Summer Trends from Hydro Ottawa Pilot Program**




### Hydro Ottawa System EV Impact

Using Hydro Ottawa demand growth data from section 7.3, estimated EV penetration trends, and commonly used home charging technology, Hydro Ottawa adjusted its demand growth forecast to reflect the possible impact of EVs on Hydro Ottawa's distribution system. On-peak penetration levels of 13%, 25% and 50% were analyzed for system peak demand forecasting effect.

**Figure 8.7 – Impact of EV Penetration on System Demand Forecast**




A peak demand forecast graph comparing the projections with and without EV considerations is shown in Figure 8.7. All three scenarios show very little impact over the short term; however, long term impacts to demand forecasts drastically increase under all three scenarios. There are many factors that may influence the growth of EVs the further into the future a projection is made. In the next five years, the EV population in Ontario – and by extension, Ottawa – is expected to grow significantly. From 2019-2025, the EV population is projected to grow to approximately 43,000 vehicles. Applying the 13%, 25% and 50% charging diversity factors results in an increase in the demand forecasts by up to 212 MW by 2025, as shown in Table 8.9.

**Table 8.9 – Demand Forecast by 2025 with EVs**

| Scenarios | 2025 | | |
|---|---|---|---|
| | **13%** | **25%** | **50%** |
| Forecast (MVA) | 1708 | 1708 | 1708 |
| Forecast +EV Home (MVA) | 1745 | 1778 | 1920 |
| Forecast increase with EVs (MVA) | 37 | 70 | 212 |

In addition to home charging, public charging infrastructure will also impact this future electrical demand. A report issued in 2019 by Natural Resources Canada ("NRCan") on DC Fast Charging clusters in the Ottawa region concluded that these new L3 charging stations would increase system peak load demand of the system by 2.7% in 2037.[2] Notably, the impact of DC fast charging stations on utility demand is much smaller than the impact of home charging. This is primarily because approximately 80% of an EV's charging occurs at home due to convenience and lower charging costs. This trend may change in the future as charging stations become more widely available, which will further increase market competition and lower charging costs.

**Station Level EV Impact**

For station level transformers, current and future investment in capacity increases will further strengthen the system's ability to not only serve future development growth but also to accommodate the impact of new technologies such as EVs. The 37MVA of additional demand expected under the 13% on-peak penetration scenario by 2025 is not expected to significantly shift the station capacity planning utilization factor shown in Figure 8.4 since EVs will be spread across different areas of Hydro Ottawa's service territory.

**Distribution Transformer EV Impact**

As EV penetration levels continue to rise in the Ottawa area, loading on distribution transformers at the residential level will be impacted. In new residential neighbourhoods, Hydro

[2] L. Wilkens and H. Ribberink, "The Impact of Clusters of DC Fast Chargers on the Electricity Grid in Ottawa," Natural Resource Canada (2019).

Ottawa typically would install 50kW transformers to connect a maximum of 10 customers. Taking into consideration future increases in EV penetration, the standard transformer size has increased to 100kW for a max connection of 12 customers. The changes from the current practice are shown in Table 8.10.

**Table 8.10 – Changes in Standard Transformer Sizing**

| XFMR Size (kVA) | Max # of Homes | |
|---|---|---|
| | New Standard | Current Practice |
| 50 | 5 | 10 |
| 75 | 8 | 25 |
| 100 | 12 | 37 |
| 167 | 20 | 51 |

The changes to the distribution transformers sizes in new and upgraded residential loops provide higher capacity for future EV penetration without affecting the life of the transformer.

As more data is collected from Hydro Ottawa's EV Charger pilot study, a more accurate on-peak EV demand profile will be created and applied to the transformer and system-wide impact analysis, thereby increasing the accuracy of the demand profile. In order to manage the impacts from EV growth, Hydro Ottawa will continue to monitor these trends to ensure a reliable power supply is maintained.

Hydro Ottawa will continue to lead and participate in pilot projects to get a better understanding of new technologies and their impact on the distribution system. Projects such as the Great-DR Project – Phase 2 (currently known as MiGen) will enable participants to share power from their renewable energy micro-generation plant with connected neighbours, store power at optimal times, and deliver excess power to the grid. This technology can be an invaluable tool in managing power supply at the demand source especially during peak demand situations where EVs at the neighbourhood level are a main cause. For more information on MiGen, please see the Material Investment Plan for Distribution Enhancements, in the System Service segment of Attachment 2-4-3(E).

### *8.1.6.5. Impact of Customer Preferences, Technology, and Innovation on Total Capital Cost*

As identified in section 1.10.1 and Exhibit 1-2-1: Customer Engagement Overview, Hydro Ottawa utilizes a variety of activities to maintain awareness of its customers' preferences, which were incorporated into the draft 2021-2025 plans presented to its customers in Phase II of the Customer Engagement. Through this engagement, Hydro Ottawa's customers have expressed overall support of the draft plan, with 48% of residential and 47% of small business having identified that "Hydro Ottawa should maintain the forecasted annual increase to deliver a program which delivers on the stated priorities." This survey also identified support for furthering renewal of Hydro Ottawa's infrastructure and system renewal where it will positively impact customer reliability. In contrast, mid-market customers have expressed concern over proposed rate increases, and an openness to decreases in service reliability if it would reduce the forecasted increases in the bill.

Based on this feedback, Hydro Ottawa will continue forward with its proposed balanced investment plan – with a continued focus on efficiencies and a strategy to maximize the impact of investments to match residential customer expectations, without further increasing rate pressures on business customers.

### *8.1.6.6. Technology Based Opportunities*

Over the next five years, Hydro Ottawa will continue implementing grid technologies to improve the reliability and efficiency of the distribution system. Annual automation installations will continue to improve system reliability and operational performance. Continued investment in the communication infrastructure will be essential to support current automation plans while maintaining the flexibility to integrate the technologies of tomorrow.

Hydro Ottawa's Supervisory Control and Data Acquisition ("SCADA") was upgraded in 2018. SCADA supports system reliability by providing system operators with real-time access to system status and control, reducing the time required to identify service disruptions, locate system faults, and operate the system to restore customers. As more distribution assets are connected to the SCADA system, the operator's situational awareness improves, resulting in a more focused and effective restoration effort. As a continuation of the SCADA upgrade project, Hydro Ottawa will be purchasing Distribution Management System ("DMS") functions to complement earlier efforts. The DMS implementation will enable analysis and automation tools as well as integration of other existing tools.

Another follow up to the SCADA project is the integration of the existing Outage Management System ("OMS") to the same platform as the new SCADA/DMS solution, making it a true Advanced Distribution Management System ("ADMS") platform. This includes software and services upgrades as well as new hardware implementation to run the system. This investment will enhance the efficiency and performance of the system operators in the control room by removing separate interfaces and incorporating SCADA, DMS and OMS into a single view.

Hydro Ottawa will be investing in new sensors and remotely operated devices in the distribution system. These additional devices will provide real-time data into the new DMS and OMS platforms as well as provide opportunities to remotely operated devices to improve restoration times.

#### *8.1.6.7. Innovative Processes, Services, Business Models, or Technologies*

In 2020, Hydro Ottawa will upgrade Copperleaf C55, an industry-leading and established Asset Investment Planning tool. This planning tool was first implemented in 2014, enabling the development of a strategic framework, investment decision optimization, and performance management. Copperleaf C55 achieves the objectives of value creation through better decision making, improved efficiency in the planning process, and meeting the standards set by the OEB's performance-based Renewed Regulatory Framework. The budget for upgrading C55 has been allocated to remain current with vendor support and take advantage of new functionality. Additionally, new value models will be configured to aid in the decision making process.

Hydro Ottawa

## 8.2. SYSTEM ACCESS INVESTMENTS

System Access expenditures are mandated by provincial legislation. While Hydro Ottawa strives to ensure projects in this Investment Category are completed as efficiently as possible, the company does not control the timing of these projects. While every attempt is made to predict and budget these costs, the actual implementation is not within Hydro Ottawa's control.

Budgeting is based on historical spending, known large projects and changes in legislative requirements. The System Access Investment Category is broken down into eight Capital Programs which are described below:

**Table 8.11 – System Access Capital Programs**

| | Capital Program | Description |
|---|---|---|
| SYSTEM ACCESS | Plant Relocation & Upgrade | Relocation or upgrade of Hydro Ottawa owned or Joint-Use overhead or underground equipment |
| | Residential Subdivision | New residential subdivisions consisting of townhomes, semi-detached, singles, or any combination of thereof |
| | Commercial Development | New Commercial development serviced via underground or vault equipment |
| | System Expansion | A demand driven addition to a distribution system in response to a request for additional customer connections that otherwise could not be made |
| | Embedded Generation | Customer driven embedded generation projects |
| | Infill Service (Residential & Small Commercial) | Infill service, or service upgrade, either Residential or Small Commercial |
| | Damage to Plant | Replacement of asset damages resulting in the loss of functional use caused by a third party |
| | Metering | Revenue Meter installations or retrofits |

Spending in the System Access Capital Programs focuses on:

- Relocation of existing plant due to infrastructure projects undertaken by third party agencies (e.g. the City of Ottawa and Village of Casselman, Ministry of Transportation of Ontario, National Capital Commission)
- Costs associated with the connection of new residential and commercial customers
- Expansion of Hydro Ottawa's distribution system to meet a specific customer or developer's needs
- Connection of new generation customers under various provincial programs
- Connection of one-off residential and small commercial infill connection requests that do not fall under the dedicated Residential and Commercial Capital Programs
- Replacement of damaged assets caused by a third party
- New and retrofit meter installations

As of 2021, the Damage to Plant Program will be moved to the System Renewal Investment Category since the primary driver for replacement of assets under this program is asset failure. Although the failure of the asset is caused by a third party, it aligns better with the description of System Renewal in the OEB Chapter 5 Filing Requirements.

The Capital Programs under System Access are broken down by Budget Program, as shown in Table 8.12. The table below includes a description for each Budget Program along with the primary driver. Please refer to section 5.2.1 Project Concept Definition for the definition of the drivers.

## Table 8.12 – System Access Expenditure Categories

| Capital Program | Budget Program | Primary Driver | Description |
|---|---|---|---|
| **Plant Relocation & Upgrade** | Plant Relocation & Upgrade | 3rd Party Requirements | • Relocation or upgrade of Hydro Ottawa owned or joint-use overhead or underground equipment;<br>• Equipment to permit for safe limits of approach. |
| **Residential Subdivision** | Residential Subdivision | Customer Service Request | • To connect new residential subdivisions consisting of townhomes, semi-detached, single, or any combination of housing units;<br>• Includes alternative bid and Hydro Ottawa built subdivisions;<br>• Trunk, primary & secondary distribution infrastructure all considered within scope. |
| **Commercial Development** | New Commercial Development | Customer Service Request | • New developments serviced via padmounted equipment (switchgear and/or transformers) or via a vault. |
| **System Expansion** | System Expansion Demand | Customer Service Request | • A demand driven addition to a distribution feeder in response to a request for additional customer; for example a line extension. |
| | Long Term Load Transfers | Mandated Service Obligation | • OEB mandated elimination of load transfers between Hydro Ottawa and HONI. Mandated load transfers have been completed. |
| | PSPC – Asset Transfer | Customer Service Request | • Ownership transfer and upgrade of customer-owned equipment at Tunney's Pasture, Central Experimental Farm and Confederation Height. |
| **Embedded Generation** | Embedded Generation | Customer Service Request | • Connection of customer driven embedded generation projects;<br>• Includes metering, service connection and protection and control as required. |
| **Infill Service** | Infill (Res & Small Com) | Customer Service Request | • Infill service or service upgrade for either residential or small commercial developments, i.e. services that do not require padmounted equipment or vault installations. |
| | ESA Flash Notice | Mandated Service Obligation | • Corrective actions to eliminate configurations where there is a transformer with a solidly grounded wye secondary with a potential return path via ground from the service to the transformer |
| **Damage to Plant** | Damage to Plant | Mandated Service Obligation | • Unplanned replacement of damaged assets caused by a third party;<br>• Target 100% recovery of cost from the third party; however, where tracking information is not available, Hydro Ottawa absorbs the cost or may attempt at recovery from its insurer. |
| **Metering** | Suite Metering | Customer Service Request | • Retrofit of suite meters (retrofit of bulk meters) for commercial and multi-residential buildings;<br>• Focus of the program is on residential retrofits in vertically arranged establishments |

### 8.2.1. Historical Expenditures

The following section outlines Hydro Ottawa's System Access Capital Programs and projects from 2016 through 2020 and discusses the variance in spending from the 2016-2020 rate application budgets previously approved by the OEB. Gross historical spending for each program under System Access is shown in Table 8.13.

**Table 8.13 – Historical Spending in System Access (Gross) ($'000s)**

| Investment Category / Capital Program | 2016 | | 2017 | | 2018 | | 2019 | | 2020 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Act. | Var. | Act. | Var. | Act. | Var. | Act. (*) | Var. | Act. (*) | Var. |
| Plant Relocation | $7,129 | (30)% | $5,183 | (33)% | $4,737 | (40)% | $11,719 | 45% | $12,012 | 46% |
| Residential | $4,350 | (37)% | $4,945 | (30)% | $6,179 | (14)% | $8,090 | 11% | $4,681 | (37)% |
| Commercial | $11,880 | (11)% | $10,990 | (16)% | $19,519 | 55% | $10,793 | (16)% | $11,023 | (16)% |
| System Expansion | $8,726 | 146% | $3,833 | 62% | $5,984 | 148% | $8,216 | 234% | $19,128 | 662% |
| Embedded Generation | $678 | 80% | $291 | (24)% | $89 | (77)% | $165 | (59)% | $338 | (17)% |
| Infill & Upgrade | $3,844 | 22% | $4,787 | 49% | $3,046 | (7)% | $3,658 | 9% | $4,087 | 19% |
| Damage to Plant | $1,122 | (2)% | $851 | (27)% | $1,125 | (6)% | $1,250 | 3% | $986 | (21)% |
| Metering | $77 | (54)% | $26 | (84)% | $169 | (3)% | $884 | 400% | $1,075 | 496% |
| **Total System Access** | **$37,805** | **(3)%** | **$30,908** | **(12)%** | **$40,849** | **16%** | **$44,775** | **25%** | **$53,331** | **46%** |
| Capital Contribution | $(19,490) | (18)% | $(17,310) | (25)% | $(16,701) | (27)% | $(25,928) | 11% | $(32,945) | 38% |
| **Net System Access** | **$18,316** | **20%** | **$13,597** | **14%** | **$24,147** | **98%** | **$18,847** | **51%** | **$20,387** | **61%** |

(*) Note that 2019 Actuals and 2020 Forecast are based on a 2019 Q2 Forecast

Since a large portion of projects under this Investment Category are customer driven, customer contributions are determined through the application of the OEB's prescribed economic evaluation methodology. Historically, customers contributed approximately 50% of the gross expenditure for System Access investments. Table 8.14 shows historical capital contribution by Capital Program. Hydro Ottawa expects this trend to continue based on the OEB's prescribed methodology.

### Table 8.14 – System Access Historical Contributions ($'000s)

| SA Capital Contributions | 2016 | | 2017 | | 2018 | | 2019 | | 2020 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Act. | Var. | Act. | Var. | Act. | Var. | Act. (*) | Var. | Act. (*) | Var. |
| Plant Relocation | $(4,039) | (12)% | $(2,731) | (41)% | $(2,781) | (42)% | $(7,099) | 46% | $(9,261) | 87% |
| Residential | $(3,676) | (44)% | $(3,112) | (53)% | $(7,398) | 9% | $(9,182) | 32% | $(3,288) | (54)% |
| Commercial | $(9,447) | (23)% | $(9,200) | (22)% | $(10,022) | (11)% | $(8,657) | (25)% | $(9,417) | (20)% |
| System Expansion | $(1,915) | 120% | $(2,200) | 272% | $(1,362) | 126% | $(4,936) | 702% | $(10,557) | 1582% |
| Embedded Generation | $(284) | 18% | $(223) | (17)% | $(87) | (68)% | $(100) | (64)% | $(186) | (35)% |
| Infill & Upgrade | $(1,452) | 15% | $(1,699) | 32% | $(1,701) | 29% | $(1,796) | 34% | $(1,643) | 20% |
| Damage to Plant | $0 | | $0 | | $0 | | $0 | | $0 | |
| Metering | $(21) | | $(37) | | $37 | | $0 | | $0 | |
| **Contributed Capital** | **$(20,835)** | **(19)%** | **$(19,201)** | **(24)%** | **$(23,313)** | **(7)%** | **$(31,770)** | **24%** | **$(34,352)** | **32%** |
| Plant Relocation | $0 | | $0 | | $1,332 | | $0 | | $0 | |
| Residential | $1,345 | (35)% | $1,891 | (10)% | $5,280 | 146% | $5,707 | 160% | $1,407 | (37)% |
| Commercial | $0 | | $0 | | $0 | | $135 | | $0 | |
| Infill & Upgrade | $1 | | $0 | | $0 | | $0 | | $0 | |
| **Contributed Plant** | **$1,346** | **(35)%** | **$1,891** | **(10)%** | **$6,612** | **207%** | **$5,842** | **166%** | **$1,407** | **(37)%** |
| **Capital Contributions** | **$(19,490)** | **(18)%** | **$(17,310)** | **(25)%** | **$(16,701)** | **(27)%** | **$(25,928)** | **11%** | **$(32,945)** | **38%** |

*Note that 2019 Actuals and 2020 Forecast are based on a 2019 Q2 Forecast

Gross historical spending in System Access has increased from 2016 through 2019 with the exception of 2017 due to delays in some majors projects. In 2020, the increase in spending is expected to continue. While some Capital Programs have remained consistent, others have seen considerable growth, causing the overall trend to show a steady increase in gross spending. While attempts are made to budget for both the historical trending and known major projects in System Access, variances from the budget do occur on a regular basis and are typically offset by the other Capital Programs within this category.

**Plant Relocation and Upgrade**

Hydro Ottawa experienced a lower than expected Plant Relocation and Upgrade spending in during 2016-2018. Spending in 2016 was largely driven by the City of Ottawa's LRT project while a decrease in 2017 spending was due to the Canada 150 celebration. In 2018, spending decreased primarily due to project delays. Spending in 2019 increased in comparison to previous years due to various City road rehabilitation projects such as Elgin Street renewal and Leitrim Road widening, as well as an increase in commercial customers requesting equipment upgrades. This trend is forecasted to continue in 2020 due to known planned projects such as Ottawa's LRT Stage 2, Montreal Road revitalization, and continued work on Elgin Street renewal.

Contributions to Plant Relocation and Upgrade projects are, on average, approximately 60% of total spending under this program. This is primarily due to cost sharing under the *Public Service Works on Highways Act* ("PSWHA") covering road work. Contributions are expected to increase in 2020 due to relocations required for the Ottawa's LRT Stage 2 project which does not fall under PSWHA.

**Residential Subdivisions**

Historically, residential subdivisions in Hydro Ottawa's service territory have followed a seven to 10 year rolling trend that has been consistent with the provincial and national averages since amalgamation. Hydro Ottawa experienced lower than expected Residential Subdivision spending in 2016 and 2017, but demand has increased through 2018 and 2019. Demand growth has been driven by a shift in development housing trends over this timeline due to intensification policies, where more blocks within a subdivision are being used for high density housing (stacked townhomes) on private streets. In addition, Hydro Ottawa is installing capacity infrastructure to accommodate future vehicle electrification. The forecast spend in 2020 is expected to be in line with 2016 and 2017 spending based on projects closing in 2019 and the known projects for 2020.

Contribution to Residential Subdivision projects are, on average, approximately 40% of total spending under this program. This is primarily due to the cost sharing using the OEB's prescribed economic evaluation methodology and incorporating contributed plant for assets the customers install which will be owned by Hydro Ottawa. Contributions typically fluctuate with respect to spending due to project delays year over year, but are expected to be in line with the average in 2020.

**Commercial Developments**

New Commercial Development has remained strong in Ottawa in recent years due to developer demand. Hydro Ottawa experienced a slightly lower than expected Commercial Development spending in 2016 and 2017 where the Canada 150 celebration had construction restrictions throughout the City. Spending in 2018 increased due to large projects such as the Museum of Science and Technology Storage Facility project. Spending in 2019 and forecasted for 2020 is in line with 2016 and 2017 trends.

Contributions to Commercial Development projects are on average approximately 80% of total spending. This is primarily due to the cost sharing using the OEB's prescribed economic evaluation methodology. Contributions typically fluctuate with respect to spending due to project delays year over year, but are expected to be in line with the average in 2020.

**System Expansion**

System Expansion spending fluctuates year-over-year due to customer requests and significant project requirements. Hydro Ottawa works with the relevant City of Ottawa departments and third parties to ensure that the forecasts are in line with their forecasted projects. However, the timing of these projects, and therefore the actual costs, are driven by third parties and not controlled by Hydro Ottawa.

Hydro Ottawa experienced above-forecasted System Expansion spending in the period of 2016-2019 due to various projects. A major project in 2016 and 2017 was the system expansion required for connecting the Domtar-Chaudiere project, a green energy hydro generation facility.

In 2018 and 2019, major contributors to this program are the Hull 1 & 2 projects, which involve connection of additional green energy hydro generation facilities, Ottawa's LRT Stage 2 extension projects, and the Public Services and Procurement Canada ("PSPC") asset transfer. The latter two projects are major drivers in the forecasted expenditures in 2020 making up 77% of total spending under this program.

Contributions to System Expansion projects are on average approximately 43% of total spending. This is primarily due to the cost sharing using the OEB's prescribed economic evaluation methodology for load and generation customers. Contributions have increased in 2019 and are forecasted to increase in 2020 compared to the average due to the contribution for the PSPC asset transfer project.

**Embedded Generation**

Costs associated with the connection of ERFs decreased over the period from 2016-2018. Spending in 2016 increased due to the connection of the Domtar-Chaudiere project, a green energy hydro generation facility. However, due to the IESO's FIT program ending, generation project spending has been decreasing. Spending in 2019 and 2020 are forecasted to increase due to customers participating in installing net-metering projects and the connection of Hull1 & 2, additional green energy hydro generation facilities.

Contributions to Embedded Generation projects are, on average, approximately 66% of total spending. This is primarily due to the cost sharing using the OEB's prescribed methodology for utilities to enable the connection of renewable generation. Contributions fluctuate based on the generation type and scope of the required connections year over year.

**Infill Service (Residential & Small Commercial)**

Infill services remain strong due to the City's Official Plan which encourages urban infill developments. Spending for Infill Services has remained consistent year-over-year with a slight decrease in 2018 due to reduction in customer demand. On average, program spending is 18% higher than forecasted budgets for the period of 2016-2020. The timing of Infill Service projects, and therefore actual costs, are driven by third parties and are not controlled by Hydro Ottawa. Spending in 2020 is forecasted to be consistent with recent years.

Contributions to Infill Service projects are, on average, approximately 44% of total spending under this program. This includes cost sharing using the OEB's prescribed methodology for a basic connection credit and Hydro Ottawa's annual free isolation to encourage customer maintenance. Contributions are expected to be in line with the average in 2020.

**Damage to Plant**

The Damage to Plant program covers costs associated with damage to Hydro Ottawa-owned plant caused by a third party. Hydro Ottawa targets 100% recovery of the costs from the third party; however, where tracking information is not available, Hydro Ottawa absorbs the cost or may attempt at recovery from the insurer. Due to the largely unpredictable and variable nature of the Damage to Plant Capital Program historical trends are used as the basis for budgeting and forecasting. Since 2007, Damage to Plant expenditures have remained relatively consistent year-over-year. The vast majority of damages occur to overhead and underground transformers, and wooden poles. The impact of increasing material and labour costs has offset gains made in reducing volumes and/or severity of incidents. As of 2021, the Damage to Plant Program will be moved to the System Renewal Investment Category.

**Metering**

Spending under this program has fluctuated over the years and focuses on customer requested installations of new and retrofits suite metering. This program experienced a significant increase in spend in 2019 from customer requests, majority from multi-residential high rises, to retrofit to Hydro Ottawa individual unit metering from a bulk meter. This trend is expected to continue in 2020 while customers look to provide tenants with more control of their electrical usage and cost.

### 8.2.2. Forecasted Expenditure

Forecasted annual spending takes into consideration a number of variables:

- Historic spending levels – trending of each category
- Known large future developments
- City plans and projects
- Economic indicators

The capital planning process has minimal impact on System Access capital expenditures since they are customer and third party driven, and thus, typically considered to be mandatory.

System Access projects may in some cases require a System Renewal or Service project to be delayed due to physical restrictions in the work area or system operability restrictions. In these circumstances, the risk to the system is evaluated and an optimal solution is determined with regards to work timing and prioritization.

**Table 8.15 – System Access Forecast Expenditures by Capital Program ($'000s)**

| Investment Category / Capital Program | Forecast | | | | |
|---|---|---|---|---|---|
| | 2021 | 2022 | 2023 | 2024 | 2025 |
| Plant Relocation | $10,135 | $8,418 | $8,474 | $5,451 | $5,427 |
| Residential | $4,893 | $4,999 | $5,006 | $5,010 | $4,980 |
| Commercial | $16,078 | $13,465 | $11,639 | $11,806 | $11,914 |
| System Expansion | $20,116 | $8,685 | $6,960 | $6,768 | $6,289 |
| Embedded Generation | $ 360 | $296 | $297 | $306 | $319 |
| Infill & Upgrade | $4,164 | $4,221 | $4,099 | $4,164 | $4,151 |
| Metering | $947 | $947 | $958 | $957 | $959 |
| **Total System Access** | **$56,693** | **$41,032** | **$37,434** | **$34,462** | **$34,039** |
| Capital Contribution | $(38,872) | $(23,153) | $(19,713) | $(18,836) | $(18,784) |
| **Net System Access** | **$17,820** | **$17,879** | **$17,720** | **$15,626** | **$15,255** |

System Access spending for the period of 2021-2025 is expected to be initially higher due to large known projects described below and then reduce to consistently lower levels. The majority of the increase in spending will be offset due to customer contributions based on the project drivers. The forecasted net spending in the System Access category is expected to remain at consistent levels through 2021-2025 as seen in Table 8.16. Hydro Ottawa expects that the economy in Ottawa will remain steady over the next five years, and work associated with the System Access Category will remain, on average, at the levels seen from 2016 through 2020.

**Table 8.16 – System Access Forecast Contributions by Capital Program ($'000s)**

| Capital Contribution | Forecast | | | | |
|---|---|---|---|---|---|
| | 2021 | 2022 | 2023 | 2024 | 2025 |
| Plant Relocation | $(7,919) | $(4,241) | $(4,274) | $(3,270) | $(3,256) |
| Residential | $(3,423) | $(3,497) | $(3,502) | $(3,505) | $(3,483) |
| Commercial | $(14,057) | $(11,198) | $(9,893) | $(10,035) | $(10,127) |
| System Expansion | $(13,075) | $(3,864) | $(1,740) | $(1,692) | $(1,572) |
| Stations Embedded Generation | $(198) | $(163) | $(163) | $(168) | $(176) |
| Infill & Upgrade | $(1,666) | (1,688) | $(1,640) | $(1,666) | $(1,660) |
| Metering | $0 | $0 | $0 | $0 | $0 |
| **Contributed Capital** | **$(40,337)** | **$(24,650)** | **$(21,212)** | **$(20,336)** | **$(20,275)** |
| Residential | $ 1,465 | $1,497 | $1,499 | $1,500 | $ 1,491 |
| **Contributed Plant** | **$1,465** | **$1,497** | **$1,499** | **$1,500** | **$1,491** |
| **CAPITAL CONTRIBUTION** | **$(38,872)** | **$(23,153)** | **$(19,713)** | **$(18,836)** | **$(18,784)** |

**Plant Relocation and Upgrade**

Plant Relocation costs are expected to remain at the elevated costs seen since 2016 as a result of the Ottawa LRT project. This project has resulted in a large increase in relocation costs for Hydro Ottawa. With Stage 1 of the Ottawa LRT completed in 2019, the City of Ottawa will continue directly into Stage 2 of the project. Additionally, there is a continued focus on customers looking to upgrade their aging equipment. Due to the combination of these drivers, Hydro Ottawa expects the spending to remain high from 2021-2023 before decreasing to previous historical averages.

**Residential Subdivisions**

With the housing starts forecast in line with historicals in Ottawa, Hydro Ottawa is expecting that the customer connection needs in the Residential Subdivision Program in the period of 2021-2025 will remain consistent with the average spend levels from 2016 through 2020. Hydro Ottawa plans to continue installing capacity infrastructure to accommodate future vehicle electrification.

**Commercial Developments**

Commercial connections in 2021 and 2022 are expected to experience an increase in spending due to the forecasted connection of Ottawa's LRT Stage 2 stations in addition to typical customer demand. Hydro Ottawa is expecting that the customer connection needs in the Commercial Developments Program from 2023-2025 will remain consistent with recent historical averages.

**System Expansion**

System Expansion is expected to return to historical values once all stages of Ottawa's LRT project are completed. Stage 1 of the Ottawa's LRT project was completed in 2019, with Hydro Ottawa completing its required work for this project in 2018. Stage 2 of the Ottawa's LRT project started in 2018 and will continue to 2023. Hydro Ottawa plans on starting system expansion work in 2020, with an expectation to complete this work by 2021. Additionally, the PSPC Asset Transfer Program of equipment transfer and upgrading is expected to continue through to 2022.

**Embedded Generation**

The Embedded Generation program is expected to remain at the consistent levels forecasted in 2020, with an increase for net metering connections from 2021 through 2025.

**Infill Service (Residential & Small Commercial)**

Hydro Ottawa is expecting that the customer connection needs in Infill & Upgrade Capital Programs will remain consistent with the levels from 2021 through 2025.

**Damage to Plant**

Starting in 2021, the Damage to Plant Capital Program will be moved to System Renewal since work done under this program aligns better with the OEB's definition for the System Renewal category. A damaged asset by a third party is a failed asset that needs to be replaced to be able to continue to provide customers with electricity services. Therefore, the forecast for the Damage to Plant Capital Program will not be part of the 2021-2025 forecasts for System Access.

**Metering**

With the continued interest from customers requesting to retrofit to Hydro Ottawa unit metering from a bulk meter, Hydro Ottawa is expecting that the Metering Program will remain consistent with spending levels in 2019 and 2020 for the 2021-2025 Test Years.

### 8.2.3. Material Investments

System Access investments are "modifications (including asset relocation) to a distributor's Distribution System a distributor is obligated to perform to provide a customer (including a generation customer) or group of customers with access to electricity services via the distribution system" as per the Chapter 5 Filing Requirements. Table 8.17 shows historical and forecast average expenditures by Budget Program within System Access.

**Table 8.17 – Average System Access Expenditures by Budget Program ($'000s)**

| Investment Category / Capital Program | 2016-2020 Avg | 2021-2025 Avg |
|---|---|---|
| Plant Relocation | $8,156 | $7,581 |
| Residential | $5,649 | $4,978 |
| Commercial | $12,841 | $12,981 |
| System Expansion | $9,178 | 9,764 |
| Embedded Generation | $312 | $316 |
| Infill & Upgrade | $3,885 | $4,160 |
| Metering | $446 | $953 |
| **TOTAL SYSTEM ACCESS** | **$ 40,467** | **$40,732** |

### *8.2.3.1. Plant Relocation*

The Hydro Ottawa Plant Relocation Capital projects are undertaken in response to requests to relocate Hydro Ottawa's distribution plant. When such a request is received, Hydro Ottawa will exercise its rights and discharge its obligations in accordance with existing acts, by-laws and Regulations including the *Public Service Works on Highways Act* for public road authorities, formal agreements, easements and law.

### *8.2.3.2. Residential, Commercial, System Expansion and Infill & Upgrade*

Hydro Ottawa's Residential, Commercial, System Expansion, and Infill & Upgrade Capital Programs are driven by the requirements as set out in the DSC, s*ection 6 – Distributors' Responsibilities, 6.1 – Responsibilities to Load Customers, 6.1.1,* which states that "A distributor shall make every reasonable effort to respond promptly to a customer's request for connection. In any event a distributor shall respond to a customer's written request for a customer connection within 15 calendar days. A distributor shall make an offer to connect within 60 calendar days of receipt of the written request, unless other necessary information is required from the load customer before the offer can be made."

### *8.2.3.3. Stations Embedded Generation*

The Hydro Ottawa Stations Embedded Generation Capital Program is driven by the DSC requirement from s*ection 6.2 – Responsibilities to Generators, 6.2.4* that states "Subject to all applicable laws, a distributor shall make all reasonable efforts in accordance with the provisions of section 6.2 to promptly connect to its distribution system a generation facility which is subject to an application for connection".

### *8.2.3.4. Metering*

The Hydro Ottawa Metering Capital Program is driven by the DSC requirement from s*ection 5.1 – Provision of Meters and Metering Services, 5.1.1* that states "A distributor shall provide, install and maintain a meter installation for retail settlement and billing purposes for each customer connected to the distributor's distribution system…".

## 8.3. SYSTEM RENEWAL INVESTMENTS

System Renewal investment includes sustainment programs that replace or refurbish assets which are nearing or have reached the end of their useful lives. The System Renewal Investment Category is broken down into four Capital Programs as described in Table 8.18.

**Table 8.18 – System Renewal Capital Programs**

| | Capital Program | Description |
|---|---|---|
| SYSTEM RENEWAL | Station Asset Renewal | Sustainment of discreet stations assets based on condition (Health Index) and prioritization. |
| | Overhead Distribution Assets Renewal | Sustainment of discreet overhead distribution assets based on assessed condition (Health Index) and prioritization. |
| | Underground Distribution Assets Renewal | Sustainment of discreet underground distribution assets based on assessed condition (Health Index) and prioritization. |
| | Corrective Renewal | Unplanned replacement of failed assets. |

Capital expenditures for System Renewal are sustainment investments that are determined as an output of the Asset Investment Strategy (see section 5 - Asset Management & Capital Expenditure Process Overview). The primary planning activities which impact System Renewal investments are the Asset Management Plans. The Asset Management Plans provide strategic guidance on replacement and investment forecasts, manage priorities, and identify process gaps.

Spending in the System Renewal Capital Programs is focused around the following:

- Replacement of end of life and obsolete station equipment such as power transformers, switchgear and protection devices
- Refurbishment of station building structures and facility systems

- Replacement of end of life Distribution Assets such as poles, distribution transformers, cables and switches
- Replacement of in service failed assets through the Corrective Renewal Program

The Capital Programs under System Renewal are broken down by Budget Program, as shown in Table 8.19. Table 8.19 includes a description for each Budget Program along with the primary driver. Please refer to section 5.2.1 Project Concept Definition for the definition of the drivers.

**Table 8.19 – System Renewal Expenditure Categories**

| | Capital Program | Budget Program | Primary Driver | Description |
|---|---|---|---|---|
| SYSTEM RENEWAL | Station Assets Renewal | Station Transformer Renewal | Failure Risk | • Station transformer refurbishment (life extension), or replacement as guided by the Asset Management Process. |
| | | Station Switchgear Renewal | Failure Risk | • Stations switchgear and relay refurbishment (life extension), or replacement as guided by the Asset Management Process. |
| | | Station Major Rebuilt | Failure Risk | • Station major rebuilds driven by multiple end-of-life assets. |
| | | Station P&C Renewal | Failure Risk | • Station protection and control devices refurbishment (life extension) or replacement guided by the Asset Management Process. |
| | | Station Battery Renewal | Failure Risk | • Station battery and charger refurbishment (life extension) or replacement guided by the Asset Management Process |
| | | Station Minor Assets Renewal | Failure Risk | • Station minor assets (such as insulators, arrestors, structures, etc.) refurbishment (life extension) or replacement<br>• Repairs, refurbishment or replacement of existing station building or property assets |
| | OH Distribution Assets Renewal | Pole Renewal | Failure Risk | • Planned replacement or upgrade of Hydro Ottawa owned poles or cross-arms based on condition assessment;<br>• Pole attachments and conductors are considered in scope for replacement along with the poles/cross-arms where they are of the same vintage as the poles |

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| | Capital Program (Cont'd) | Budget Program (Cont'd) | Primary Driver (Cont'd) | Description (Cont'd) |
|---|---|---|---|---|
| SYSTEM RENEWAL | OH Distribution Assets Renewal | Insulator Replacement | High Performance Risk | • Replacement or upgrade of Hydro Ottawa owned insulators that have been deemed a safety hazard, operationally inadequate and/or may cause pole fires |
| | | OH Transformer Renewal | Failure Risk | • Replacement of overhead distribution transformers due to functional, safety or environmental concern (leaks, PCBs, corrosion, failure risk, etc.), or upgrade, including transformer shop testing and commissioning |
| | | OH Switch/Recloser Renewal | Failure Risk | • Installation of new or the rehabilitation of overhead equipment ( i.e. switches, reclosers, cutouts, or arrestors) based on condition or functional requirements (i.e. upgrade to gang operable switches or automated devices) |
| | UG Distribution Assets Renewal | Elbow & Insert Replacement | Substandard Performance | • Replacement and upgrade of distribution transformer non-vented elbows and/or inserts on the 28 kV system due to safety concerns of flash over during operation below 0°C. |
| | | Vault Renewal | Failure Risk | • Vault rehabilitation due to condition of equipment or removal for consolidation or system betterment;<br>• Includes replacement of Jack-Bus arrangements;<br>• Exclusive of work considered under Plant Relocation & Upgrade |
| | | Civil Renewal | Failure Risk | • Rehabilitation or rebuild of underground cable chambers, collars, ducts, and equipment pads due to condition or failure risk;<br>• Includes installation of pads and vault space under pads;<br>• Duct extensions considered under Line Extensions |
| | | Cable Renewal | Failure Risk | • Replacement of underground cable based on condition;<br>• All cable types considered, i.e. PILC, XLPE, butyl rubber, etc.;<br>• Can include associated distribution transformer replacements based on condition assessment on a case-by-case basis |

| | Capital Program (Cont'd) | Budget Program (Cont'd) | Primary Driver (Cont'd) | Description (Cont'd) |
|---|---|---|---|---|
| | UG Distribution Assets Renewal | UG Switchgear Renewal | Failure Risk | • Replacement, refurbishment or upgrade of Hydro Ottawa owned switchgear based on condition |
| | | Cable Rejuvenation | Failure Risk | • Injection of underground cable based on condition. |
| | | UG Transformer Renewal | Failure Risk | • Replacement of underground distribution transformers due to functional, safety or environmental concern (leaks, PCBs, corrosion, failure risk, etc.), or upgrade, including transformer shop testing and commissioning |
| | Corrective Renewal | Damage to Plant | Failure | • Replacement of harmed or injured assets, resulting in the loss of functional use of the asset caused by a third party. |
| | | Emergency Renewal | Failure | • Failed equipment typically resulting in an outage but not necessarily. |
| | | Critical Renewal | Failure | • Failed equipment that may still be providing service, but no longer meet their designed requirements for safety, environmental or reliability reasons. |

### 8.3.1. Historical Expenditures

The following section outlines the capital expenditures in the System Renewal category from 2016 through 2020. Projects contained in the System Renewal and System Service categories are determined through Hydro Ottawa's Capital Expenditure Process described in section 5.2 - Variances in this category are tracked and approved through Hydro Ottawa's change order request process. This process documents changes in project plans or costs associated with each individual project. This process allows Hydro Ottawa to track and adjust the progress of the project to ensure that spending is completed as close as possible to the planned budget. Any large variance in the plan can be identified and allow for adjustment of the plan to keep the Asset Management Plan on track.

Historical spending in System Renewal has fluctuated over the five-year period, but overall has seen an increase in the spending trend, as in the other capital categories. Historical spending for 2016-2018 and spending for the bridge years (2019 and 2020), along with the variance from the plan budgets presented in the 2016-2020 rate application, are shown in Table 8.20. All of the Capital Programs under the System Renewal investment category are for the replacement of existing aging infrastructure and assets in poor condition.

**Table 8.20 – System Renewal Historical Variances ($'000s)**

| Investment Category / Capital Program | 2016 | | 2017 | | 2018 | | 2019 | | 2020 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Act. | Var. | Act. | Var. | Act. | Var. | Act.* | Var. | Act.* | Var. |
| Stations Asset Renewal | $13,346 | (20)% | $13,991 | 16% | $20,478 | 43% | $8,531 | (45)% | $6,970 | (52)% |
| OH Distribution Assets Renewal | $11,801 | 21% | $11,099 | 31% | $10,846 | 11% | $6,487 | (27)% | $9,164 | (1)% |
| UG Distribution Assets Renewal | $9,677 | 14% | $9,421 | 46% | $9,023 | 21% | $4,627 | (31)% | $7,415 | 5% |
| Corrective Renewal | $7,815 | 160% | $9,304 | 210% | $14,595 | 386% | $9,801 | 227% | $8,739 | 191% |
| **Total System Renewal** | **$42,639** | **12%** | **$43,816** | **46%** | **$54,942** | **59%** | **$29,446** | **(14)%** | **$32,288** | **(4)%** |
| Capital Contribution | $(2) | | $(5) | | $(41) | | $0 | | $0 | |
| **NET SYSTEM RENEWAL** | **$42,637** | **12%** | **$43,811** | **46%** | **$54,901** | **59%** | **$29,446** | **(14)%** | **$32,288** | **(4)%** |

(*) Note that 2019 Actuals and 2020 Forecast are based on a 2019 Q2 Forecast

**Stations Asset Renewal**

The investments in Stations Asset have remained steady from 2016-2017 with a large increase in 2018. While attempts to maintain overall spending on major station projects (Transformer Replacement and Switchgear Replacement) remain consistent year over year, it is not possible to smooth the spending over all years of the Capital Programs. The individual projects are budgeted to maximize the efficiency of the project and can cause the timing of costs required for these multiyear projects to fluctuate.

**Distribution Overhead and Underground Asset Renewal**

Spending in Distribution Assets has varied from 2016-2018 and is expected to decrease for 2019 and 2020. Spending in the Capital Program continues to focus on Pole and Cable Replacement Projects.

**Corrective Renewal**

The Corrective Renewal Capital Program previously known as "Plant Failure," was re-named and re-structured in 2018. Under the old structure, there were two budget programs- Distribution Plant Failure and Stations Plant Failure. Captured within these two Budget Programs was work to replace assets that had functionally failed requiring urgent intervention, as well as those that had fully failed requiring emergency replacement.

Under the new Corrective Renewal Program, there are two Budget Programs - Emergency Asset Renewal and Critical Asset Renewal. Emergency Asset Renewal addresses failed assets that typically, but not necessarily, result in an outage. Critical Asset Renewal addresses assets that still provide service, but no longer meet design requirements in regards to safety, environmental or reliability.

### *8.3.1.1. Historical Variances*

In 2016, spending in the System Renewal Investment Category was 5% over the approved budget. Sustainment (System Renewal and System Service) as defined by Hydro Ottawa was 4% below the approved budget. Individual programs variances are described below:

- The Corrective Renewal program was 160% over the approved budget. Poles, PILC cable and underground transformer failures continued to be major contributors to spending. In 2016, poles showed a significant increase in spending due to an increase in the required interventions identified through the distribution inspection programs.
- The Overhead Distribution Assets Renewal Program showed an increase of 21% over the approved budget. Pole replacement projects in Centretown East and West had some minor adjustments to scope due to issues found in the field. The Hawthorne 48M2

overhead pole line was identified for replacement through inspection results in late 2015 following the acquisition of the overhead line from HONI. The project was added to the budget early in the year.

- The Underground Distribution Assets Renewal Program was 14% above the approved budget primarily due to overspending in Cable Renewal.
- The Station Assets Program was 20% below the approved budget mainly due to delays in the construction of the Merivale Rebuilt project as HONI demanded changes in the new station design. The items identified in the HONI feasibility study failed to capture HONI's concern and a large change in scope was required after final review of the design drawings.

In 2017, spending in the System Renewal Investment Category was 46% over the approved budget. Sustainment (System Renewal and System Service) as defined by Hydro Ottawa was 4% above the approved budget. Individual programs variances are described below.

- The Corrective Renewal program was 210% over the approved budget. Poles, PILC cable and underground transformer failures continued to be major contributors to spending in this program. In 2017, poles and underground transformers showed high levels of spending due to increased attention to distribution inspection programs which identified a number of very poor poles and transformers.
- The Underground Asset Renewal Program was 46% above approved budget. Results from cable testing identified new areas where cables were in poor condition increasing budget requirements under the Cable Renewal Program. Through inspections, a switchgear was identified with major arcing and in need of replacement, and two adjacent switchgears were deemed as end of life and with no replacement parts. Therefore, scope was expanded to replace all three switchgear increasing spending under the Underground Switchgear Renewal Program.
- The Overhead Asset Renewal Program was 31% above approved budget mainly due to increases in the Pole Renewal Program. An overhead section on Hawthorne Road was identified as end of life and in poor condition during the installation of fiber in the area

that was part of the Telecommunication Masterplan project. Replacement was therefore accelerated to be able to install fiber on these poles. Composite poles were installed since this area was prone to woodpecker damage. In addition, there were two pole replacement projects which had an increase in scope after initial field inspections to include replacement of additional poor condition poles and secondary work.

In 2018, spending in the System Renewal Investment Category was 59% over the approved budget. Sustainment (System Renewal and System Service) as defined by Hydro Ottawa was 28% above the approved budget. Requirements for additional funds for the programs listed below were required to complete the project or meet required timelines. Unfortunately, they were determined late in the year not allowing enough time to react by adjusting other programs and projects leading to the overspend. Budgets for 2019 and 2020 have been adjusted to ensure alignment with OEB approved budget level for the 2016-2020 rate period. Individual programs variances are described below.

- The Corrective Renewal Program was 386% above the approved budget. Poles, PILC cable and underground transformer failures continued to be major contributors to spending in this program. In 2018, there were three major weather events that affected the Ottawa area heavily impacting the spending in emergency replacement of overhead assets. These events are described in section 4.3.2 Major Events.
- The Station Assets Renewal Program was 43% above approved budget mainly due to shift in spending from delays in the Merivale station project and increased spending required for Overbrook station project due to site issues.

In 2019, spending in the System Renewal Investment Category is forecasted to be 14% below the approved budget. Sustainment (System Renewal and System Service) as defined by Hydro Ottawa is forecasted to be 14% below the approved budget. Individual programs variances are described below.

- Due to overspending in 2018 in the Corrective Renewal Program, the 2019 sustainment budget was reduced by $9.5M from approved levels.
- The System Renewal Investment Category was reduced by $4.7M primarily due to reductions in Station Asset Renewal, OH Asset Renewal, and UG Asset Renewal.
- Corrective Renewal is expected to continue spending trends experienced in 2016-2017 due to increased attention to distribution inspection programs, which continue to identify a number of very poor poles and transformers.

In 2020, spending in the System Renewal Investment Category is forecasted to be 4% below the approved budget. Sustainment (System Renewal and System Service) as defined by Hydro Ottawa is forecasted to be 6% below the approved budget. Individual programs variances are described below.

- An additional reduction of $4.1M to the 2020 sustainment budget is required due to overspending in 2018 including a $1.5M reduction from System Renewal.

#### 8.3.2. Forecasted Expenditures

Annual spending for System Renewal is expected to on average $41.5M over the 2021-2025 period, which is a slight increase from the $40.6M annual spending during the 2016-2020 period, as seen in Table 8.21. The main driving factor for fluctuations in spending over 2020-2025 is due to timing of the major station projects. A continued focus will be seen through to 2025 and beyond on replacements of the critical assets as outlined in Section 6 Asset Lifecycle Optimization.

- **Station Assets Renewal** will decrease from spending levels seen in 2016-2020 due to moderate slowing of station asset replacements mitigated by increased monitoring of station transformers' condition. On average, this program will see a 25% reduction from the 2016-2020 rate period. A switchgear Renewal project is planned for Overbrook TO and Major Station Renewal projects are planned at Bells Corners DS, Rideau Heights DS, Fisher DS, Dagmar DS, and Shillington DS.

- **Overhead Distribution Asset Renewal** will focus on the replacement of poles with a 14% decrease from previous years mainly due to elimination/reduction of other OH equipment programs such as Insulator Renewal, OH Switch Renewal and OH Transformer Renewal.
- **Underground Distribution Asset Renewal** will see a 37% increase from previous rate submission mainly due to increased spending in Cable Renewal and Civil Renewal programs in order to maintain overall distribution system reliability
- **Corrective Renewal** will be kept at the same spending levels seen from 2017-2020.
- **Metering Renewal** is a new program introduced in the 2021-2025 rate period for replacement of various types of metering equipment that have reached end of life.

**Table 8.21 – System Renewal Forecast Expenditures by Capital Program ($'000s)**

| Investment Category / Capital Program | Forecast | | | | |
|---|---|---|---|---|---|
| | 2021 | 2022 | 2023 | 2024 | 2025 |
| Stations Asset Renewal | $9,938 | $12,071 | 8,444 | $7,437 | $9,316 |
| OH Distribution Assets Renewal | $7,999 | $8,795 | $8,795 | $8,841 | $8,044 |
| UG Distribution Assets Renewal | $11,082 | $10,780 | $11,164 | $11,079 | $11,077 |
| Corrective Renewal | $9,822 | $9,805 | $9,838 | $9,812 | $9,817 |
| Metering Renewal | $4,455 | $2,561 | $1,950 | $2,266 | $2,219 |
| **TOTAL SYSTEM RENEWAL** | **$43,296** | **$44,012** | **$40,191** | **$39,436** | **$40,474** |

### 8.3.3. Material Investments

System Renewal investments "involve replacing and/or refurbishing system assets to extend the original service life of the assets and thereby maintain the ability of the distributor's distribution system to provide customers with electricity services" as per section 5.1.2 of the OEB's Chapter 5 Filing Requirements.

The full Budget Program expenditures over the forecast period is shown in Table 8.22. Details for Hydro Ottawa's System Renewal Budget Programs from 2021 through 2025 that meet the materiality threshold of $750K are included in Attachment 2-4-3(E): Material Investments.

### Table 8.22 – System Renewal Forecast Expenditure by Program ($'000s)

| Capital Program | Budget Program[3] | Forecast 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|
| Stations Asset Renewal | Station Transformer Renewal | $2,365 | $0 | $0 | $0 | $0 |
| | Station Switchgear Renewal | $1,572 | $2,242 | $1,669 | $1,199 | $32 |
| | Station Battery Renewal | $84 | $84 | $84 | $84 | $84 |
| | Station P&C Renewal | $576 | $618 | $0 | $0 | $0 |
| | Station Minor Asset Renewal | $616 | $785 | $499 | $709 | $499 |
| | Station Major Rebuilt | $4,725 | $8,342 | $6,192 | $5,444 | $8,700 |
| OH Distribution Assets Renewal | Pole Renewal | $7,999 | $8,044 | $8,044 | $8,044 | $8,044 |
| | OH Switch/Recloser Renewal | $0 | $751 | $751 | $797 | $0 |
| UG Distribution Assets Renewal | Vault Renewal | $496 | $496 | $496 | $496 | $496 |
| | Civil Renewal | $1,010 | $1,010 | $1,010 | 1,010 | $1,010 |
| | Cable Replacement | $8,972 | $8,453 | $9,053 | $8,969 | $8,967 |
| | UG Switchgear Renewal | $605 | $605 | $605 | $605 | $605 |
| | UG Transformer Renewal | $0 | $216 | $0 | $0 | $0 |
| Corrective Renewal | Emergency Renewal | $4,482 | $4,482 | $4,482 | $4,482 | $4,482 |
| | Critical Renewal | $4,297 | $4,297 | $4,297 | $4,297 | $4,297 |
| | Damage to Plant[4] | $1,043 | $1,026 | $1,059 | $1,033 | $1,038 |
| Metering Renewal | Metering Upgrades | $4,455 | $2,561 | $1,950 | $2,266 | $2,219 |
| **TOTAL SYSTEM RENEWAL** | | **$43,296** | **$44,012** | **$40,191** | **$ 39,436** | **$ 40,474** |

[3] For further details on System Renewal Budget Programs, please see Attachment 2-4-3(E): Material Investments.
[4] Hydro Ottawa's Damage to Plant Capital Program covers costs associated with damage to Hydro Ottawa owned plant which is caused by a third party. Hydro Ottawa targets 100% recovery of the costs from the third party; however, when Hydro Ottawa is unable to identify the responsible party, Hydro Ottawa absorbs the cost or may attempt at recovery from the insurer.

## 8.4. SYSTEM SERVICE INVESTMENTS

System Service investments are "modifications to a distributor's distribution system to ensure the distribution system continues to meet distributor operational objectives while addressing anticipated future electricity service requirements" as per Section 5.1.2 of the OEB's Chapter 5 Filing Requirements. The five capital programs under System Service are described in Table 8.23 below.

**Table 8.23 – System Service Capital Programs**

| | Capital Program | Description |
|---|---|---|
| SYSTEM SERVICE | Capacity Upgrades | For relieving system capacity constraints resulted from load growth. |
| | Distribution Enhancements | A modification to the distribution system for purposes of improving system operating characteristics. |
| | Station Enhancements | A modification to a station for purposes of improving system operating characteristics. |
| | Grid Technologies | For improving and upgrading the operation of the system through new technologies and enhanced communications |
| | Metering | Upgrading customer meters for the ability to remotely disconnect and reconnect. |

Spending in the System Service Investment Category focuses on the following:

- Stations Capacity Upgrades, which covers the building of new or rebuilding of stations for the addition of transformation capacity or supply
- Enhancements, which includes a range of system betterment project such as Line Extensions and System Voltage Conversions projects

- Grid Technologies Program, which includes upgrades to the SCADA and communication systems

Capital Programs under System Service are broken down by Budget Program, as shown in Table 8.24. It includes a description of each Budget Program along with the primary driver. Please refer to section 5.2.1 Project Concept Definition for the definition of the drivers.

**Table 8.24 – System Service Expenditure Categories**

| | Capital Program | Budget Program | Primary Driver | Description |
|---|---|---|---|---|
| SYSTEM SERVICE | Capacity Upgrades | Stations Capacity Upgrades | Capacity Constraint | • New stations or increased station transformation capacity through transformer upgrades or additions at existing stations as identified through the System Capacity Assessment. |
| | | Distribution Capacity Upgrades | Capacity Constraint | • New distribution capacity projects identified through the System Capacity Assessment including conductor upgrades, and line extensions (Not deemed "System Expansion"). |
| | Distribution Enhancement | Distribution System Reliability | Reliability | • Specific enhancements to particular areas identified as having poor system reliability; typically more complex projects, including line extensions and addition of remote operable switches. |
| | | System Voltage Conversion | Capacity Constraint | • Distribution voltage conversion to increase capacity in areas seeing significant growth;<br>• Typically coincides with the retirement of existing stations or distribution assets due to condition or failure risk |
| | | Distribution Enhancements | System Efficiency | • Modifications to the existing distribution system made to improve system operating characteristics or operability (e.g. circuit reconfiguration)<br>• Installation of automated equipment for the purposes of improving operability |
| | Grid Technologies | SCADA Upgrades | System Efficiency | • Upgrades to the Supervisory Control and Data Acquisition (SCADA) system; both hardware and software upgrades are considered. |
| | | RTU Upgrades | System Efficiency | • Upgrading and addition of Remote Terminal Units (RTUs) in the distribution network to improve SCADA functionality |
| | | Communication Infrastructure | System Efficiency | • Installation of automated equipment for the purposes of communication. |
| | Station Enhancements | Stations Enhancements | System Efficiency | • Modifications to an existing station that is made to improve system operating characteristics. |
| | | Station Reliability | Reliability | • Specific enhancements to particular areas identified as having poor system reliability, typically more complex projects |
| | Metering | Remote Disconnected Smart Meter | System Efficiency | • Upgrading customer meters to enable remote disconnects and reconnects |

### 8.4.1. Historical Expenditures

The following section and Table 8.25 outlines capital spending in the System Service Investment Category from 2016 through 2020. Projects contained in the System Renewal and System Service categories are determined through Hydro Ottawa's capital expenditure planning process. Variances in this category are tracked and approved though Hydro Ottawa's change order request process. This process documents changes in project plans or costs associated with each individual project. This process allows Hydro Ottawa to track and adjust the progress of the sustainment project to ensure that spending is completed as close as possible to the planned budget. Any large variance in the plan can be identified and allow for adjustment of the plan to keep the asset management plan on track.

**Table 8.25 – System Service Historical Spending**

| Investment Category / Capital Program | 2016 | | 2017 | | 2018 | | 2019 | | 2020 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Act. | Var. | Act. | Var. | Act. | Var. | Act.* | Var. | Act.* | Var. |
| Capacity Upgrades | $3,186 | (44)% | $6,050 | (60)% | $14,423 | 38% | $13,870 | (4)% | $22,127 | 42% |
| Stations Enhancements | $219 | 61% | $1 | (99)% | $14 | (96)% | $20 | (92)% | $21 | (93)% |
| Distribution Enhancements | $12,715 | 6% | $11,805 | (4)% | $6,108 | (57)% | $7,920 | (38)% | $7,420 | (45)% |
| Grid Technology | $1,306 | (70)% | $6,098 | (5)% | $8,243 | 69% | $4,685 | 46% | $2,021 | (53)% |
| Metering | 357 | (14)% | $890 | (42)% | $1,013 | (36)% | $1,013 | (38)% | $1,031 | (38)% |
| **Total System Service** | **$17,783** | **(21)%** | **$24,844** | **(30)%** | **$29,801** | **(5)%** | **$27,509** | **(15)%** | **$32,621** | **(7)%** |
| Capital Contribution | $0 | | $0 | | $0 | | $0 | | $(1,177) | |
| **Net System Service** | **$17,783** | **(21)%** | **$24,844** | **(30)%** | **$29,801** | **(5)%** | **$27,509** | **(15)%** | **$31,443** | **(11)%** |

(*) Note that 2019 Actuals and 2020 Forecast are based on a 2019 Q2 Forecast

Historical spending in the System Service category has fluctuated within each Capital Program over the past five years, but overall has shown a steady upward trend. The largest contributors to System Service costs were Capacity Upgrades and Distribution Enhancements Capital Programs. These programs are designed to build out the distribution system to efficiently serve the customer at the best possible value.

**Capacity Upgrades**

The spending in Stations Capacity has fluctuated over the past five years, mainly due to timing in construction of major station projects. While attempts were made to keep overall spending on major station projects (Stations Capacity, Transformer Replacement and Switchgear Replacement) consistent year-over-year, it was not possible to levelize spending over all years of the Budget Programs. However, individual projects are budgeted in a manner that maximizes the efficiency of the project, but nonetheless can cause the timing of costs for these multiyear projects to fluctuate.

**Distribution Enhancements**

Spending in Distribution Enhancements has fluctuated since 2016, but overall has shown a decreasing trend. The largest spending in 2016 was in the Voltage Conversion Budget Program, which focused on the Woodroffe TS, South Nepean and Richmond areas. Line Extensions projects designed to deliver more capacity to areas have been moved to the Capacity Upgrades Capital Program. The majority of these projects are tied to the timing of the completion of Station New Capacity projects.

Capital Contributions are expected in 2020 for the Great DR Project - Phase 2 (currently known as MiGen) due to funding from NRCan.

**Grid Technologies**

The first year of Hydro Ottawa's Telecom Plan implementation and the SCADA upgrade projects was 2015. There have been some delays in these projects which shifted the original completion date from 2019 to 2020.

**Metering**

A new program was initiated in 2016 to upgrade meters to enable remote disconnection and reconnection of customers. This project eliminates the requirement to send a meter technician to the premise to disconnect or reconnect the meter when required. This also eliminates the need to install power limiters based on timer functionality for non-payment during the winter months along with the associated expense of travelling to the premise.

#### *8.4.1.1. Historical Variances*

In 2016, System Service spending was 21% below the original budget due to the following:

- The Capacity Upgrades program was 44% below budget due mainly to changes in project scope and delays in review of SIA/CIA by the IESO. The regulatory delay for TransCanada's Energy East pipeline and subsequent load deferral from the planned pumping station West of Richmond resulted in significant changes to the Richmond South Rebuild scope. The station project scope was reduced to a single transformer and half-switchgear line-up, with the infrastructure available for a second transformer in the future.
- The Grid Technology program was 70% below budget due to delays in fibre design and deployment in the Telecommunication Master Plan project.

In 2017, System Service spending was 30% below the approved budget due to the following:

- The Capacity Upgrades program was 60% below mainly due to the delays for the Richmond South as explained in previous year.
- The Metering program was 42% below budget since actual costs for installation were significantly less than what was estimated.

In 2018, System Service spending was 5% below the approved budget due to the following:

- The Capacity Upgrades program was 38% above budget due to major spending for Richmond South Station Project. This spending was originally forecasted for 2016 and 2017.

- The Grid Technology program was 69% above budget as a result of 2016-2017 under budget spending. In 2018, work was issued to an external contractor and execution accelerated in order to complete previous years scope.
- Distribution Enhancements program was 57% below budget due to underspent in Line Extensions and Voltage Conversion projects.

Spending in 2019 and 2020 for System Service is expected to be 15% and 7% below budget, respectively, as a result of the overall decrease in the sustainment (System Renewal and System Service) budget to accommodate for overspending in 2018. Major reductions occurred in the Distribution Enhancements Program.

### 8.4.2. Forecasted Expenditures

Annual spending for System Service is expected to average $26.3M over the 2021-2025 period which is an increase from the $22M average annual spending during the 2016-2020. Spending in the System Service category is expected to be high in 2021-2022 with a slight decrease over the last three years mainly due to timing of the major station projects. The requirement for the Stations Capacity and Distribution Enhancement Capital Programs has been defined in section 7 System Capacity Assessment.

Hydro Ottawa will continue to build and enhance stations while developing distribution feeders and ties similar to the 2016-2020 rate period as described in the following and summarized in Table 8.26:

- **Capacity Upgrades Program** will increase spending mainly due to the final years of the building of Cambrian MTS in the South Nepean region, as well as the construction of a new station in the east Leitrim region along with additional transmission upgrades to improve reliability and increase transmission capacity. Another contributor to the increased spending is the extension of associated new feeders to connect the new capacity with the customers and load

- **Distribution Enhancement Program** will slightly decrease spending from previous years. Spending will be focused on targeted distribution reliability improvements, the MiGen project and the Smart Grid Fund Initiatives program
- **Station Enhancement Program** includes spending required for enhancing of cyber security at stations as well as installation of new monitoring equipment at station transformers
- **Grid Technology Program** will maintain similar spending levels as in the previous rate period to upgrade Hydro Ottawa's OMS and enhance the new SCADA system by adding functionality to the Distribution Management System, along with the Field Area Network upgrade project
- **Metering Program** will continue to include the replacement of meters with remote connect/disconnect ability, but at a reduced investment level from the previous rate period

**Table 8.26 – System Service Forecast Expenditures by Capital Program ($'000s)**

| Investment Category / Capital Program | Forecast | | | | |
|---|---|---|---|---|---|
| | 2021 | 2022 | 2023 | 2024 | 2025 |
| Capacity Upgrades | $19,791 | $9,717 | $14,577 | $17,799 | $13,964 |
| Stations Enhancements | $905 | $459 | $459 | $459 | $459 |
| Distribution Enhancements | $6,957 | $12,732 | $5,981 | $4,597 | $4,796 |
| Grid Technology | $2,847 | $4,006 | $2,819 | $1,799 | $4,179 |
| Metering | $501 | $501 | $501 | $501 | $501 |
| **Total System Service** | **$31,001** | **$27,415** | **$24,337** | **25,155** | **$23,899** |
| Capital Contribution | $(2,022) | $(1,723) | $0 | $0 | $0 |
| **Net System Service** | **$28,980** | **$25,691** | **$24,337** | **$25,155** | **$23,899** |

### 8.4.3. Material Investments

The full Budget Program planned expenditure over the forecast period is shown in Table 8.27. The full justifications of the projects/programs above the $750K materiality threshold can be found in Attachment 2-4-3(E): Material Investments.

**Table 8.27 – System Service Forecast Expenditure by Budget Program ($'000s)**

| Capital Program | Budget Program | Forecast 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|---|
| Capacity Upgrades | Stations Capacity Upgrades | $16,931 | $6,112 | $10,327 | $12,786 | $8,950 |
| | Distribution Capacity Upgrades | $2,860 | $3,605 | $4,250 | $5,013 | $5,013 |
| Stations Enhancements | Stations Enhancements | $905 | $459 | $459 | $459 | $459 |
| Distribution Enhancements | Distribution System Reliability | $1,002 | $5,683 | $1,620 | $2,006 | $3,007 |
| | System Voltage Conversion | $0 | $3,034 | $2,099 | $731 | $0 |
| | Distribution Enhancements | $5,955 | $4,016 | $2,262 | $1,860 | $1,788 |
| Grid Technology | SCADA Upgrades | $803 | $2,708 | $1,521 | $501 | $1,891 |
| | RTU Upgrades | $253 | $253 | $253 | $253 | $253 |
| | Communications Infrastructure | $1,790 | $1,044 | $1,044 | $1,044 | $2,035 |
| Metering | Remote Disconnected Smart Meter | $501 | $501 | $501 | $501 | $501 |
| **System Service** | | **$31,001** | **$27,415** | **$24,337** | **$25,155** | **$23,899** |

### *8.4.3.1. Stations Capacity Upgrades*

The expenditures under the Station Capacity Upgrades Budget Program are identified and prioritized through the Capital Expenditure Process (section 5.2, and more specifically, through the System Capacity Assessment process). The 20-year outlook for capacity requirements is detailed in section 7.2 Ability to Connect New Load. Details on projects under the Station Capacity Upgrade Budget Program can be found in Attachment 2-4-3(E): Material Investments.

### *8.4.3.2. Distribution Capacity Upgrades*

The expenditures under the Distribution Capacity Upgrades Budget Program are identified and prioritized through the Capital Expenditure Process (section 5.2, and more specifically through the System Capability Assessment section 7). Ability to Connect New Load. Details on the Distribution Capacity Upgrade Budget Program can be found in Attachment 2-4-3(E): Material Investments.

#### *8.4.3.3. Station Enhancements*

The expenditures under Station Enhancement Budget Program are aimed at increasing visibility into the distribution system and improving reliability and operability through increasing remote operability and reporting/alarms. This program includes station investments driven by the Cybersecurity program, to ensure Hydro Ottawa is able to identify, protect and detect cyber threats on these critical systems. Details on the projects under the Station Enhancement Budget Programs can be found in Attachment 2-4-3(E): Material Investments.

#### *8.4.3.4. Distribution System Reliability*

The expenditures under the Distribution System Reliability Budget Program are identified and prioritized through the Capital Expenditure Process (section 5.2) and include projects identified through evaluation of the Worst Feeders (section 4.3.3). Details on the Distribution System Reliability Budget Program can be found in Attachment 2-4- (E): Material Investments.

#### *8.4.3.5. Voltage Conversion*

Details on the Voltage Conversion Budget Program can be found in Attachment 2-4-3(E): Material Investments.

#### *8.4.3.6. Distribution Enhancements*

Distribution Enhancement projects are targeted at making improvements to the existing distribution system in terms of reliability and/or operability and are typically targeted towards areas or equipment that are deemed problematic. Details on the Distribution Enhancement Budget Program can be found in Attachment 2-4-3(E): Material Investments.

#### *8.4.3.7. SCADA Upgrades*

The SCADA Upgrades Budget Program covers expenditures related to upgrading and/or renewing SCADA equipment that has reached end of life or has become obsolete. Details on the projects under the SCADA Upgrades Budget Program can be found in Attachment 2-4-3(E): Material Investments.

#### *8.4.3.8. RTU Upgrades*

The SCADA RTU Budget Program covers expenditures related to upgrading and/or renewing SCADA remote terminal units that have reached end of life or have become obsolete. Details on the projects under the RTU Upgrades Budget Program can be found in Attachment 2-4-3(E): Material Investments.

#### *8.4.3.9. Communication Infrastructure*

The Communication Infrastructure Budget Program covers expenditures related to the installation of equipment for the purposes of communication. Details on the projects under the Communication Infrastructure Budget Program can be found in Attachment 2-4-3(E): Material Investments.

#### *8.4.3.10. Remote Disconnect Metering*

Details on the Remote Disconnect Metering Budget Program can be found in Attachment 2-4-3(E): Material Investments.

### *8.5. GENERAL PLANT INVESTMENTS*

General Plant investments are "modifications, replacements or additions to a distributor's assets that are not part of its distribution system; including land and buildings; tools and equipment; rolling stock, electronic devices and software used to support day to day business and operations activities and capital contributions to other utilities" as per Section 5.1.2 of OEB's Chapter 5 Filing Requirements. Projects and programs in this category are driven by the requirements for capital to support day-to-day business and operations activities. There are nine capital programs under General Plant which are described in Table 8.28 below.

**Table 8.28 – General Plant Capital Programs**

| | Capital Program | Program Description |
|---|---|---|
| GENERAL PLANT | HONI Payments | Capital contributions to intangible assets purchased from HONI in conjunction with Hydro Ottawa's major station projects. Generally referred to as Connection and Cost Recovery Agreements (CCRAs). |
| | Buildings - Facilities | The program addresses the necessary building improvements for the administrative buildings, the operation centres including warehouse, storage and fleet space to ensure employees have a safe and efficient environment to operate within. |
| | Customer Service | The program includes the Customer Care and Billing system, Customer Service strategy, and Website Enhancements. The program objective is to add value to the customers and ensure accurate billing. |
| | ERP System | The Enterprise Resource Planning (ERP) system is a vital technology solution to achieve business outcomes. Hydro Ottawa utilizes J.D. Edwards (JDE) with an integration to WorkDay as its financial system. It is used to manage budgets, procure to pay, inventory, payroll, job costing, and all general ledger functions. |
| | Fleet Replacement | Acquisition of vehicles to replace end of life vehicles. Program objective is to provide safe, reliable and efficient vehicles to meet the operational requirements. |
| | IT New Initiatives | The program focuses on initiatives to optimize business operations including a Document Management System, an Enterprise Architecture Program, and a Data Management System. |
| | IT Life Cycle & Enhancements | The program addresses the renewal and maintenance of the IT infrastructure including device replacements, network security, data loss prevention program, network switches upgrade, network file storage, and software licenses. |
| | Operation Initiatives | The program objective is to strengthen the Geospatial Resource Management (GRM) system, enhance reliability services, and increase productivity and organizational effectiveness. |
| | Tools Replacement | Tools are needed to carry out the distribution maintenance and capital program efficiently and effectively, this program covers replacement of aged tool equipment. |

General Plant includes three major funding requirements:

1) The largest part of the General Plant investments is to replace assets that have reached end of life, including vehicles, tools, information technology equipment and software, and facilities. The investments are essential to meet the day-to-day operational needs and to provide employees with the tools and vehicles necessary to perform their work safely and efficiently;

2) Capital contributions to HONI for associated expansion work under CCRAs; and

3) New technology initiatives which have been identified in the 2021-2025 rate period. The key focus is to add value to customers and to increase operational efficiencies.

The Capital Programs under General Plant are broken down by Budget Program, as shown in Table 8.29. It includes the associated primary driver for each Budget Program. Please refer to section 5.2.1 - Project Concept Definition for the driver definitions.

**Table 8.29 – General Plant Expenditure Categories**

| | Capital Program | Budget Program | Primary Driver |
|---|---|---|---|
| GENERAL PLANT | HONI Payments | HONI Payments | System Capital Investment Support |
| | Facilities Management | Facilities Management | Non-System Physical Plant |
| | Fleet Replacement | Fleet Replacement | System Capital Investment Support |
| | Tools Replacement | Tools Replacement | System Maintenance Support |
| | IT Life Cycle & On-Going Enhancements | IT Life Cycle & On-Going Enhancements | Business Operation Efficiency |
| | IT New Initiatives | IT New Initiatives | Business Operation Efficiency |
| | ERP System | ERP System | Business Operation Efficiency |
| | Customer Service | Customer Service | Business Operation Efficiency |
| | Operation Initiatives | Operation Initiatives | Business Operation Efficiency |

### 8.5.1. Historical Expenditures

The following section, as well as Tables 8.30 and 8.31, outline Hydro Ottawa's General Plant Programs from 2016 through 2020 and discuss the spending variances over this five-year period. Expenditures and variances are tracked regularly by Hydro Ottawa's management team and are adjusted to align with any changes in corporate priorities.

## Table 8.30 – General Plant Historical Expenditure ($'000s)

| Investment Category / Capital Program | 2016 | | 2017 | | 2018 | | 2019 | | 2020 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Act. | Var. | Act. | Var. | Act. | Var. | Act.* | Var. | Act.* | Var. |
| HONI Payments | $4,647 | 2% | $5,647 | 13% | $3,143 | (37)% | $6,757 | 35% | $30,070 | 501% |
| Buildings - Facilities | $3,904 | (85)% | $18,207 | (48)% | $46,658 | 620% | $18,627 | 5659% | $453 | 87% |
| Customer Service | $1,296 | (65)% | $2,275 | (4)% | $38 | (97)% | $4,528 | (32%) | $5,099 | 348% |
| ERP System | $3,721 | (26)% | $7,309 | 1966% | $104 | (70)% | $159 | (55)% | $679 | (36)% |
| Fleet Replacement | $2,619 | 80% | $1,584 | 31% | $1,195 | (18)% | $583 | (61)% | $1,632 | (13)% |
| IT New Initiatives | $1,658 | (22)% | $651 | (44)% | $2,839 | 182% | $2,057 | 69% | 1,115 | (7)% |
| IT Life Cycle & Ongoing Enhancement | $1,152 | (19)% | $858 | (51)% | $2,059 | 8% | $800 | (64)% | $1,458 | (20)% |
| %Operations Initiatives | $937 | (13)% | $1,327 | 194% | $199 | (51)% | $688 | (23)% | $1,624 | 52% |
| Tools Replacement | $390 | (24)% | $442 | (15)% | $503 | (5)% | $1,039 | 93% | $450 | (18)% |
| **TOTAL GENERAL PLANT** | **$20,323** | **(56)%** | **$38,300** | **(20)%** | **$56,738** | **210%** | **$35,239** | **88%** | **$42,580** | **205%** |
| **Capital Contribution and Other** | **$0** | | **$0** | | **$0** | | **$(1,652)** | | **$(410)** | |
| **NET GENERAL PLANT** | **$20,323** | **(56)%** | **$38,300** | **(20)%** | **$56,738** | **210%** | **$33,586** | **80%** | **$42,170** | **202%** |

(*) Note that 2019 Actuals and 2020 Forecast are based on a Q2 2019 Forecast

**Table 8.31 – General Plant Historical Contributions ($'000s)**

| Capital Contribution | Actual | | | | |
|---|---|---|---|---|---|
| | 2016 | 2017 | 2018 | 2019* | 2020* |
| IT Life Cycle & Ongoing Enhancement | $0 | $0 | $0 | $(1,330) | $(410) |
| Operations Initiatives | $0 | $0 | $0 | $(323) | $0 |
| **Contributed Capital and Other** | **$0** | **$0** | **$0** | **$(1,652)** | **$(410)** |

*Note that 2019 Actuals and 2020 Forecast are based on Q2 2019 Forecast

Historical spending in the General Plant investments, excluding the Facilities Renewal Program and CCRAs, were kept at an average of $12M per year and spending was relatively consistent over the past five years. The details of these variances are outlined below.

**HONI Payments**

The HONI Payments Program is expected to be 105% above the total budget for 2016-2020 mainly due to $34.2M in transmission payments to HONI for the Cambrian MTS project. The total cost for the transmission upgrades required for connecting the new station is $50.2M; the remaining $16.0M will be paid in 2021. Other projects that contributed to spending under this program were:

- Richmond South ($60.9K)
- Hawthorne new 44M6 feeder ($1.8M)
- A6R Upgrade ($7.0M)
- Woodroffe TS CCRA ($1.9M)
- King Edward TS CCRA($100K)
- Merivale MTS Rebuilt ($2.3M)
- Slater T1 Emergency Replacement ($0.2M)
- Limebank T4 ($56.6K)
- Ellwood TS True up payment ($1.2M)
- Hawthorne 115kV True up payment ($2.2M)

**Buildings - Facilities**

Spending in this category was kept at a minimum level in 2016 and 2017 due to the anticipated move to the new facilities in 2019. In 2018, spending increased due to a renovation project at the Bank Street location. Bank Street was renovated to align with the Training & Development Plan (Exhibit 4-1-5: Workforce Staffing and Compensation), with the renovations completed in 2019. In 2019, the increase in spending is also partially due to Hydro Ottawa's behind-the-meter Solar arrays at the new facilities. This investment is expected to reduce Hydro Ottawa's environmental footprint and electricity costs for the next 30 years. Initiatives such as these demonstrate Hydro Ottawa's leadership with respect to reducing its environmental footprint. Moreover, the company was recognized as one of Canada's Greenest Employers for the seventh time.

**Facilities Renewal Program ("FRP")**

This project is a once in a generation investment to consolidate operations and administrative staff from the aging facilities carried since amalgamation into new facilities. For details, please see Attachment 2-1-1(A): New Administrative Office and Operations Facilities.

**Customer Service**

The essence of Hydro Ottawa's strategy is to put the customer at the centre of everything the company does. In the past five years, $13M was spent on capital investments to add value and improve the customer experience. The spending was slightly below the budget of $15M. Of this $13M, $8M was spent on an upgrade of the Customer Care and Billing system to meet regulatory and business requirements. The upgrade started in 2019 (later than the budget expectation). It is anticipated to be completed in 2020.

**Enterprise Resource Planning ("ERP") System**

Spending in 2016 and 2017 was largely for the implementation of a new ERP system with streamlined and automated Human Resources, Finance, Accounting, and Supply Chain processes. Back office operation improved significantly. Decision making improved due to increased self-service capabilities. The implementation was a huge success and Hydro Ottawa won the award for the Most Innovative Use of HR Technology at the Canadian HR Awards. This award recognizes Hydro Ottawa's use of the latest HR-specific technology to greatest effect. Due to an expanded project scope, some spending on the ERP system was delayed from 2016 to 2017.

**Fleet Replacement**

The increase in 2016 spending was due to a significant increase in US exchange rates and steel price increase subsequent to the budget preparation in late 2014. With Hydro Ottawa's strong commitment to budget control, 2019 spending was reduced significantly to allow five-year spending to materially achieve the approved budget of $7.5M. Also, as part of the company's central focus on innovation, productivity and cost control, there were two new models of mini bucket trucks purchased, making construction in narrow areas possible. These mini machines make digging and setting utility poles, restoring power, undertaking construction of distribution systems and maintaining power lines both safe and more efficient.

**Figure 8.8 – Mini Bucket Truck in Use**

**IT New Initiatives**

This program focuses on initiatives to optimize business operations. Spending in 2016 and 2017 was largely for the implementation of the Enterprise Communication Platform. The customer contact platform was expanded to allow multi-channel communication (voice, test, email, chat, etc.). Voice and data infrastructure was also upgraded before moving into the new facilities in 2019, which saved approximately $1M to $2M to install a traditional phone system in the facilities, and ongoing OM&A savings as well. The aging Interactive Voice Response ("IVR") was replaced by the new IVR, which improved reliability and call volume capability. In 2018 and 2019, the largest investment was the IT infrastructure for the Data Center in the new buildings. The project was designed to increase reliability and to minimize disruption to the business from the move. A Hot Aisle Containment Unit was purchased to increase data center cooling and energy efficiency which avoids the need for expensive raised floor construction. Overall spending was delayed slightly to align with the building move-in date.

**IT Life Cycle & Ongoing Enhancements**

The IT Life Cycle & Ongoing Enhancements Capital Program was largely to replace computer and network equipment. Spending was significantly below budget due to investments that were re-evaluated none of the end of life assets were being replaced automatically. Instead, they were reassessed with the consideration of innovation, productivity, and cost control to meet future technology needs. Certain funding was therefore reprioritized to fund the IT New Initiatives described in the previous paragraph.

**Operations Initiatives**

Spending in this program was mainly to finish the implementation of Mobile Workforce Management ("MWM"), the ongoing enhancement for Geographical Information System ("GIS"), OMS, and GPS. Spending exceeded the five-year budget, in part, due to the delay in completing the full implementation of the MWM system. The system went live in December 2015 with the new residential service connections contractor; however, some technical difficulties throughout implementation delayed full adoption by other groups including metering, collections, forestry until early 2016.[5] Additional increases in 2020 were due to the addition of Field Service Management and the Mobile Application Programs referenced in Attachment 2-4-3(E): Material Investments. These investments are aimed at increasing field service efficiency.

**Tools Replacement**

Spending for the Tools Replacement Capital Program was consistent over the past five years, with the exception of 2019 due to the new buildings and the old warehouse tools no longer being usable. The new warehouse tools allow for maximum capacity and efficiency.

### 8.5.2. Forecasted Expenditures

General Plant expenditure (excluding HONI Payments) are expected to average $12M annually over the 2021-2025 period (Table 8.32). This is an increase from the $11M annual spending during the 2016-2020 period (excluding the Facilities Renewal Program and HONI Payments).

[5] For more information on MWM implementation, please see Attachment 1-1-10(A): 2016 Annual Summary: Achieving Ontario Energy Board Renewed Regulatory Framework Performance Outcomes.

**Table 8.32 – General Plant Forecast Expenditure ($'000s)**

| Investment Category / Capital Program | Plan | | | | | Average |
|---|---|---|---|---|---|---|
| | 2021 | 2022 | 2023 | 2024 | 2025 | |
| HONI Payments | $16,918 | $210 | $200 | $5,130 | $4,200 | $5,332 |
| Buildings - Facilities | $428 | $428 | $403 | $403 | $403 | $413 |
| Customer Service | $2,539 | $1,616 | $846 | $826 | $1,188 | $1,403 |
| ERP System | $756 | $896 | $1,245 | $6,554 | $5,588 | $3,008 |
| Fleet Replacement | $6,345 | $4,526 | $2,220 | $1,681 | $2,008 | $3,356 |
| IT New Initiatives | $924 | $549 | $609 | $333 | $887 | $660 |
| IT Life Cycle & Ongoing Enhancement | $1,981 | $1,411 | $1,250 | $1,035 | $1,664 | $1,468 |
| Operations Initiatives | $1,681 | $1,572 | $321 | $928 | $477 | $996 |
| Tools Replacement | $474 | $474 | $462 | $465 | $469 | $469 |
| **TOTAL GENERAL PLANT** | **$32,047** | **$11,681** | **$7,556** | **$17,354** | **$16,884** | **$17,105** |
| Capital Contribution and Other | $(360) | $(340) | $(230) | $(390) | $(480) | $(360) |
| **NET GENERAL PLANT** | **$31,687** | **$11,341** | **$7,326** | **$16,964** | **$16,404** | **$16,745** |

Over the 2021-2025 rate period, Hydro Ottawa's General Plant investments will address the following needs under each Capital Program, which will continue to add value to Hydro Ottawa customers and to increase operational efficiencies:

- **HONI Payments** will increase significantly, especially in 2021, due to $16M forecasted for the S7M line upgrade associated with the Cambrian MTS project.
- **Buildings - Facilities** will encompass minimal investments in capital work relating to substations.
- **Customer Service** is mainly annual enhancements forecasted to meet the regulatory requirements and business needs of systems and services.In 2021, there will be an upgrade of the Meter Data System.
- **ERP Solution** spending is required to leverage next generation technology to provide a more cost-effective, flexible, and agile solution. The project will start in 2023 and be completed by 2025.

- **Fleet** spending will be higher than historical spending due to the need to replace aging fleet. The program objective is to maintain safe and reliable operation, as well as cost effective investments i.e. to avoid large repair costs or inefficiency caused by the aged vehicles.
- **IT New and Life Cycle** spending will continue to focus on innovation, productivity, and cost control. This is designed to move Hydro Ottawa from Good to Great and aid in achieving greatest efficiencies through automation, accurate information, and faster response time. Cybersecurity is strengthened to ensure customer data and Hydro Ottawa's distribution system are protected.
- **Operation** Initiatives continue to enhance Hydro Ottawa's GIS and OMS system annually. In addition, in 2021 and 2022, the Field Service Management and the new AMI Management will be implemented. This will benefit operations and increase efficiencies.
- **Tools** spending will be in line with historical spending.

### 8.5.3. Material Investments

The full justifications of the General Plant Programs above the materiality threshold can be found in Attachment 2-4-3(E): Material Investments.

#### *8.5.3.1. HONI Payments*

The forecast for HONI Payments is expected to fluctuate over the 2021-2025 rate term. In 2021, there will be a final $16M payment to HONI for the transmission cost associated with the supply to the new Cambrian MTS.

New agreements are expected to be signed for a number of transmission connected stations and jointly owned stations through 2025. Below is a list of projects that have been identified to start in the 2021-2025 rate period that will have new agreements with HONI issued. Forecasted capital contributions by Hydro Ottawa have been estimated, this forecast will only be confirmed once HONI completes the evaluation of projects and a contract is signed.

- Limebank MTS T4 CCRA ($800K)
- Overbrook TS CCRA ($400K)
- Riverdale TS CCRA ($2.4M)
- New East Station CCRA ($6.1M)
- Additional breakers at Bilberry CCRA (TBD)
- Uplands MTS CCRA ($83K)

Hydro Ottawa has a number of agreements signed with HONI. As a result, the company has obligations under these agreements to complete true-up reviews on five-year increments. These reviews may require that payments be made for any shortfall of revenue generated by HONI as a result of the forecasted load from Hydro Ottawa not materializing. While Hydro Ottawa attempts to maintain the loading committed to in the CCRA agreements, shortfalls do occur. Table 8.33 outlines the existing CCRA contracts that have true-up reviews over the 2021-2025 period.

**Table 8.33 – CCRA True-ups Schedule**

| Project Name | 2021 | 2022 | 2023 | 2024 | 2025 |
|---|---|---|---|---|---|
| A6R Upgrade | | | | X | |
| Hawthorne Transformer Upgrade | | | | X | |
| Overbrook Transformer Upgrade | | X | | | |
| Limebank MTS T3 | | | | X | |
| Orleans TS Feeder | | | | X | |
| Terry Fox MTS | | | X | | |

### *8.5.3.2. Buildings-Facilities*

The Buildings-Facilities Program anticipates minimal investments in capital work relating to substations.

### *8.5.3.3. Customer Service*

The Customer Service Capital Program is mainly forecasted for annual enhancement to meet regulatory requirements and business needs. No major upgrades are required over the next five years, except for a Meter Data System upgrade in 2021. Details on projects under the Customer Service Budget Program can be found in Attachment 2-4-3(E): Material Investments .

### *8.5.3.4. ERP Solution*

Details on projects under the ERP Solution Program can be found in Attachment 2-4-3(E): Material Investments.

### *8.5.3.5. Fleet*

Details on projects under the Fleet Replacement Program can be found in Attachment 2-4-3(F): Fleet Replacement Program.

### 8.5.3.6 IT New and Life Cycle

Details on projects under the IT New and Life Cycle Programs can be found in Attachment 2-4-3 (E): Material Investments.

### 8.5.3.7. Operation Initiatives

Details on projects under the Operations Initiatives can be found in Attachment 2-4-3(E): Material Investments.

### 8.5.3.8. Tools

Tools spending will be consistent with historical levels.

## GLOSSARY to the DSP

| | |
|---|---|
| CAIDI | Customer Average Interruption Duration Index |
| CCRA | Connection & Cost Recovery Agreement |
| CDP | Community Design Plan |
| CEATI | Centre for Energy Advancement through Technological Innovation |
| Chapter 5 | Ontario Energy Board's Filing Requirements for Electricity Distribution Rate Applications- 2018 Edition for 2019 Rate Applications-, Chapter 5, Consolidated Distribution System Plan, July 12th, 2018 |
| CIA | Connection Impact Assessment |
| CSA | Canadian Standard Association |
| DC | Direct Current |
| DER | Distributed Energy Resources |
| DGA | Dissolved Gas Analysis |
| DS | Distribution Station |
| DSC | Distribution System Code |
| DSP | Distribution System Plan |
| ECA | Electrical Contractors Association |
| ESA | Electrical Safety Authority |
| ERF | Energy Resource Facility |
| FEMI | Feeders Experiencing Multiple Interruptions |
| FIT | Feed-In-Tariff |
| GEA | Green Energy Act |
| GIS | Geographic Information System |
| GTAP | Grid Transformation Action Plan |
| HCI | Hydroelectric Contract Initiative |
| HESOP | Hydroelectric Standard Offer Program |
| HONI | HONI Networks Inc. |
| Hydro Ottawa | Hydro Ottawa Limited |
| HVDS | High Voltage Distribution Station |
| IEEE | Institute of Electrical and Electronics Engineers |
| IESO | Independent Electricity System Operator |
| IR | Infrared |
| IRRP | Integrated Regional Resource Planning |
| ITIC | Information Technology Industry Council |
| KPI | Key Performance Indicator |
| LDC | Local Distribution Company |
| LoS | Loss of Supply |
| LRT | Light Rail Transit |
| LTR | Limited Time Rating |
| O&M | Operation & Maintenance |
| OEB | Ontario Energy Board |
| OM&A | Operation, Maintenance & Administration |
| OMS | Outage Management System |
| ORTAC | Ontario Resource and Transmission Assessment Criteria |

| | |
|---|---|
| PILC | Paper Insulated Lead Cable |
| PMBOK | Project Management Body of Knowledge |
| PSUI-CDM | Process and Systems Upgrade initiative - Conservation Demand Management |
| REG | Renewable Energy Generation |
| RESOP | Renewable Energy Standard Offer Program |
| RIP | Regional Infrastructure Planning |
| RTU | Remote Terminal Units |
| SAIDI | System Average Interruption Duration Index |
| SAIFI | System Average Interruption Frequency Index |
| SARFI | System Average Root Mean Square (RMS) Variation Frequency Index |
| SCADA | Supervisory Control And Data Acquisition |
| SF6 | Sulfur Hexafluoride |
| the City | City of Ottawa |
| TIM | Testing, Inspection & Maintenance |
| TOD | Transit Oriented Developments |
| TS | Transmission Station |
| UCC | Utility Coordinating Committee |
| XFMR | Transformer |
| XLPE | Cross-Linked Polyethylene |

## Definitions

| | |
|---|---|
| 10 day Limited Time Rating (LTR) | The maximum loading level that can be applied to a station power transformer over a 10 day period resulting in a 0.1% loss in transformer life |
| Asset Owner | Shall be the Chief Electricity Distribution Officer or competent delegate. The Asset Owner is responsible for supporting the Asset Management System and providing top level visibility, as well as making high-level strategic decisions and approvals such as approving asset management objectives. |
| Asset Manager | Shall be the Director, Distribution Engineering and Asset Management supported by the Director, Distribution Operations or a competent delegate. The Asset Manager is responsible for the operation and continual improvement of the Asset Management System, making strategic decisions such as determining the balance of asset cost, risk and performance to meet the asset management objectives. |
| Asset Management Council | For asset management, the Asset Management Council (AMC) determines:<br>● the stakeholders that are relevant to the asset management system;<br>● the requirements and expectations of these stakeholders with respect to asset management;<br>● the criteria for asset management decision making; and<br>● the stakeholder requirements for recording financial and non-financial information relevant to asset management. |
| Budget Program | A grouping of similar projects that address the same assets and primary drivers. |
| Capital Program | A grouping of Budget Programs that have a similar asset type which are grouped on a meaningful basis for management reporting and are associated with the OEB Investment Categories. |
| Cold Load Pick Up | The operation of restoring power to equipment that has been without power for a period of time and thus will require additional current for the equipment restart |
| Corrective Maintenance | Activities aimed at fixing discovered issues of an asset |
| Distribution Assets | All infrastructure and equipment owned by Hydro Ottawa outside of the station used to distribute power to customers |
| Distribution Station (DS) | A sub-transmission (44kV or 13.2kV) connected station that steps down voltage to a distribution level (<44kV) |
| High Voltage Distribution Station (HVDS) | A transmission (≥50kV) connected station that steps down voltage to a distribution or sub-transmission level (<50kV) |
| Key Performance Indicator (KPI) | A measure of continuous improvement in asset management planning, capital investment planning and in customer oriented performance |
| Maintenance Program | A set of planned activities which improve the condition of Hydro Ottawa's assets |
| Measures | A quantifiable unit used to identify KPIs |
| Overhead | All infrastructure and equipment used to distribute power to customers that is supported above ground level by a series of poles |
| Predictive Maintenance | Activities that are used to determine the condition of an asset in order to predict when maintenance or replacement should be performed |

| | |
|---|---|
| Preventative Maintenance | Activities that are regularly performed on equipment to lessen the likelihood of it failing |
| Program | An activity plan that includes multiple subprojects |
| Project | A specific plan carried out to address a need |
| Station Assets | All infrastructure and equipment owned by Hydro Ottawa inside the station yard used to convert transmission voltages to distribution voltages |
| Transmission Station (TS) | A transmission (≥50kV ) connected station that steps down voltage to a lower transmission voltage (≥50kV ) |
| Underground | All infrastructure and equipment used to distribute power to customers that is located beneath ground level |

## Appendix A: Chapter 5 Filing Requirements to DSP Cross-reference

| OEB Chapter 5 Filing Requirements Section | | Hydro Ottawa DSP Section | |
|---|---|---|---|
| **5.2** | **Distribution System Plans** | | |
| 5.2 | Cross Reference Table from DSP to Chapter 5 Requirements | | Appendix A |
| **5.2.1** | **Distribution System Plan overview** | **1.0** | **Distribution System Plan Background** |
| | | 1.1 | Introduction |
| | | 1.2 | Overview of the document |
| 5.2.1 a) | Key Elements of the DSP | 1.3 | Key Elements of the DSP |
| 5.2.1 b) | Customers' preferences and expectations | 1.6 | Overview of Customer's Preferences and Expectations |
| 5.2.1 c) | Sources of Cost Savings | 1.7 | Sources of Cost Savings and Planning Coordination |
| 5.2.1 d) | DSP Period | 1.4 | DSP Period |
| 5.2.1 e) | Vintage of Information | 1.5 | Vintage of Information |
| 5.2.1 f) | Asset Management Process Updates | 1.8 | Changes in the DSP |
| 5.2.1 g) | Aspects Contingent on Ongoing Activities or Future Events | 1.9 | Aspects Contingent on Ongoing Activities or Future Events |
| 5.2.1 h) | Projects addressing the goals of the LTEP | 1.11 | Grid Modernization |
| 5.2.2 | Coordinated planning with third parties | 1.1 | Coordination with Third Parties |
| 5.2.2 a) | Consultations | 1.10.1 | Customer Consultations |
| 5.2.2 b) | Deliverables | 1.1 | Coordination with Third Parties |
| 5.2.2 c) | Relevant material documents | | Appendix E: Integrated Regional Planning -Load Forecast |
| 5.2.2 d) | IESO Letter of Comment – HOL's REG Investments Plan | 1.10.4 | Energy Resource Facility Generation Investment Coordination |
| **5.2.3** | **Performance measurement for continuous improvement** | **4.0** | **Performance Measurement for Continuous Improvement** |
| 5.2.3 a) | Distribution System Planning Process Performance Indicators | 4.1 | Distribution System Planning Process Key Performance Indicators |
| 5.2.3 b) | Unit cost metrics for capital expenditures and O&M | 4.2 | Unit Cost Metrics |
| 5.2.3 c) | Performance Summary | 4.3 | Historical Reliability Performance Analysis |

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|---|---|---|---|
| 5.2.3 d) | Effect of Performance Indicators on the DSP | 4.4 | Historical Performance Impact on DSP |
| 5.2.4 | Realized efficiencies due to smart meters | 4.5 | Realized Efficiencies Due to Smart Meters |
| 5.3 | Asset Management Process | 5.1 | Asset Management Process |
| 5.3.1 | Asset management process overview | 5.1 | Asset Management Process |
| **5.3.1 a)** | **Asset Management Objectives** | **3.0** | **Asset Management Strategy & Objectives** |
| 5.3.1 b) | Asset Management Process Components | 5.1 | Asset Management Process |
| **5.3.2** | **Overview of assets managed** | **2.0** | **Overview of the Distribution System** |
| 5.3.2 a) | Features of the Distribution Service Area | 2.1 | Features of the Distribution Service Area |
| | | 2.3 | Area Consideration |
| | | 2.4 | Current and Future Climate |
| 5.3.2 b) | System Configuration | 2.2 | System Configuration |
| 5.3.2 c) | Asset Demographics and Condition | 6.1 | Asset Demographics and Condition |
| 5.3.2 d) | Capacity of the Existing System Assets | 7.1 | Capacity of the Existing Assets |
| | | 7.2 | Ability to Connect New Load |
| 5.3.3 | Asset lifecycle optimization policies and practices | 6.2 | Asset Lifecycle Optimization Policies & Practices |
| 5.3.3 a) | Asset Replacement and Refurbishment | 6.2.1 | Asset Replacement and Refurbishment Policies |
| 5.3.3 b) | Asset Life Cycle Risk Management | 6.3 | Asset Lifecycle Risk Management |
| 5.3.4 | System Capability assessment for renewable energy generation | 7.3.1 | System Capability Assessment for Energy Resource Facilities |
| 5.3.4 a) | Connected Renewable generators over 10kW | 7.3.1.1 | Existing Facilities over 10kW |
| 5.3.4 b) | Renewable generation Forecast | 7.3.2 | Energy Resource Facilities Forecast |
| 5.3.4 c) | Capacity of the System to Connect REG | 7.3.5 | Energy Resource Facility Connection Capacity |
| 5.3.4 d) | System Constraints | 7.3.4 | System Constraints for Connecting New Energy Resource Facilities |
| 5.3.4 e) | Constraints for an Embedded distributor | 7.3.6 | Constraints for Embedded Distributors |
| **5.4** | **Capital Expenditure Plan** | **8.0** | **Capital Expenditure Plan** |
| 5.4 a) | Customer Engagement Activities | 5.4 | Customer Engagement Activities |
| 5.4 b) | System Development Expectations | 8.1.6 | System Development Expectations |

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|---|---|---|---|
| 5.4.1 | Capital expenditure planning process overview | 5.2 | Capital Expenditure Process |
| 5.4.1 a) | Analytics tools and Risk Management Methods | 5.2.2 | Project Evaluation |
| 5.4.1 b) | Prioritization Process, Tools and Methods | 5.2.4 | Project Optimization |
| 5.4.1 c) | Prioritization of REG Investments | | |
| 5.4.1 d) | Non-Distribution System Alternatives | 5.3 | Non-distribution System Activities |
| 5.4.1 e) | Strategy for Grid Modernization | 5.5 | Implementation of Cost Effective Modernization of the Distribution System |
| 5.4.1 f) | Rate-Funded Activities to Defer Distribution Infrastructure | 8.1.4 | Non-distribution Activities |
| 5.4.2 | Capital expenditure summary | 8.1 | Overall Capital Investments |
| 5.4.2 | System Access | 8.2 | System Access |
| 5.4.2 | System Renewal | 8.3 | System Renewal |
| 5.4.2 | System Service | 8.4 | System Service Investments |
| 5.4.2 | General Plant | 8.5 | General Plant |
| 5.4.3 | Justifying capital expenditures | 8.1.1 | Historical and Forecasted Expenditure Comparison |
| | | 8.1.2 | Impact O&M Cost |
| | | 8.1.3 | Drivers by Investment Categories |
| 5.4.3.1 | Overall plan | 8.1 | Overall Capital Investments |
| 5.4.3.2 | Material investments | Att. 2-4-3(E) | Material Investments |

## Appendix B: Hydro Ottawa Station Table

The following Hydro Ottawa and HONI owned stations in the table below are used to supply Hydro Ottawa's customers. The stations are herein referenced by the nomenclature (Hydro Ottawa Station Name) used by Hydro Ottawa.

| Hydro Ottawa Station Name | Designation | Owner | Primary/Secondary Voltage (kV) |
|---|---|---|---|
| Albion TA | HVDS | HONI-Hydro Ottawa | 230/13.2 |
| Albion UA | DS | Hydro Ottawa | 13.2/4.16 |
| Augusta UD | DS | Hydro Ottawa | 13.2/4.16 |
| Bantree AL | DS | Hydro Ottawa | 13.2/4.16 |
| Barrhaven DS | DS | Hydro Ottawa | 44/8.32 |
| Bayshore DS | DS | Hydro Ottawa | 44/8.32 |
| Bayswater UJ | DS | Hydro Ottawa | 13.2/4.16 |
| Beaconhill MS | DS | Hydro Ottawa | 44/8.32 |
| Beaverbrook | DS | Hydro Ottawa | 44/12.43 |
| Beckwith DS | DS | HONI | 44/27.6 |
| Beechwood UB | DS | Hydro Ottawa | 13.2/4.16 |
| Bells Corner DS | DS | Hydro Ottawa | 44/8.32 |
| Bilberry TS | HVDS | HONI-Hydro Ottawa | 115/27.6 |
| Blackburn MS | DS | Hydro Ottawa | 44/8.32 |
| Borden Farm DS | DS | Hydro Ottawa | 44/8.32 |
| Bridlewood MS 27kV | HVDS<br>DS | Hydro Ottawa | 115/27.6<br>44/27.6 |
| Bridlewood MS 8kV | HVDS<br>DS | Hydro Ottawa | 115/8.32<br>44/8.32 |
| Bronson SB | DS | Hydro Ottawa | 13.2/4.16 |
| Brookfield AF | DS | Hydro Ottawa | 13.2/4.16 |
| Cahill AN | DS | Hydro Ottawa | 13.2/4.16 |
| Cambridge AM | DS | Hydro Ottawa | 13.2/4.16 |
| Carling SM | DS | Hydro Ottawa | 13.2/4.16 |
| Carling TM | HVDS | HONI-Hydro Ottawa | 115/13.2 |
| Casselman MS | DS | Hydro Ottawa | 44/8.32 |
| Centrepointe DS | HVDS | Hydro Ottawa | 115/8.32 |
| Church AA | DS | Hydro Ottawa | 13.2/4.16 |

| | | | |
|---|---|---|---|
| Clifton UL | DS | Hydro Ottawa | 13.2/4.16 |
| Clyde UC | DS | Hydro Ottawa | 13.2/4.16 |
| Cyrville MTS | HVDS | Hydro Ottawa | 115/27.6 |
| Dagmar AC | DS | Hydro Ottawa | 13.2/4.16 |
| Eastview UT | DS | Hydro Ottawa | 13.2/4.16 |
| Edwin UV | DS | Hydro Ottawa | 13.2/4.16 |
| Ellwood MTS | HVDS | Hydro Ottawa | 230/13.2 |
| Epworth DS | HVDS | Hydro Ottawa | 115/8.32 |
| Fallowfield MS | HVDS | Hydro Ottawa | 115/27.6 |
| Fisher AK | DS | Hydro Ottawa | 13.2/4.16 |
| Florence UF | DS | Hydro Ottawa | 13.2/4.16 |
| Gladstone UX | DS | Hydro Ottawa | 13.2/4.16 |
| Hawthorne TS | HVDS | HONI | 230/44 |
| Henderson UN | DS | Hydro Ottawa | 13.2/4.16 |
| Hillcrest AH | DS | Hydro Ottawa | 13.2/4.16 |
| Hinchey TH | HVDS | HONI-Hydro Ottawa | 115/13.2 |
| Holland SH | DS | Hydro Ottawa | 13.2/4.16 |
| Janet King DS 28kV | DS | Hydro Ottawa | 44/27.6 |
| Janet King DS 8kV | DS | Hydro Ottawa | 44/8.32 |
| Jockvale DS | DS | Hydro Ottawa | 44/8.32 |
| Kanata MTS | HVDS | Hydro Ottawa | 230/27.6 |
| King Edward SK | DS | Hydro Ottawa | 13.2/4.16 |
| King Edward TK | HVDS | HONI-Hydro Ottawa | 115/13.2 |
| Langs AP | DS | Hydro Ottawa | 13.2/4.16 |
| Leitrim MS | DS | Hydro Ottawa | 44/27.6 |
| Limebank MS | HVDS | Hydro Ottawa | 115/27.6 |
| Lincoln Heights TD | HVDS | HONI-Hydro Ottawa | 115/13.2 |
| Lisgar TL | HVDS | HONI-Hydro Ottawa | 115/13.2 |
| Longfields DS | DS | Hydro Ottawa | 44/27.6 |
| Manordale DS | HVDS | Hydro Ottawa | 115/8.32 |
| Marchwood MS | HVDS | Hydro Ottawa | 115/27.6 |
| McCarthy AQ | DS | Hydro Ottawa | 13.2/4.16 |
| Merivale MTS | HVDS | Hydro Ottawa | 115/8.32 |
| Moulton MS | HVDS | Hydro Ottawa | 115/27.6 |
| Munster DS | DS | Hydro Ottawa | 44/8.32 |
| Nepean AB | DS | Hydro Ottawa | 13.2/4.16 |
| Nepean TS | HVDS | HONI | 230/44 |

| | | | |
|---|---|---|---|
| Orleans TS | HVDS | HONI | 230/27.6<br>115/27.6 |
| Overbrook SO | DS | Hydro Ottawa | 13.2/4.16 |
| Overbrook TO | HVDS | HONI-Hydro Ottawa | 115/13.2 |
| Parkwood Hills DS | DS | Hydro Ottawa | 44/8.32 |
| Playfair AJ | DS | Hydro Ottawa | 13.2/4.16 |
| Q.C.H. DS | DS | Hydro Ottawa | 44/8.32 |
| Queens UQ | DS | Hydro Ottawa | 13.2/4.16 |
| Richmond North DS | DS | Hydro Ottawa | 44/8.32 |
| Richmond South DS | HVDS | Hydro Ottawa | 115/8.32 |
| Rideau Heights DS | DS | Hydro Ottawa | 44/8.32 |
| Riverdale SR | DS | Hydro Ottawa | 13.2/4.16 |
| Riverdale TR | HVDS | HONI-Hydro Ottawa | 115/13.2 |
| Russell TB | HVDS | HONI-Hydro Ottawa | 115/13.2 |
| Shillington AD | DS | Hydro Ottawa | 13.2/4.16 |
| Slater SA | DS | Hydro Ottawa | 13.2/4.16 |
| Slater TS | HVDS | HONI-Hydro Ottawa | 115/13.2 |
| South Gloucester DS | HVDS | HONI | 115/8.32 |
| South March TS | HVDS | HONI | 230/44 |
| South March DS | DS | Hydro Ottawa | 44/12.43 |
| Stafford Road DS | DS | Hydro Ottawa | 44/8.32 |
| Startop MS | DS | Hydro Ottawa | 44/8.32 |
| Terry Fox MTS | HVDS | Hydro Ottawa | 230/27.6 |
| Uplands MS | HVDS | Hydro Ottawa | 115/27.6 |
| Urbandale AE | DS | Hydro Ottawa | 13.2/4.16 |
| Vaughan UG | DS | Hydro Ottawa | 13.2/4.16 |
| Walkley UZ | DS | Hydro Ottawa | 13.2/4.16 |
| Woodroffe DS | DS | Hydro Ottawa | 44/8.32 |
| Woodroffe TW | HVDS | HONI-Hydro Ottawa | 115/13.2 |

## Appendix C: Capital Budget Restructure

| | OLD | | NEW | |
|---|---|---|---|---|
| | **Capital Program** | **Budget Program** | **Capital Program** | **Budget Program** |
| **SYSTEM ACCESS** | Plant Relocation | Plant Relocation & Upgrade | Plant Relocation | Plant Relocation & Upgrade |
| | Residential | Residential Subdivision | Residential | Residential Subdivision |
| | Commercial | Commercial Development | Commercial | Commercial Development |
| | System Expansion | System Expansion | System Expansion | System Expansion |
| | | | | Long Term Load Transfers |
| | | | | PWGSC – Asset Transfer |
| | Embedded Generation | Embedded Generation | Embedded Generation | Embedded Generation |
| | Infill & Upgrade | Infill Service (Res & Small Com) | Infill & Upgrade | Infill Service (Res & Small Com) |
| | | | | ESA Flash Notice |
| | Damage to Plant | Damage to Plant | Metering Upgrades | Metering - Reverification |
| | | | | Suite Metering |
| **SYSTEM RENEWAL** | Station Assets | Stations Transformer Replacement | Station Assets Renewal | Station Transformer Renewal |
| | | Stations Switchgear Replacement | | Station Switchgear Renewal |
| | | Stations Plant Failure | | **Station Battery Renewal** |
| | Stations Refurbishment | Stations Enhancements | | **Station P&C Renewal**[1] |
| | | | | **Station Ground Grid Renewal**[1] |
| | | | | **Station Minor Assets Renewal**[1] |
| | | | | **Station Major Rebuild**[1] |

| | | | | |
|---|---|---|---|---|
| | Distribution Assets | Pole Replacement | OH Distribution Assets Renewal | Pole Renewal |
| | | Insulator Replacement | | Insulator Replacement |
| | | Elbow & Insert Replacement | | OH Transformer Renewal |
| | | Distribution Transformer Replacement | | OH Switch/Recloser Renewal |
| | | Vault Rehab or Removal | UG Distribution Assets Renewal | Elbow & Insert Replacement |
| | | Civil Rehabilitation | | Vault Renewal |
| | | Cable Replacement | | Civil Renewal |
| | | Switchgear New & Rehab | | Cable Renewal |
| | | O/H Equipment New & Rehab | | UG Switchgear Renewal |
| | | | | **Cable Rejuvenation**[1] |
| | | | | **UG Transformer Renewal 1** |
| | | Distribution Plant Failure | Corrective Renewal | **Damage to Plant**[2] |
| | | | | **Emergency Renewal**[1] |
| | | | | **Critical Renewal**[1] |
| | Distribution Enhancement | System Voltage Conversion | | |
| | Metering | Remote Disconnected Smrt Meter | | |
| SYSTEM | Stations Capacity | Stations New Capacity | Capacity Upgrades | Stations Capacity Upgrades |
| | Distribution Enhancement | Line Extensions | | Distribution Capacity Upgrades |
| | | System Reliability | Distribution Enhancement | **Distribution System Reliability**[1] |
| | | Distribution Enhancements | | **System Voltage Conversion**[2] |
| | Automation | Distribution Automation | | **Distribution** |

| | | | | |
|---|---|---|---|---|
| SERVICE | | | | **Enhancements**[2] |
| | | Substation Automation | Grid Technologies | SCADA Upgrades |
| | | SCADA Upgrades | | RTU Upgrades |
| | | RTU Additions | | Communication Infrastructure |
| | | | **Stations Enhancements** | **Stations Enhancements**[2] |
| | | | | **Station Reliability**[1] |
| | | | **Metering** | **Remote Disconnected Smrt Meter**[2] |
| GENERAL PLANT | HONI Payments | HONI Payments | HONI Payments | HONI Payments |
| | Facilities Management | Facilities Management | Facilities Management | Facilities Management |
| | Fleet Replacement | Fleet Replacement | Fleet Replacement | Fleet Replacement |
| | Tools Replacement | Tools Replacement | Tools Replacement | Tools Replacement |
| | IT Life Cycle & On-Going Enhancements | IT Life Cycle & On-Going Enhancements | IT Life Cycle & On-Going Enhancements | IT Life Cycle & On-Going Enhancements |
| | IT New Initiatives | IT New Initiatives | IT New Initiatives | IT New Initiatives |
| | ERP System | ERP System | ERP System | ERP System |
| | Customer Service | Customer Service | Customer Service | Customer Service |
| | Operation Initiatives | Operation Initiatives | Operation Initiatives | Operation Initiatives |
| | Facilities Renewal Program (FRP) | FacilitiesRenewal Program(FRP) | | |

Table Notes:

**1 - New Programs**

**2 - Programs relocated**

## Appendix D: Integrated Regional Planning-Load Forecast

| Pocket | Station | 10-Day LTR (MVA) | 10-Day LTR (MW) @0.9 | 2017 Net Coincident Demand | Starting Point of Forecast (Gross, Median Weather) | Net Demand Forecast with Extreme Weather Conditions | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 |
| West Side of Ottawa (Merivale Pocket) | Bridlewood MTS | 25 | 22.5 | 9.8 | 11.2 | 14.6 | 14.5 | 14.4 | 15.4 | 15.3 | 16.3 | 16.2 | 16.7 | 19.1 | 20.9 | 21.5 | 21.3 | 21.2 | 21.0 | 20.9 | 20.8 | 20.8 | 20.8 | 20.9 | 21.0 |
| | Marchwood MTS | 33 | 29.7 | 39.2 | 44.8 | 59.5 | 65.0 | 67.0 | 68.5 | 69.8 | 70.5 | 71.0 | 71.3 | 71.5 | 70.8 | 70.2 | 69.5 | 68.9 | 68.5 | 68.1 | 67.9 | 67.9 | 67.9 | 67.9 | 67.9 |
| | Fallowfield DS | 25 | 22.5 | 39.5 | 47.1 | 48.7 | 43.0 | 49.9 | 53.1 | 23.3 | 26.6 | 27.1 | 28.0 | 28.2 | 29.1 | 29.3 | 31.1 | 31.4 | 32.5 | 32.3 | 33.1 | 33.2 | 33.2 | 33.2 | 33.3 |
| | Manotick DS | 8.6 | 7.74 | 5.6 | 6.5 | 6.9 | 7.7 | 8.6 | 9.4 | 10.3 | 11.1 | 11.9 | 11.8 | 11.8 | 11.5 | 11.6 | 11.3 | 11.5 | 11.3 | 11.3 | 11.2 | 11.3 | 11.3 | 11.4 | 11.3 |
| | Richmond DS | 75 | 67.5 | 4.5 | 5.1 | 7.4 | 12.6 | 14.3 | 18.6 | 22.7 | 25.9 | 27.6 | 27.3 | 28.8 | 28.5 | 28.3 | 28.0 | 27.7 | 27.5 | 27.3 | 27.3 | 27.2 | 27.1 | 27.1 | 27.2 |
| | Manordale MTS | 10 | 9 | 8.5 | 9.7 | 10.2 | 10.0 | 10.0 | 10.1 | 10.1 | 10.1 | 10.1 | 10.1 | 10.2 | 10.2 | 10.3 | 10.2 | 10.2 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 | 10.3 |
| | Limebank MTS | 66 | 59.4 | 46.8 | 53.5 | 55.8 | 62.0 | 74.6 | 77.5 | 85.1 | 78.3 | 81.4 | 77.0 | 79.9 | 84.5 | 88.8 | 93.2 | 97.5 | 101.8 | 105.3 | 108.4 | 110.8 | 113.3 | 115.9 | 118.5 |
| | Marionville DS | 15 | 13.5 | 10.3 | 11.8 | 12.6 | 12.6 | 12.8 | 13.0 | 13.1 | 13.2 | 13.2 | 13.3 | 13.2 | 13.1 | 13.0 | 13.0 | 12.9 | 12.9 | 12.9 | 12.9 | 13.0 | 13.0 | 13.1 | 13.1 |
| | Uplands MTS | 33 | 29.7 | 19.8 | 22.6 | 24.5 | 27.6 | 29.8 | 31.3 | 38.0 | 43.1 | 48.1 | 57.4 | 57.3 | 57.2 | 57.5 | 57.8 | 57.8 | 57.8 | 57.9 | 58.1 | 58.5 | 58.8 | 59.3 | 59.3 |
| | South Gloucester DS | 7.5 | 6.75 | 3.8 | 4.3 | 4.6 | 4.6 | 4.7 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.9 | 4.8 | 4.8 | 4.8 | 4.8 | 4.7 | 4.7 | 4.7 | 4.7 | 4.7 | 4.8 | 4.8 |
| | Greely DS | 30 | 27 | 16.0 | 18.2 | 19.3 | 19.5 | 19.8 | 20.1 | 20.5 | 20.7 | 20.9 | 21.0 | 21.0 | 20.9 | 21.0 | 21.0 | 20.9 | 20.9 | 20.9 | 21.1 | 21.3 | 21.4 | 21.8 | 22.0 |
| | Russell DS | 7.5 | 6.75 | 3.4 | 3.9 | 4.1 | 4.2 | 4.3 | 4.3 | 4.4 | 4.4 | 4.3 | 4.5 | 4.4 | 4.4 | 4.3 | 4.3 | 4.3 | 4.3 | 4.3 | 4.3 | 4.2 | 4.3 | 4.3 | 4.3 |
| | Centerpoint MTS | 14 | 12.6 | 13.8 | 15.8 | 16.6 | 16.8 | 16.7 | 16.7 | 16.7 | 16.7 | 16.6 | 16.4 | 16.3 | 16.1 | 16.1 | 15.9 | 15.7 | 15.6 | 15.5 | 15.5 | 15.5 | 15.5 | 15.5 | 15.5 |
| | Merivale TS | 25 | 22.5 | 14.4 | 16.5 | 17.4 | 17.1 | 19.9 | 20.0 | 20.0 | 20.2 | 20.6 | 20.9 | 20.8 | 21.1 | 21.2 | 21.0 | 20.7 | 20.5 | 20.3 | 20.4 | 20.3 | 21.1 | 21.1 | 21.1 |
| | National Aeronautical CTS | 1.2 | 1.08 | 0.4 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| | Kanata MTS | 54.2 | 48.78 | 51.6 | 59.0 | 64.8 | 67.1 | 68.8 | 72.5 | 72.5 | 72.2 | 71.7 | 71.3 | 70.6 | 70.9 | 70.7 | 70.0 | 69.4 | 69.0 | 68.8 | 68.7 | 68.6 | 68.6 | 68.6 | 68.7 |
| | South March TS | 122.3 | 110.07 | 78.0 | 89.2 | 93.9 | 94.4 | 95.2 | 95.8 | 106.2 | 106.0 | 105.0 | 104.6 | 103.9 | 102.6 | 100.3 | 98.2 | 96.8 | 96.5 | 96.4 | 96.8 | 97.1 | 97.4 | 98.1 | 98.6 |
| | Nepean TS | 160.6 | 144.54 | 131.9 | 150.8 | 157.9 | 157.2 | 142.5 | 146.7 | 138.4 | 137.9 | 138.0 | 137.1 | 135.9 | 134.5 | 133.2 | 132.1 | 131.0 | 130.2 | 129.5 | 129.5 | 129.4 | 129.5 | 129.6 | 129.7 |
| | Terry Fox MTS | 90 | 81 | 49.7 | 56.8 | 63.4 | 68.4 | 69.9 | 71.9 | 73.8 | 75.4 | 76.8 | 78.1 | 79.3 | 80.4 | 81.5 | 82.6 | 83.6 | 84.7 | 85.9 | 85.7 | 85.7 | 85.6 | 85.6 | 85.7 |
| | South Nepean TS | TBD | TBD | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 39.2 | 43.2 | 47.0 | 49.7 | 53.2 | 56.4 | 58.7 | 61.1 | 63.9 | 66.3 | 67.7 | 69.4 | 72.1 | 75.2 | 75.3 | 75.3 |
| Outer Ottawa West* | Almonte | TBD | TBD | 0.0 | N/A | 47.9 | 47.9 | 50.1 | 46.1 | 47.0 | 47.6 | 48.0 | 48.0 | 47.9 | 47.8 | 47.8 | 47.8 | 47.8 | 47.8 | 47.8 | 47.8 | 47.8 | 47.8 | 47.8 | 47.8 |
| **Merivale Pocket TOTAL** | | | | **547** | **627** | **683** | **705** | **724** | **750** | **785** | **797** | **813** | **822** | **831** | **838** | **843** | **847** | **851** | **857** | **861** | **866** | **872** | **880** | **884** | **888** |
| Downtown | Nepean Epworth TS | 14 | 12.6 | 10.5 | 11.7 | 12.1 | 12.0 | 11.9 | 11.9 | 11.8 | 11.9 | 11.8 | 11.7 | 11.5 | 11.4 | 11.3 | 11.2 | 11.0 | 11.1 | 11.0 | 10.9 | 10.9 | 10.9 | 10.9 | 10.9 |
| | Carling TS | 106 | 95.4 | 78.9 | 88.1 | 94.4 | 95.4 | 97.0 | 98.1 | 98.7 | 98.5 | 102.9 | 102.6 | 101.7 | 100.8 | 100.3 | 99.8 | 99.2 | 98.5 | 97.9 | 97.7 | 97.5 | 97.6 | 97.6 | 97.6 |
| | Albion TS | 79.8 | 71.82 | 38.1 | 42.5 | 45.6 | 45.9 | 45.6 | 47.9 | 47.8 | 47.7 | 47.5 | 56.2 | 55.7 | 55.1 | 54.7 | 54.2 | 53.7 | 53.4 | 53.0 | 52.8 | 52.8 | 52.8 | 52.8 | 52.9 |
| | Woodroffe TS | 101 | 90.9 | 26.7 | 29.8 | 33.1 | 32.7 | 33.2 | 34.1 | 34.7 | 35.1 | 51.6 | 51.1 | 50.6 | 50.1 | 49.6 | 49.2 | 48.7 | 48.4 | 48.1 | 48.0 | 47.8 | 47.9 | 47.9 | 47.9 |
| | Hinchey TS | 96 | 86.4 | 42.4 | 47.3 | 49.9 | 51.6 | 56.0 | 41.0 | 43.2 | 44.9 | 47.4 | 49.9 | 50.8 | 51.8 | 52.8 | 53.7 | 54.7 | 55.4 | 56.9 | 57.7 | 58.9 | 60.0 | 61.2 | 62.4 |
| | Slater TS | 215 | 193.5 | 102.1 | 114.0 | 128.1 | 128.0 | 126.8 | 126.6 | 126.7 | 126.5 | 125.7 | 124.6 | 123.3 | 121.8 | 120.3 | 119.3 | 118.1 | 118.0 | 117.0 | 116.8 | 116.7 | 116.6 | 116.6 | 116.7 |
| | Lisgar TS | 83 | 74.7 | 55.6 | 62.1 | 72.5 | 71.8 | 72.1 | 64.8 | 71.5 | 71.7 | 72.7 | 72.5 | 72.4 | 74.8 | 74.5 | 74.3 | 74.0 | 74.9 | 74.7 | 75.0 | 75.5 | 75.9 | 76.5 | 77.0 |
| | King Edward TS | 91.5 | 82.35 | 75.8 | 84.6 | 93.6 | 92.8 | 94.0 | 94.8 | 95.6 | 96.0 | 96.0 | 96.2 | 95.9 | 95.6 | 95.3 | 95.1 | 95.0 | 94.3 | 93.6 | 93.4 | 93.3 | 93.3 | 93.3 | 93.4 |
| | Russell TS | 77.8 | 70.02 | 68.8 | 76.8 | 81.1 | 83.0 | 86.9 | 86.8 | 87.1 | 87.0 | 86.8 | 86.0 | 85.1 | 84.1 | 83.2 | 82.5 | 81.6 | 81.0 | 80.5 | 80.8 | 80.7 | 80.7 | 80.8 | 80.8 |
| | Overbrook TS | 105.6 | 95.04 | 57.8 | 64.5 | 69.0 | 73.2 | 76.4 | 78.7 | 80.4 | 82.6 | 84.4 | 85.9 | 86.0 | 86.2 | 86.3 | 86.8 | 86.7 | 87.4 | 87.7 | 88.8 | 89.4 | 90.6 | 91.5 | 92.6 |
| | Riverdale TS | 117.6 | 105.84 | 70.8 | 79.1 | 87.6 | 86.5 | 87.3 | 89.3 | 91.1 | 92.1 | 92.2 | 92.4 | 92.2 | 92.0 | 91.8 | 91.7 | 91.6 | 92.8 | 92.8 | 93.2 | 94.0 | 94.5 | 95.2 | 95.9 |
| | Albion TS | 99.4 | 89.46 | 52.2 | 58.3 | 60.0 | 59.6 | 59.3 | 59.6 | 59.7 | 59.6 | 59.4 | 59.1 | 58.8 | 58.3 | 57.9 | 57.5 | 57.1 | 56.9 | 56.8 | 56.9 | 56.9 | 57.1 | 57.3 | 57.4 |
| | Ellwood TS | 50 | 45 | 34.4 | 38.4 | 39.4 | 40.0 | 40.4 | 41.6 | 42.4 | 42.9 | 42.7 | 42.4 | 42.0 | 41.7 | 41.2 | 40.9 | 40.6 | 40.3 | 40.0 | 40.0 | 39.9 | 39.9 | 40.0 | 40.5 |
| **Downtown TOTAL** | | | | **714** | **797** | **866** | **873** | **887** | **875** | **891** | **896** | **921** | **931** | **926** | **924** | **919** | **916** | **912** | **912** | **910** | **912** | **914** | **918** | **922** | **926** |
| East Side of Ottawa (Hawthorne Pocket) | Bilberry Creek TS | 94.9 | 85.41 | 35.3 | 40.6 | 42.7 | 42.4 | 42.7 | 49.1 | 52.8 | 52.7 | 52.3 | 51.9 | 51.5 | 51.0 | 50.5 | 50.0 | 49.6 | 49.3 | 49.3 | 49.3 | 49.3 | 49.3 | 49.3 | 49.4 |
| | Orleans TS | 130.3 | 117.27 | 88.2 | 101.5 | 106.0 | 107.6 | 110.0 | 112.0 | 114.6 | 117.0 | 118.4 | 119.7 | 121.8 | 123.2 | 123.2 | 123.2 | 123.0 | 122.7 | 122.4 | 122.9 | 123.5 | 124.1 | 124.5 | 124.9 |
| | Cyrville MTS | 50 | 45 | 20.9 | 24.0 | 24.8 | 25.1 | 28.1 | 33.6 | 36.8 | 39.8 | 43.9 | 45.0 | 46.4 | 47.2 | 47.8 | 48.4 | 48.8 | 49.5 | 50.1 | 50.9 | 51.7 | 52.9 | 54.0 | 55.0 |
| | Moulton MTS | 33 | 29.7 | 23.6 | 27.2 | 28.3 | 28.1 | 29.8 | 31.7 | 33.6 | 35.3 | 35.1 | 34.8 | 34.5 | 34.2 | 33.9 | 33.5 | 33.3 | 33.0 | 32.8 | 32.7 | 32.7 | 32.7 | 32.7 | 32.7 |
| | Wilhaven DS | 20 | 18 | 3.3 | 3.9 | 3.4 | 3.4 | 3.5 | 3.6 | 3.6 | 3.5 | 3.6 | 3.7 | 3.6 | 3.6 | 3.5 | 3.6 | 3.5 | 3.5 | 3.8 | 3.9 | 3.9 | 4.0 | 4.1 | 4.1 |
| | Navan DS | 15 | 13.5 | 3.6 | 4.2 | 3.6 | 3.7 | 3.7 | 3.8 | 3.8 | 3.9 | 3.9 | 3.8 | 4.0 | 3.9 | 3.9 | 3.9 | 3.9 | 3.8 | 4.2 | 4.2 | 4.2 | 4.3 | 4.5 | 4.7 |
| | Cumberland DS | 7.5 | 6.75 | 4.7 | 5.4 | 5.6 | 5.6 | 5.7 | 5.8 | 5.9 | 5.9 | 6.0 | 5.9 | 6.1 | 6.1 | 6.4 | 6.3 | 6.4 | 6.4 | 6.5 | 6.6 | 6.7 | 6.7 | 6.8 | 6.8 |
| | Hawthorne TS | 152 | 136.8 | 88.6 | 102.0 | 126.0 | 124.4 | 123.5 | 125.7 | 132.5 | 135.8 | 135.9 | 136.9 | 137.6 | 139.9 | 142.6 | 143.9 | 148.3 | 149.4 | 150.3 | 152.4 | 155.2 | 157.5 | 160.0 | 161.4 |
| | National Research TS | 28 | 25.2 | 5.7 | 6.5 | 9.3 | 9.2 | 9.1 | 9.1 | 9.1 | 9.1 | 9.0 | 9.0 | 9.1 | 9.1 | 9.2 | 9.1 | 9.2 | 9.2 | 9.2 | 9.2 | 9.2 | 9.2 | 9.2 | 9.2 |
| Outer Ottawa East* | Clarence DS | 3.7 | 3.33 | 2.4 | 2.8 | 2.9 | 2.9 | 2.9 | 3.0 | 3.0 | 3.1 | 3.1 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.1 |
| | Rockland DS | 14.3 | 12.87 | 6.9 | 8.0 | 8.3 | 8.2 | 8.3 | 8.3 | 8.4 | 8.5 | 8.5 | 8.5 | 8.5 | 8.4 | 8.4 | 8.4 | 8.4 | 8.3 | 8.3 | 8.3 | 8.4 | 8.4 | 8.4 | 8.5 |
| | Rockland East DS | 8.6 | 7.74 | 10.3 | 11.9 | 12.5 | 12.6 | 12.8 | 12.9 | 13.1 | 13.2 | 13.2 | 13.1 | 13.1 | 13.0 | 13.0 | 13.0 | 12.9 | 12.9 | 12.9 | 12.9 | 12.9 | 13.0 | 13.1 | 13.1 |
| | Wendover TS | 15 | TBD | 10.1 | 11.7 | 12.0 | 8.0 | 8.1 | 9.7 | 9.9 | 10.2 | 10.2 | 10.1 | 10.2 | 10.3 | 10.3 | 10.3 | 10.3 | 9.9 | 10.2 | 10.3 | 10.4 | 10.6 | 10.7 | 14.8 |
| | Hawkesbury MTS | TBD | TBD | 9.5 | 10.9 | 11.8 | 11.8 | 11.9 | 11.9 | 12.0 | 12.0 | 12.0 | 12.1 | 12.1 | 11.8 | 11.8 | 11.8 | 11.8 | 11.8 | 11.8 | 11.8 | 11.8 | 11.8 | 11.8 | 11.8 |
| **Hawthorne Pocket TOTAL** | | | | **274** | **315** | **350** | **349** | **356** | **374** | **393** | **403** | **408** | **411** | **415** | **418** | **421** | **422** | **426** | **427** | **429** | **432** | **436** | **441** | **445** | **448** |
| **Ottawa Area Sub-region TOTAL** | | | | **1535** | **1740** | **1899** | **1927** | **1967** | **2000** | **2068** | **2097** | **2142** | **2163** | **2171** | **2180** | **2183** | **2185** | **2189** | **2196** | **2200** | **2211** | **2223** | **2238** | **2251** | **2262** |

*Outer Ottawa Sub-Region stations are included for reference only and are excluded from the totals.

| Pocket | Station | 10-Day LTR (MVA) | 10-Day LTR (MW) @0.9 | 2017 Net Coincident Demand | Starting Point of Forecast (Gross, Median Weather) | Net Demand Forecast with Extreme Weather Conditions | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 |
| West Side of Ottawa (Merivale Pocket) | Bridlewood MTS | 25 | 22.5 | 9.8 | 11.2 | 14.6 | 14.5 | 14.4 | 15.5 | 15.4 | 16.4 | 16.3 | 16.9 | 19.4 | 21.4 | 22.2 | 22.0 | 22.0 | 21.9 | 21.8 | 21.8 | 21.8 | 21.8 | 21.9 | 21.9 |
| | Marchwood MTS | 33 | 29.7 | 39.2 | 44.8 | 59.5 | 65.0 | 67.0 | 68.8 | 70.1 | 70.8 | 71.5 | 72.2 | 72.8 | 72.5 | 72.4 | 72.0 | 71.8 | 71.5 | 71.3 | 71.1 | 71.1 | 71.1 | 71.2 | 71.2 |
| | Fallowfield DS | 25 | 22.5 | 39.5 | 47.1 | 48.7 | 43.0 | 49.9 | 53.3 | 23.4 | 26.8 | 27.3 | 28.3 | 28.7 | 29.8 | 30.2 | 32.2 | 32.6 | 33.9 | 33.8 | 34.7 | 34.7 | 34.8 | 34.8 | 34.8 |
| | Manotick DS | 8.6 | 7.74 | 5.6 | 6.5 | 6.9 | 7.7 | 8.6 | 9.5 | 10.4 | 11.2 | 12.1 | 12.1 | 12.1 | 12.0 | 12.2 | 12.1 | 12.4 | 12.2 | 12.3 | 12.3 | 12.4 | 12.4 | 12.5 | 12.4 |
| | Richmond DS | 75 | 67.5 | 4.5 | 5.1 | 7.4 | 12.6 | 14.3 | 18.6 | 22.8 | 26.0 | 27.8 | 27.7 | 29.5 | 29.4 | 29.5 | 29.3 | 29.2 | 29.1 | 29.0 | 29.0 | 28.9 | 28.9 | 28.9 | 28.9 |
| | Manordale MTS | 10 | 9 | 8.5 | 9.7 | 10.2 | 10.0 | 10.0 | 10.1 | 10.1 | 10.1 | 10.2 | 10.2 | 10.3 | 10.4 | 10.5 | 10.5 | 10.5 | 10.6 | 10.6 | 10.6 | 10.6 | 10.6 | 10.7 | 10.7 |
| | Limebank MTS | 66 | 59.4 | 46.8 | 53.5 | 55.8 | 62.0 | 74.6 | 77.8 | 85.5 | 78.6 | 82.0 | 77.9 | 81.3 | 86.5 | 91.6 | 96.5 | 101.5 | 106.2 | 110.1 | 113.4 | 116.0 | 118.7 | 121.4 | 124.1 |
| | Marionville DS | 15 | 13.5 | 10.3 | 11.8 | 12.6 | 12.6 | 12.8 | 13.1 | 13.2 | 13.3 | 13.4 | 13.6 | 13.7 | 13.8 | 13.9 | 13.9 | 14.0 | 14.1 | 14.1 | 14.2 | 14.3 | 14.4 | 14.5 | 14.5 |
| | Uplands MTS | 33 | 29.7 | 19.8 | 22.6 | 24.5 | 27.6 | 29.8 | 31.5 | 38.2 | 43.3 | 48.5 | 58.1 | 58.4 | 58.8 | 59.5 | 60.2 | 60.4 | 60.6 | 60.9 | 61.2 | 61.6 | 62.0 | 62.5 | 62.5 |
| | South Gloucester DS | 7.5 | 6.75 | 3.8 | 4.3 | 4.6 | 4.6 | 4.7 | 4.8 | 4.8 | 4.8 | 4.9 | 4.9 | 5.0 | 4.9 | 4.9 | 5.0 | 5.0 | 5.0 | 4.9 | 4.9 | 5.0 | 5.0 | 5.0 | 5.0 |
| | Greely DS | 30 | 27 | 16.0 | 18.2 | 19.3 | 19.5 | 19.8 | 20.2 | 20.6 | 20.8 | 21.1 | 21.3 | 21.5 | 21.6 | 21.9 | 22.1 | 22.2 | 22.3 | 22.4 | 22.5 | 22.8 | 23.0 | 23.4 | 23.6 |
| | Russell DS | 7.5 | 6.75 | 3.4 | 3.9 | 4.1 | 4.2 | 4.3 | 4.3 | 4.4 | 4.4 | 4.4 | 4.6 | 4.5 | 4.5 | 4.5 | 4.5 | 4.6 | 4.6 | 4.6 | 4.5 | 4.5 | 4.6 | 4.6 | 4.6 |
| | Centerpoint MTS | 14 | 12.6 | 13.8 | 15.8 | 16.6 | 16.8 | 16.7 | 16.8 | 16.8 | 16.8 | 16.7 | 16.6 | 16.6 | 16.5 | 16.6 | 16.5 | 16.4 | 16.3 | 16.3 | 16.2 | 16.3 | 16.3 | 16.3 | 16.3 |
| | Merivale TS | 25 | 22.5 | 14.4 | 16.5 | 17.4 | 17.1 | 19.9 | 20.2 | 20.2 | 20.3 | 20.9 | 21.4 | 21.5 | 22.1 | 22.6 | 22.6 | 22.5 | 22.5 | 22.4 | 22.5 | 22.5 | 23.4 | 23.4 | 23.4 |
| | National Aeronautical CTS | 1.2 | 1.08 | 0.4 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| | Kanata MTS | 54.2 | 48.78 | 51.6 | 59.0 | 64.8 | 67.1 | 68.8 | 72.8 | 72.8 | 72.5 | 72.3 | 72.2 | 71.9 | 72.7 | 73.1 | 72.7 | 72.5 | 72.2 | 72.3 | 72.2 | 72.2 | 72.2 | 72.2 | 72.3 |
| | South March TS | 122.3 | 110.07 | 78.0 | 89.2 | 93.9 | 94.4 | 95.2 | 96.3 | 106.8 | 106.6 | 106.1 | 106.3 | 106.6 | 106.3 | 105.0 | 103.5 | 102.8 | 103.0 | 103.4 | 103.8 | 104.3 | 104.8 | 105.5 | 106.1 |
| | Nepean TS | 160.6 | 144.54 | 131.9 | 150.8 | 157.9 | 157.2 | 142.5 | 147.4 | 139.0 | 138.6 | 139.3 | 139.0 | 138.8 | 138.5 | 138.4 | 137.9 | 137.6 | 137.2 | 136.9 | 137.1 | 137.1 | 137.3 | 137.4 | 137.5 |
| | Terry Fox MTS | 90 | 81 | 49.7 | 56.8 | 63.4 | 68.4 | 69.9 | 72.2 | 74.1 | 75.7 | 77.4 | 79.0 | 80.7 | 82.3 | 84.1 | 85.6 | 87.1 | 88.5 | 90.0 | 89.8 | 89.8 | 89.8 | 89.8 | 89.9 |
| | South Nepean TS | TBD | TBD | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 39.4 | 43.4 | 47.5 | 50.4 | 54.4 | 58.0 | 61.0 | 63.8 | 67.1 | 69.8 | 71.6 | 73.4 | 76.3 | 79.8 | 79.8 | 79.8 |
| Outer Ottawa West* | Almonte | TBD | TBD | 0.0 | N/A | 47.9 | 47.9 | 50.1 | 46.1 | 47.0 | 47.6 | 48.0 | 48.0 | 47.9 | 47.8 | 47.8 | 47.8 | 47.8 | 47.8 | 47.8 | 47.8 | 47.8 | 47.8 | 47.8 | 47.8 |
| **Merivale Pocket TOTAL** | | | | **547** | **627** | **683** | **705** | **724** | **754** | **788** | **801** | **820** | **833** | **848** | **863** | **875** | **884** | **893** | **902** | **909** | **916** | **923** | **931** | **936** | **940** |
| Downtown | Nepean Epworth TS | 14 | 12.6 | 10.5 | 11.7 | 12.1 | 12.0 | 11.9 | 11.9 | 11.9 | 11.9 | 11.9 | 11.9 | 11.8 | 11.8 | 11.8 | 11.7 | 11.7 | 11.7 | 11.7 | 11.7 | 11.7 | 11.6 | 11.6 | 11.7 |
| | Carling TS | 106 | 95.4 | 78.9 | 88.1 | 94.4 | 95.4 | 97.0 | 98.6 | 99.2 | 98.9 | 103.8 | 104.0 | 103.8 | 103.8 | 104.1 | 104.2 | 104.1 | 103.8 | 103.5 | 103.3 | 103.3 | 103.4 | 103.4 | 103.5 |
| | Lincoln Hights TS | 79.8 | 71.82 | 38.1 | 42.5 | 45.6 | 45.9 | 45.6 | 48.1 | 48.0 | 47.9 | 47.9 | 56.9 | 56.8 | 56.6 | 56.6 | 56.4 | 56.1 | 56.0 | 55.8 | 55.6 | 55.6 | 55.7 | 55.7 | 55.7 |
| | Woodroffe TS | 101 | 90.9 | 26.7 | 29.8 | 33.1 | 32.7 | 33.2 | 34.2 | 34.9 | 35.2 | 52.0 | 51.8 | 51.6 | 51.6 | 51.4 | 51.3 | 51.0 | 50.9 | 50.7 | 50.6 | 50.5 | 50.6 | 50.6 | 50.6 |
| | Hinchey TS | 96 | 86.4 | 42.4 | 47.3 | 49.9 | 51.6 | 56.0 | 41.3 | 43.5 | 45.2 | 48.1 | 50.9 | 52.4 | 54.0 | 55.7 | 57.1 | 58.6 | 59.7 | 61.5 | 62.5 | 63.8 | 65.0 | 66.3 | 67.7 |
| | Slater TS | 215 | 193.5 | 102.1 | 114.0 | 128.1 | 128.0 | 126.8 | 127.4 | 127.6 | 127.3 | 127.2 | 126.9 | 126.8 | 126.7 | 126.6 | 126.4 | 126.2 | 126.9 | 126.5 | 126.4 | 126.4 | 126.6 | 126.6 | 126.6 |
| | Lisgar TS | 83 | 74.7 | 55.6 | 62.1 | 72.5 | 71.8 | 72.1 | 65.2 | 71.9 | 72.2 | 73.4 | 73.7 | 74.2 | 77.4 | 77.9 | 78.2 | 78.4 | 79.7 | 79.9 | 80.2 | 80.8 | 81.3 | 81.9 | 82.5 |
| | King Edward TS | 91.5 | 82.35 | 75.8 | 84.6 | 93.6 | 92.8 | 94.0 | 95.3 | 96.1 | 96.5 | 97.0 | 97.6 | 98.1 | 98.7 | 99.3 | 99.7 | 100.2 | 99.9 | 99.5 | 99.4 | 99.3 | 99.5 | 99.5 | 99.5 |
| | Russell TS | 77.8 | 70.02 | 68.8 | 76.8 | 81.1 | 83.0 | 86.9 | 87.3 | 87.6 | 87.6 | 87.7 | 87.5 | 87.3 | 87.2 | 87.2 | 87.0 | 86.7 | 86.5 | 86.3 | 86.7 | 86.8 | 86.8 | 86.9 | 87.0 |
| | Overbrook TS | 105.6 | 95.04 | 57.8 | 64.5 | 69.0 | 73.2 | 76.4 | 79.1 | 80.7 | 83.0 | 85.1 | 87.0 | 87.8 | 88.8 | 89.6 | 90.6 | 91.1 | 92.1 | 92.7 | 94.0 | 94.7 | 96.0 | 96.9 | 98.2 |
| | Riverdale TS | 117.6 | 105.84 | 70.8 | 79.1 | 87.6 | 86.5 | 87.3 | 89.8 | 91.6 | 92.5 | 93.0 | 93.7 | 94.2 | 94.7 | 95.3 | 95.7 | 96.2 | 97.8 | 98.1 | 98.6 | 99.5 | 100.2 | 100.9 | 101.7 |
| | Albion TS | 99.4 | 89.46 | 52.2 | 58.3 | 60.0 | 59.6 | 59.3 | 59.8 | 60.0 | 59.9 | 59.9 | 59.8 | 59.9 | 60.0 | 60.0 | 59.9 | 59.8 | 59.8 | 59.9 | 60.0 | 60.1 | 60.4 | 60.5 | 60.6 |
| | Ellwood TS | 50 | 45 | 34.4 | 38.4 | 39.4 | 40.0 | 40.4 | 41.8 | 42.6 | 43.1 | 43.0 | 43.0 | 42.8 | 42.8 | 42.7 | 42.6 | 42.5 | 42.3 | 42.1 | 42.1 | 42.1 | 42.1 | 42.2 | 42.8 |
| **Downtown TOTAL** | | | | **714** | **797** | **866** | **873** | **887** | **880** | **895** | **901** | **930** | **945** | **948** | **954** | **958** | **961** | **963** | **967** | **968** | **971** | **975** | **979** | **983** | **988** |
| East Side of Ottawa (Hawthorne Pocket) | Bilberry Creek TS | 94.9 | 85.41 | 35.3 | 40.6 | 42.7 | 42.4 | 42.7 | 49.3 | 53.0 | 52.9 | 52.7 | 52.6 | 52.6 | 52.4 | 52.4 | 52.1 | 52.0 | 51.9 | 51.9 | 52.0 | 52.0 | 52.1 | 52.1 | 52.2 |
| | Orleans TS | 130.3 | 117.27 | 88.2 | 101.5 | 106.0 | 107.6 | 110.0 | 112.8 | 115.5 | 117.9 | 120.0 | 122.3 | 125.9 | 129.0 | 130.9 | 132.0 | 133.0 | 133.7 | 134.2 | 135.0 | 135.9 | 136.9 | 137.3 | 137.8 |
| | Cyrville MTS | 50 | 45 | 20.9 | 24.0 | 24.8 | 25.1 | 28.1 | 33.8 | 37.0 | 39.9 | 44.3 | 45.5 | 47.2 | 48.3 | 49.3 | 50.1 | 50.9 | 51.7 | 52.5 | 53.4 | 54.2 | 55.5 | 56.7 | 57.7 |
| | Moulton MTS | 33 | 29.7 | 23.6 | 27.2 | 28.3 | 28.1 | 29.8 | 31.8 | 33.7 | 35.5 | 35.4 | 35.3 | 35.2 | 35.2 | 35.1 | 34.9 | 34.8 | 34.7 | 34.5 | 34.5 | 34.5 | 34.5 | 34.5 | 34.5 |
| | Wilhaven DS | 20 | 18 | 3.3 | 3.9 | 3.4 | 3.4 | 3.5 | 3.6 | 3.6 | 3.6 | 3.7 | 3.8 | 3.7 | 3.7 | 3.7 | 3.8 | 3.8 | 3.8 | 4.1 | 4.2 | 4.2 | 4.3 | 4.4 | 4.4 |
| | Navan DS | 15 | 13.5 | 3.6 | 4.2 | 3.6 | 3.7 | 3.7 | 3.8 | 3.8 | 3.9 | 3.9 | 3.9 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.1 | 4.5 | 4.5 | 4.5 | 4.6 | 4.8 | 5.0 |
| | Cumberland DS | 7.5 | 6.75 | 4.7 | 5.4 | 5.6 | 5.6 | 5.7 | 5.8 | 5.9 | 5.9 | 6.0 | 6.0 | 6.2 | 6.2 | 6.5 | 6.5 | 6.6 | 6.6 | 6.7 | 6.8 | 6.9 | 6.9 | 7.0 | 7.0 |
| | Hawthorne TS | 152 | 136.8 | 88.6 | 102.0 | 126.0 | 124.4 | 123.5 | 126.4 | 133.3 | 136.6 | 137.3 | 139.1 | 140.9 | 144.7 | 148.9 | 151.2 | 156.8 | 158.5 | 160.2 | 162.6 | 165.8 | 168.3 | 171.0 | 172.5 |
| | National Research TS | 28 | 25.2 | 5.7 | 6.5 | 9.3 | 9.2 | 9.1 | 9.1 | 9.1 | 9.1 | 9.1 | 9.1 | 9.2 | 9.3 | 9.4 | 9.4 | 9.5 | 9.5 | 9.5 | 9.5 | 9.5 | 9.5 | 9.5 | 9.5 |
| Outer Ottawa East* | Clarence DS | 3.7 | 3.33 | 2.4 | 2.8 | 2.9 | 2.9 | 2.9 | 3.0 | 3.0 | 3.1 | 3.1 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.1 |
| | Rockland DS | 14.3 | 12.87 | 6.9 | 8.0 | 8.3 | 8.2 | 8.3 | 8.3 | 8.4 | 8.5 | 8.5 | 8.5 | 8.5 | 8.4 | 8.4 | 8.4 | 8.4 | 8.3 | 8.3 | 8.3 | 8.4 | 8.4 | 8.4 | 8.5 |
| | Rockland East DS | 8.6 | 7.74 | 10.3 | 11.9 | 12.5 | 12.6 | 12.8 | 12.9 | 13.1 | 13.2 | 13.2 | 13.1 | 13.1 | 13.0 | 13.0 | 13.0 | 12.9 | 12.9 | 12.9 | 12.9 | 12.9 | 13.0 | 13.1 | 13.1 |
| | Wendover TS | 15 | TBD | 10.1 | 11.7 | 12.0 | 8.0 | 8.1 | 9.7 | 9.9 | 10.2 | 10.2 | 10.1 | 10.2 | 10.3 | 10.3 | 10.3 | 10.3 | 9.9 | 10.2 | 10.3 | 10.4 | 10.6 | 10.7 | 14.8 |
| | Hawkesbury MTS | TBD | TBD | 9.5 | 10.9 | 11.8 | 11.8 | 11.9 | 11.9 | 12.0 | 12.0 | 12.0 | 12.1 | 12.1 | 11.8 | 11.8 | 11.8 | 11.8 | 11.8 | 11.8 | 11.8 | 11.8 | 11.8 | 11.8 | 11.8 |
| **Hawthorne Pocket TOTAL** | | | | **274** | **315** | **350** | **349** | **356** | **376** | **395** | **405** | **412** | **418** | **425** | **433** | **440** | **444** | **452** | **455** | **458** | **462** | **468** | **473** | **477** | **481** |
| **Ottawa Area Sub-region TOTAL** | | | | **1535** | **1740** | **1899** | **1927** | **1967** | **2010** | **2079** | **2107** | **2163** | **2195** | **2221** | **2250** | **2273** | **2289** | **2307** | **2324** | **2336** | **2349** | **2365** | **2383** | **2397** | **2409** |

*Outer Ottawa Sub-Region stations are included for reference only and are excluded from the totals.

| Pocket | Station | 10-Day LTR (MVA) | 10-Day LTR (MW) @0.9 | 2017 Net Coincident Demand UPDATED | Starting Point of Forecast (Gross, Median Weather) | Net Demand Forecast with Median Weather Conditions | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | *2018* | *2019* | *2020* | *2021* | *2022* | *2023* | *2024* | *2025* | *2026* | *2027* | *2028* | *2029* | *2030* | *2031* | *2032* | *2033* | *2034* | *2035* | *2036* | *2037* |
| **West Side of Ottawa (Merivale Pocket)** | Bridlewood MTS | 25 | 22.5 | 9.8 | 11.2 | 13.5 | 13.4 | 13.3 | 14.2 | 14.1 | 15.0 | 14.9 | 15.4 | 17.6 | 19.2 | 19.8 | 19.6 | 19.5 | 19.4 | 19.2 | 19.2 | 19.2 | 19.1 | 19.3 | 19.3 |
| | Marchwood MTS | 33 | 29.7 | 39.2 | 44.8 | 54.8 | 59.9 | 61.7 | 63.1 | 64.3 | 64.9 | 65.4 | 65.7 | 65.9 | 65.2 | 64.7 | 64.0 | 63.5 | 63.1 | 62.8 | 62.5 | 62.5 | 62.5 | 62.5 | 62.6 |
| | Fallowfield DS | 25 | 22.5 | 39.5 | 47.1 | 44.9 | 39.6 | 46.0 | 48.9 | 21.5 | 24.5 | 24.9 | 25.8 | 26.0 | 26.8 | 27.0 | 28.6 | 28.9 | 29.9 | 29.8 | 30.5 | 30.6 | 30.6 | 30.6 | 30.6 |
| | Manotick DS | 8.6 | 7.74 | 5.6 | 6.5 | 6.4 | 7.1 | 7.9 | 8.7 | 9.5 | 10.2 | 11.0 | 10.9 | 10.8 | 10.6 | 10.6 | 10.4 | 10.6 | 10.4 | 10.4 | 10.4 | 10.4 | 10.4 | 10.5 | 10.4 |
| | Richmond DS | 75 | 67.5 | 4.5 | 5.1 | 6.8 | 11.6 | 13.1 | 17.1 | 20.9 | 23.9 | 25.4 | 25.2 | 26.6 | 26.3 | 26.1 | 25.8 | 25.5 | 25.3 | 25.1 | 25.1 | 25.1 | 25.0 | 25.0 | 25.0 |
| | Manordale MTS | 10 | 9 | 8.5 | 9.7 | 9.4 | 9.2 | 9.2 | 9.3 | 9.3 | 9.3 | 9.3 | 9.3 | 9.4 | 9.4 | 9.5 | 9.4 | 9.4 | 9.5 | 9.5 | 9.5 | 9.5 | 9.5 | 9.5 | 9.5 |
| | Limebank MTS | 66 | 59.4 | ` | 53.5 | 51.4 | 57.1 | 68.7 | 71.4 | 78.4 | 72.2 | 74.9 | 70.9 | 73.6 | 77.8 | 81.8 | 85.9 | 89.8 | 93.8 | 97.0 | 99.8 | 102.1 | 104.4 | 106.7 | 109.2 |
| | Marionville DS | 15 | 13.5 | 10.3 | 11.8 | 11.6 | 11.7 | 11.8 | 12.0 | 12.0 | 12.2 | 12.2 | 12.3 | 12.2 | 12.1 | 12.0 | 12.0 | 11.9 | 11.9 | 11.8 | 11.9 | 11.9 | 12.0 | 12.1 | 12.1 |
| | Uplands MTS | 33 | 29.7 | 19.8 | 22.6 | 22.6 | 25.4 | 27.5 | 28.9 | 35.0 | 39.7 | 44.3 | 52.9 | 52.8 | 52.7 | 53.0 | 53.3 | 53.3 | 53.2 | 53.3 | 53.5 | 53.9 | 54.2 | 54.6 | 54.6 |
| | South Gloucester DS | 7.5 | 6.75 | 3.8 | 4.3 | 4.2 | 4.3 | 4.3 | 4.4 | 4.4 | 4.4 | 4.5 | 4.4 | 4.5 | 4.4 | 4.4 | 4.4 | 4.4 | 4.3 | 4.3 | 4.3 | 4.4 | 4.4 | 4.4 | 4.4 |
| | Greely DS | 30 | 27 | 16.0 | 18.2 | 17.8 | 17.9 | 18.3 | 18.5 | 18.9 | 19.1 | 19.2 | 19.3 | 19.3 | 19.3 | 19.3 | 19.4 | 19.3 | 19.3 | 19.3 | 19.4 | 19.6 | 19.8 | 20.1 | 20.3 |
| | Russell DS | 7.5 | 6.75 | 3.4 | 3.9 | 3.8 | 3.9 | 3.9 | 3.9 | 4.0 | 4.0 | 4.0 | 4.1 | 4.1 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 3.9 | 3.9 | 3.9 | 4.0 | 4.0 | 4.0 |
| | Centerpoint MTS | 14 | 12.6 | 13.8 | 15.8 | 15.3 | 15.5 | 15.4 | 15.4 | 15.4 | 15.4 | 15.3 | 15.1 | 15.0 | 14.8 | 14.8 | 14.6 | 14.5 | 14.4 | 14.3 | 14.2 | 14.3 | 14.3 | 14.3 | 14.3 |
| | Merivale TS | 25 | 22.5 | 14.4 | 16.5 | 16.0 | 15.7 | 18.3 | 18.4 | 18.4 | 18.6 | 19.0 | 19.2 | 19.1 | 19.4 | 19.6 | 19.3 | 19.1 | 18.9 | 18.7 | 18.8 | 18.7 | 19.4 | 19.4 | 19.4 |
| | National Aeronautical CTS | 1.2 | 1.08 | 0.4 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| | Kanata MTS | 54.2 | 48.78 | 51.6 | 59.0 | 59.7 | 61.8 | 63.4 | 66.8 | 66.8 | 66.5 | 66.0 | 65.7 | 65.0 | 65.3 | 65.1 | 64.5 | 63.9 | 63.5 | 63.4 | 63.2 | 63.2 | 63.2 | 63.2 | 63.3 |
| | South March TS | 122.3 | 110.07 | 78.0 | 89.2 | 86.5 | 86.9 | 87.7 | 88.2 | 97.8 | 97.6 | 96.7 | 96.3 | 95.8 | 94.5 | 92.4 | 90.4 | 89.1 | 88.9 | 88.8 | 89.1 | 89.4 | 89.8 | 90.4 | 90.9 |
| | Nepean TS | 160.6 | 144.54 | 131.9 | 150.8 | 145.4 | 144.8 | 131.2 | 135.1 | 127.5 | 127.1 | 127.1 | 126.3 | 125.2 | 123.9 | 122.7 | 121.7 | 120.7 | 119.9 | 119.3 | 119.3 | 119.2 | 119.3 | 119.4 | 119.4 |
| | Terry Fox MTS | 90 | 81 | 49.7 | 56.8 | 58.4 | 63.0 | 64.4 | 66.2 | 68.0 | 69.5 | 70.8 | 72.0 | 73.1 | 74.0 | 75.1 | 76.1 | 77.1 | 78.1 | 79.2 | 79.0 | 78.9 | 78.9 | 78.9 | 79.0 |
| | South Nepean TS | #REF! | #REF! | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 36.1 | 39.8 | 43.3 | 45.8 | 49.0 | 51.9 | 54.1 | 56.3 | 58.8 | 61.0 | 62.4 | 63.9 | 66.4 | 69.3 | 69.3 | 69.4 |
| | Temp | | | | | 80.5 | 85.1 | 87.5 | 87.5 | 125.8 | 131.2 | 136.2 | 139.9 | 144.2 | 148.0 | 151.2 | 154.4 | 157.9 | 161.1 | 163.6 | 164.9 | 167.3 | 170.2 | 170.2 | 170.3 |
| **Outer Ottawa West*** | Almonte | TBD | TBD | 0.0 | N/A | 44.1 | 44.1 | 46.1 | 42.5 | 43.3 | 43.8 | 44.2 | 44.2 | 44.1 | 44.0 | 44.0 | 44.0 | 44.0 | 44.0 | 44.0 | 44.0 | 44.0 | 44.0 | 44.0 | 44.0 |
| **Merivale Pocket TOTAL** | | | | | **627** | **629** | **649** | **667** | **691** | **723** | **734** | **749** | **757** | **765** | **772** | **776** | **780** | **784** | **789** | **793** | **798** | **804** | **810** | **815** | **818** |
| **Downtown** | Nepean Epworth TS | 14 | 12.6 | 10.5 | 11.7 | 11.3 | 11.2 | 11.1 | 11.1 | 11.0 | 11.1 | 11.0 | 10.9 | 10.8 | 10.7 | 10.5 | 10.4 | 10.3 | 10.3 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 | 10.2 |
| | Carling TS | 106 | 95.4 | 78.9 | 88.1 | 88.1 | 89.1 | 90.5 | 91.6 | 92.1 | 91.9 | 96.0 | 95.8 | 94.9 | 94.1 | 93.6 | 93.2 | 92.6 | 91.9 | 91.4 | 91.2 | 91.0 | 91.1 | 91.1 | 91.1 |
| | Lincoln Hights TS | 79.8 | 71.82 | 38.1 | 42.5 | 42.6 | 42.8 | 42.5 | 44.7 | 44.6 | 44.5 | 44.3 | 52.4 | 52.0 | 51.5 | 51.0 | 50.6 | 50.1 | 49.8 | 49.5 | 49.3 | 49.3 | 49.3 | 49.3 | 49.3 |
| | Woodroffe TS | 101 | 90.9 | 26.7 | 29.8 | 30.9 | 30.6 | 31.0 | 31.8 | 32.4 | 32.7 | 48.1 | 47.7 | 47.2 | 46.8 | 46.3 | 45.9 | 45.5 | 45.2 | 44.9 | 44.8 | 44.7 | 44.7 | 44.7 | 44.7 |
| | Hinchey TS | 96 | 86.4 | 42.4 | 47.3 | 46.6 | 48.2 | 52.3 | 38.3 | 40.3 | 41.9 | 44.3 | 46.6 | 47.4 | 48.4 | 49.3 | 50.2 | 51.1 | 51.8 | 53.1 | 53.9 | 55.0 | 56.0 | 57.1 | 58.3 |
| | Slater TS | 215 | 193.5 | 102.1 | 114.0 | 119.6 | 119.5 | 118.3 | 118.2 | 118.3 | 118.1 | 117.3 | 116.3 | 115.1 | 113.7 | 112.3 | 111.3 | 110.2 | 110.2 | 109.2 | 109.0 | 108.9 | 108.8 | 108.9 | 108.9 |
| | Lisgar TS | 83 | 74.7 | 55.6 | 62.1 | 67.7 | 67.0 | 67.3 | 60.5 | 66.7 | 67.0 | 67.8 | 67.7 | 67.5 | 69.8 | 69.5 | 69.4 | 69.1 | 69.9 | 69.8 | 70.0 | 70.4 | 70.8 | 71.4 | 71.8 |
| | King Edward TS | 91.5 | 82.35 | 75.8 | 84.6 | 87.3 | 86.6 | 87.8 | 88.4 | 89.2 | 89.6 | 89.6 | 89.8 | 89.5 | 89.3 | 89.0 | 88.8 | 88.7 | 88.0 | 87.4 | 87.2 | 87.1 | 87.1 | 87.1 | 87.1 |
| | Russell TS | 77.8 | 70.02 | 68.8 | 76.8 | 75.7 | 77.5 | 81.1 | 81.0 | 81.3 | 81.2 | 81.0 | 80.3 | 79.4 | 78.5 | 77.7 | 77.0 | 76.2 | 75.6 | 75.1 | 75.4 | 75.4 | 75.3 | 75.4 | 75.4 |
| | Overbrook TS | 105.6 | 95.04 | 57.8 | 64.5 | 64.4 | 68.3 | 71.3 | 73.5 | 75.0 | 77.1 | 78.8 | 80.2 | 80.2 | 80.5 | 80.5 | 81.0 | 81.0 | 81.6 | 81.9 | 82.9 | 83.5 | 84.6 | 85.4 | 86.5 |
| | Riverdale TS | 117.6 | 105.84 | 70.8 | 79.1 | 81.7 | 80.7 | 81.5 | 83.4 | 85.1 | 85.9 | 86.0 | 86.2 | 86.1 | 85.9 | 85.7 | 85.6 | 85.5 | 86.6 | 86.6 | 87.0 | 87.7 | 88.2 | 88.9 | 89.5 |
| | Albion TS | 99.4 | 89.46 | 52.2 | 58.3 | 56.0 | 55.6 | 55.4 | 55.6 | 55.7 | 55.6 | 55.4 | 55.1 | 54.8 | 54.4 | 54.1 | 53.7 | 53.3 | 53.1 | 53.0 | 53.1 | 53.1 | 53.3 | 53.5 | 53.5 |
| | Ellwood TS | 50 | 45 | 34.4 | 38.4 | 36.8 | 37.4 | 37.7 | 38.8 | 39.6 | 40.1 | 39.8 | 39.6 | 39.2 | 38.9 | 38.5 | 38.2 | 37.9 | 37.6 | 37.3 | 37.3 | 37.2 | 37.3 | 37.4 | 37.8 |
| **Downtown TOTAL** | | | | | **797** | **809** | **814** | **828** | **817** | **831** | **837** | **859** | **869** | **864** | **862** | **858** | **855** | **851** | **852** | **849** | **851** | **853** | **857** | **860** | **864** |
| **East Side of Ottawa (Hawthorne Pocket)** | Bilberry Creek TS | 94.9 | 85.41 | 35.3 | 40.6 | 39.4 | 39.2 | 39.5 | 45.4 | 48.8 | 48.7 | 48.3 | 48.0 | 47.6 | 47.1 | 46.7 | 46.3 | 45.9 | 45.6 | 45.6 | 45.6 | 45.6 | 45.6 | 45.6 | 45.7 |
| | Orleans TS | 130.3 | 117.27 | 88.2 | 101.5 | 98.0 | 99.5 | 101.7 | 103.5 | 106.0 | 108.2 | 109.4 | 110.7 | 112.6 | 113.9 | 114.0 | 113.9 | 113.7 | 113.5 | 113.2 | 113.6 | 114.2 | 114.7 | 115.1 | 115.5 |
| | Cyrville MTS | 50 | 45 | 20.9 | 24.0 | 22.9 | 23.2 | 26.0 | 31.1 | 34.1 | 36.8 | 40.6 | 41.6 | 42.9 | 43.6 | 44.2 | 44.7 | 45.1 | 45.8 | 46.3 | 47.1 | 47.8 | 48.9 | 49.9 | 50.8 |
| | Moulton MTS | 33 | 29.7 | 23.6 | 27.2 | 26.2 | 26.0 | 27.5 | 29.3 | 31.0 | 32.6 | 32.5 | 32.2 | 31.9 | 31.6 | 31.3 | 31.0 | 30.8 | 30.5 | 30.3 | 30.2 | 30.2 | 30.2 | 30.2 | 30.2 |
| | Wilhaven DS | 20 | 18 | 3.3 | 3.9 | 3.2 | 3.1 | 3.2 | 3.3 | 3.3 | 3.3 | 3.3 | 3.4 | 3.4 | 3.3 | 3.3 | 3.3 | 3.3 | 3.2 | 3.5 | 3.6 | 3.6 | 3.7 | 3.8 | 3.8 |
| | Navan DS | 15 | 13.5 | 3.6 | 4.2 | 3.3 | 3.4 | 3.4 | 3.5 | 3.5 | 3.6 | 3.6 | 3.5 | 3.7 | 3.6 | 3.6 | 3.6 | 3.6 | 3.5 | 3.9 | 3.9 | 3.9 | 4.0 | 4.2 | 4.4 |
| | Cumberland DS | 7.5 | 6.75 | 4.7 | 5.4 | 5.2 | 5.2 | 5.3 | 5.3 | 5.4 | 5.4 | 5.5 | 5.5 | 5.6 | 5.7 | 5.9 | 5.9 | 5.9 | 5.9 | 6.0 | 6.1 | 6.2 | 6.2 | 6.3 | 6.3 |
| | Hawthorne TS | 152 | 136.8 | 88.6 | 102.0 | 116.5 | 115.1 | 114.2 | 116.2 | 122.5 | 125.6 | 125.6 | 126.6 | 127.2 | 129.4 | 131.8 | 133.0 | 137.2 | 138.1 | 139.0 | 141.0 | 143.5 | 145.6 | 148.0 | 149.2 |
| | National Research TS | 28 | 25.2 | 5.7 | 6.5 | 8.6 | 8.5 | 8.4 | 8.4 | 8.4 | 8.4 | 8.4 | 8.3 | 8.4 | 8.4 | 8.5 | 8.4 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 |
| **Outer Ottawa East*** | Clarence DS | 3.7 | 3.33 | 2.4 | 2.8 | 2.7 | 2.7 | 2.7 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 |
| | Rockland DS | 14.3 | 12.87 | 6.9 | 8.0 | 7.6 | 7.6 | 7.6 | 7.7 | 7.8 | 7.9 | 7.9 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 7.7 | 7.7 | 7.7 | 7.7 | 7.7 | 7.8 | 7.8 | 7.8 |
| | Rockland East DS | 8.6 | 7.74 | 10.3 | 11.9 | 11.6 | 11.7 | 11.8 | 11.9 | 12.1 | 12.2 | 12.2 | 12.1 | 12.1 | 12.1 | 12.0 | 12.0 | 11.9 | 11.9 | 11.9 | 11.9 | 12.0 | 12.0 | 12.1 | 12.1 |
| | Wendover TS | 15 | TBD | 10.1 | 11.7 | 11.1 | 7.4 | 7.4 | 9.0 | 9.1 | 9.4 | 9.4 | 9.4 | 9.4 | 9.5 | 9.5 | 9.5 | 9.5 | 9.2 | 9.5 | 9.5 | 9.6 | 9.8 | 9.9 | 13.7 |
| | Hawkesbury MTS | TBD | TBD | 9.5 | 10.9 | 10.9 | 10.9 | 11.0 | 11.0 | 11.1 | 11.1 | 11.1 | 11.2 | 11.2 | 10.9 | 10.9 | 10.9 | 10.9 | 10.9 | 10.9 | 10.9 | 10.9 | 10.9 | 10.9 | 10.9 |
| **Hawthorne Pocket TOTAL** | | | | | **315** | **323** | **323** | **329** | **346** | **363** | **373** | **377** | **380** | **383** | **387** | **389** | **390** | **394** | **395** | **396** | **400** | **404** | **407** | **412** | **414** |
| **Ottawa Area Sub-region TOTAL** | | | | | **1740** | **1761** | **1787** | **1824** | **1854** | **1917** | **1944** | **1986** | **2006** | **2013** | **2021** | **2024** | **2026** | **2029** | **2036** | **2039** | **2049** | **2061** | **2074** | **2086** | **2097** |

*Outer Ottawa Sub-Region stations are included for reference only and are excluded from the totals.

| Pocket | Station | 10-Day LTR (MVA) | 10-Day LTR (MW) @0.9 | 2017 Net Coincident Demand UPDATED | Starting Point of Forecast (Gross, Median Weather) | Net Demand Forecast with Median Weather Conditions | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 |
| West Side of Ottawa (Merivale Pocket) | Bridlewood MTS | 25 | 22.5 | 9.8 | 11.2 | 13.5 | 13.4 | 13.3 | 14.2 | 14.2 | 15.1 | 15.0 | 15.5 | 17.9 | 19.7 | 20.4 | 20.3 | 20.3 | 20.2 | 20.1 | 20.1 | 20.1 | 20.0 | 20.2 | 20.2 |
| | Marchwood MTS | 33 | 29.7 | 39.2 | 44.8 | 54.8 | 59.9 | 61.7 | 63.3 | 64.5 | 65.2 | 65.9 | 66.5 | 67.0 | 66.8 | 66.7 | 66.4 | 66.1 | 65.9 | 65.7 | 65.5 | 65.5 | 65.5 | 65.5 | 65.6 |
| | Fallowfield DS | 25 | 22.5 | 39.5 | 47.1 | 44.9 | 39.6 | 46.0 | 49.1 | 21.6 | 24.6 | 25.1 | 26.1 | 26.5 | 27.4 | 27.8 | 29.6 | 30.1 | 31.2 | 31.1 | 31.9 | 32.0 | 32.1 | 32.1 | 32.1 |
| | Manotick DS | 8.6 | 7.74 | 5.6 | 6.5 | 6.4 | 7.1 | 7.9 | 8.7 | 9.6 | 10.3 | 11.2 | 11.1 | 11.2 | 11.1 | 11.3 | 11.2 | 11.4 | 11.3 | 11.3 | 11.3 | 11.4 | 11.4 | 11.5 | 11.4 |
| | Richmond DS | 75 | 67.5 | 4.5 | 5.1 | 6.8 | 11.6 | 13.1 | 17.2 | 21.0 | 24.0 | 25.6 | 25.5 | 27.2 | 27.1 | 27.1 | 27.0 | 26.9 | 26.8 | 26.7 | 26.7 | 26.7 | 26.6 | 26.6 | 26.7 |
| | Manordale MTS | 10 | 9 | 8.5 | 9.7 | 9.4 | 9.2 | 9.2 | 9.3 | 9.3 | 9.3 | 9.4 | 9.4 | 9.5 | 9.6 | 9.7 | 9.7 | 9.7 | 9.8 | 9.8 | 9.8 | 9.8 | 9.8 | 9.8 | 9.8 |
| | Limebank MTS | 66 | 59.4 | ` | 53.5 | 51.4 | 57.1 | 68.7 | 71.7 | 78.7 | 72.4 | 75.5 | 71.7 | 74.9 | 79.7 | 84.4 | 88.9 | 93.5 | 97.9 | 101.5 | 104.5 | 106.9 | 109.3 | 111.8 | 114.3 |
| | Marionville DS | 15 | 13.5 | 10.3 | 11.8 | 11.6 | 11.7 | 11.8 | 12.0 | 12.1 | 12.3 | 12.4 | 12.5 | 12.6 | 12.7 | 12.8 | 12.8 | 12.9 | 12.9 | 13.0 | 13.1 | 13.2 | 13.2 | 13.3 | 13.3 |
| | Uplands MTS | 33 | 29.7 | 19.8 | 22.6 | 22.6 | 25.4 | 27.5 | 29.0 | 35.2 | 39.9 | 44.7 | 53.5 | 53.8 | 54.1 | 54.8 | 55.4 | 55.7 | 55.8 | 56.1 | 56.4 | 56.8 | 57.2 | 57.6 | 57.6 |
| | South Gloucester DS | 7.5 | 6.75 | 3.8 | 4.3 | 4.2 | 4.3 | 4.3 | 4.5 | 4.4 | 4.4 | 4.5 | 4.5 | 4.6 | 4.6 | 4.5 | 4.6 | 4.6 | 4.6 | 4.6 | 4.5 | 4.6 | 4.6 | 4.6 | 4.6 |
| | Greely DS | 30 | 27 | 16.0 | 18.2 | 17.8 | 17.9 | 18.3 | 18.6 | 19.0 | 19.2 | 19.4 | 19.6 | 19.8 | 19.9 | 20.2 | 20.4 | 20.4 | 20.5 | 20.6 | 20.8 | 21.0 | 21.2 | 21.5 | 21.7 |
| | Russell DS | 7.5 | 6.75 | 3.4 | 3.9 | 3.8 | 3.9 | 3.9 | 4.0 | 4.1 | 4.0 | 4.0 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.3 | 4.3 | 4.3 |
| | Centerpoint MTS | 14 | 12.6 | 13.8 | 15.8 | 15.3 | 15.5 | 15.4 | 15.5 | 15.4 | 15.5 | 15.4 | 15.3 | 15.3 | 15.2 | 15.3 | 15.2 | 15.1 | 15.1 | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 |
| | Merivale TS | 25 | 22.5 | 14.4 | 16.5 | 16.0 | 15.7 | 18.3 | 18.6 | 18.6 | 18.7 | 19.3 | 19.7 | 19.8 | 20.4 | 20.8 | 20.8 | 20.7 | 20.7 | 20.6 | 20.7 | 20.7 | 21.5 | 21.5 | 21.5 |
| | National Aeronautical CTS | 1.2 | 1.08 | 0.4 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| | Kanata MTS | 54.2 | 48.78 | 51.6 | 59.0 | 59.7 | 61.8 | 63.4 | 67.1 | 67.0 | 66.8 | 66.6 | 66.5 | 66.3 | 67.0 | 67.3 | 67.0 | 66.8 | 66.6 | 66.6 | 66.5 | 66.5 | 66.5 | 66.5 | 66.6 |
| | South March TS | 122.3 | 110.07 | 78.0 | 89.2 | 86.5 | 86.9 | 87.7 | 88.7 | 98.4 | 98.2 | 97.8 | 97.9 | 98.2 | 97.9 | 96.7 | 95.4 | 94.7 | 94.9 | 95.2 | 95.7 | 96.1 | 96.6 | 97.2 | 97.7 |
| | Nepean TS | 160.6 | 144.54 | 131.9 | 150.8 | 145.4 | 144.8 | 131.2 | 135.8 | 128.1 | 127.7 | 128.3 | 128.1 | 127.8 | 127.6 | 127.5 | 127.1 | 126.8 | 126.4 | 126.2 | 126.3 | 126.3 | 126.5 | 126.5 | 126.6 |
| | Terry Fox MTS | 90 | 81 | 49.7 | 56.8 | 58.4 | 63.0 | 64.4 | 66.5 | 68.2 | 69.7 | 71.3 | 72.8 | 74.4 | 75.8 | 77.4 | 78.8 | 80.2 | 81.5 | 82.9 | 82.7 | 82.7 | 82.7 | 82.7 | 82.8 |
| | South Nepean TS | #REF! | #REF! | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 36.3 | 40.0 | 43.7 | 46.4 | 50.1 | 53.5 | 56.2 | 58.7 | 61.8 | 64.3 | 65.9 | 67.6 | 70.3 | 73.5 | 73.5 | 73.5 |
| | Temp | | | | | 80.5 | 85.1 | 87.5 | 87.8 | 126.2 | 131.7 | 137.1 | 141.3 | 146.5 | 151.3 | 155.6 | 159.6 | 164.0 | 167.8 | 170.8 | 172.3 | 175.0 | 178.2 | 178.2 | 178.3 |
| Outer Ottawa West* | Almonte | TBD | TBD | 0.0 | N/A | 44.1 | 44.1 | 46.1 | 42.5 | 43.3 | 43.8 | 44.2 | 44.2 | 44.1 | 44.0 | 44.0 | 44.0 | 44.0 | 44.0 | 44.0 | 44.0 | 44.0 | 44.0 | 44.0 | 44.0 |
| **Merivale Pocket TOTAL** | | | | | **627** | **629** | **649** | **667** | **694** | **726** | **738** | **755** | **767** | **781** | **795** | **806** | **814** | **822** | **831** | **838** | **844** | **850** | **858** | **862** | **866** |
| Downtown | Nepean Epworth TS | 14 | 12.6 | 10.5 | 11.7 | 11.3 | 11.2 | 11.1 | 11.1 | 11.1 | 11.2 | 11.1 | 11.1 | 11.0 | 11.0 | 11.0 | 10.9 | 10.9 | 11.0 | 10.9 | 10.9 | 10.9 | 10.9 | 10.9 | 10.9 |
| | Carling TS | 106 | 95.4 | 78.9 | 88.1 | 88.1 | 89.1 | 90.5 | 92.0 | 92.6 | 92.3 | 96.9 | 97.1 | 96.9 | 96.9 | 97.1 | 97.2 | 97.2 | 96.9 | 96.6 | 96.4 | 96.4 | 96.5 | 96.5 | 96.6 |
| | Lincoln Hights TS | 79.8 | 71.82 | 38.1 | 42.5 | 42.6 | 42.8 | 42.5 | 44.9 | 44.8 | 44.7 | 44.7 | 53.1 | 53.0 | 52.9 | 52.8 | 52.7 | 52.4 | 52.3 | 52.1 | 51.9 | 51.9 | 52.0 | 52.0 | 52.0 |
| | Woodroffe TS | 101 | 90.9 | 26.7 | 29.8 | 30.9 | 30.6 | 31.0 | 32.0 | 32.5 | 32.9 | 48.5 | 48.3 | 48.2 | 48.1 | 48.0 | 47.9 | 47.6 | 47.5 | 47.4 | 47.2 | 47.2 | 47.2 | 47.2 | 47.3 |
| | Hinchey TS | 96 | 86.4 | 42.4 | 47.3 | 46.6 | 48.2 | 52.3 | 38.6 | 40.6 | 42.2 | 44.9 | 47.5 | 48.9 | 50.4 | 52.0 | 53.3 | 54.7 | 55.7 | 57.4 | 58.3 | 59.5 | 60.7 | 61.9 | 63.2 |
| | Slater TS | 215 | 193.5 | 102.1 | 114.0 | 119.6 | 119.5 | 118.3 | 118.9 | 119.1 | 118.8 | 118.7 | 118.5 | 118.4 | 118.2 | 118.2 | 118.0 | 117.8 | 118.4 | 118.0 | 118.0 | 118.0 | 118.1 | 118.1 | 118.2 |
| | Lisgar TS | 83 | 74.7 | 55.6 | 62.1 | 67.7 | 67.0 | 67.3 | 60.9 | 67.1 | 67.3 | 68.5 | 68.8 | 69.2 | 72.3 | 72.7 | 73.0 | 73.2 | 74.4 | 74.5 | 74.9 | 75.4 | 75.9 | 76.5 | 77.0 |
| | King Edward TS | 91.5 | 82.35 | 75.8 | 84.6 | 87.3 | 86.6 | 87.8 | 88.9 | 89.7 | 90.0 | 90.5 | 91.1 | 91.6 | 92.1 | 92.7 | 93.1 | 93.5 | 93.2 | 92.9 | 92.8 | 92.7 | 92.8 | 92.9 | 92.9 |
| | Russell TS | 77.8 | 70.02 | 68.8 | 76.8 | 75.7 | 77.5 | 81.1 | 81.5 | 81.7 | 81.7 | 81.9 | 81.6 | 81.5 | 81.4 | 81.4 | 81.2 | 81.0 | 80.8 | 80.6 | 80.9 | 81.0 | 81.1 | 81.1 | 81.2 |
| | Overbrook TS | 105.6 | 95.04 | 57.8 | 64.5 | 64.4 | 68.3 | 71.3 | 73.8 | 75.4 | 77.4 | 79.5 | 81.2 | 81.9 | 82.8 | 83.6 | 84.5 | 85.0 | 85.9 | 86.5 | 87.7 | 88.4 | 89.6 | 90.5 | 91.6 |
| | Riverdale TS | 117.6 | 105.84 | 70.8 | 79.1 | 81.7 | 80.7 | 81.5 | 83.8 | 85.5 | 86.4 | 86.8 | 87.4 | 87.9 | 88.4 | 89.0 | 89.3 | 89.8 | 91.2 | 91.6 | 92.1 | 92.9 | 93.5 | 94.2 | 94.9 |
| | Albion TS | 99.4 | 89.46 | 52.2 | 58.3 | 56.0 | 55.6 | 55.4 | 55.8 | 56.0 | 55.9 | 55.9 | 55.8 | 55.9 | 56.0 | 56.0 | 55.9 | 55.9 | 55.8 | 55.9 | 56.0 | 56.1 | 56.3 | 56.5 | 56.5 |
| | Ellwood TS | 50 | 45 | 34.4 | 38.4 | 36.8 | 37.4 | 37.7 | 39.0 | 39.7 | 40.2 | 40.2 | 40.1 | 40.0 | 39.9 | 39.8 | 39.7 | 39.7 | 39.5 | 39.3 | 39.3 | 39.3 | 39.3 | 39.4 | 39.9 |
| **Downtown TOTAL** | | | | | **797** | **809** | **814** | **828** | **821** | **836** | **841** | **868** | **882** | **885** | **891** | **894** | **897** | **899** | **903** | **904** | **906** | **910** | **914** | **918** | **922** |
| East Side of Ottawa (Hawthorne Pocket) | Bilberry Creek TS | 94.9 | 85.41 | 35.3 | 40.6 | 39.4 | 39.2 | 39.5 | 45.6 | 49.0 | 48.8 | 48.8 | 48.6 | 48.6 | 48.5 | 48.4 | 48.2 | 48.1 | 48.0 | 48.0 | 48.1 | 48.1 | 48.2 | 48.2 | 48.2 |
| | Orleans TS | 130.3 | 117.27 | 88.2 | 101.5 | 98.0 | 99.5 | 101.7 | 104.3 | 106.8 | 109.0 | 111.0 | 113.1 | 116.5 | 119.3 | 121.0 | 122.1 | 123.0 | 123.6 | 124.1 | 124.8 | 125.7 | 126.6 | 127.0 | 127.4 |
| | Cyrville MTS | 50 | 45 | 20.9 | 24.0 | 22.9 | 23.2 | 26.0 | 31.2 | 34.2 | 36.9 | 40.9 | 42.1 | 43.7 | 44.7 | 45.6 | 46.4 | 47.0 | 47.8 | 48.5 | 49.3 | 50.2 | 51.3 | 52.4 | 53.3 |
| | Moulton MTS | 33 | 29.7 | 23.6 | 27.2 | 26.2 | 26.0 | 27.5 | 29.4 | 31.2 | 32.8 | 32.8 | 32.6 | 32.5 | 32.5 | 32.4 | 32.3 | 32.2 | 32.1 | 31.9 | 31.9 | 31.9 | 31.9 | 31.9 | 31.9 |
| | Wilhaven DS | 20 | 18 | 3.3 | 3.9 | 3.2 | 3.1 | 3.2 | 3.3 | 3.3 | 3.3 | 3.4 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 | 3.8 | 3.9 | 3.9 | 3.9 | 4.1 | 4.1 |
| | Navan DS | 15 | 13.5 | 3.6 | 4.2 | 3.3 | 3.4 | 3.4 | 3.6 | 3.5 | 3.6 | 3.6 | 3.6 | 3.8 | 3.8 | 3.8 | 3.8 | 3.8 | 3.8 | 4.2 | 4.2 | 4.2 | 4.3 | 4.5 | 4.6 |
| | Cumberland DS | 7.5 | 6.75 | 4.7 | 5.4 | 5.2 | 5.2 | 5.3 | 5.4 | 5.5 | 5.5 | 5.5 | 5.5 | 5.7 | 5.8 | 6.0 | 6.0 | 6.1 | 6.1 | 6.2 | 6.3 | 6.4 | 6.4 | 6.5 | 6.5 |
| | Hawthorne TS | 152 | 136.8 | 88.6 | 102.0 | 116.5 | 115.1 | 114.2 | 116.9 | 123.2 | 126.3 | 126.9 | 128.6 | 130.3 | 133.8 | 137.7 | 139.8 | 145.0 | 146.6 | 148.1 | 150.4 | 153.3 | 155.7 | 158.2 | 159.5 |
| | National Research TS | 28 | 25.2 | 5.7 | 6.5 | 8.6 | 8.5 | 8.4 | 8.4 | 8.4 | 8.4 | 8.4 | 8.4 | 8.5 | 8.6 | 8.7 | 8.7 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 |
| Outer Ottawa East* | Clarence DS | 3.7 | 3.33 | 2.4 | 2.8 | 2.7 | 2.7 | 2.7 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 | 2.8 |
| | Rockland DS | 14.3 | 12.87 | 6.9 | 8.0 | 7.6 | 7.6 | 7.6 | 7.7 | 7.8 | 7.9 | 7.9 | 7.8 | 7.8 | 7.8 | 7.8 | 7.8 | 7.7 | 7.7 | 7.7 | 7.7 | 7.7 | 7.8 | 7.8 | 7.8 |
| | Rockland East DS | 8.6 | 7.74 | 10.3 | 11.9 | 11.6 | 11.7 | 11.8 | 11.9 | 12.1 | 12.2 | 12.2 | 12.1 | 12.1 | 12.1 | 12.0 | 12.0 | 11.9 | 11.9 | 11.9 | 11.9 | 12.0 | 12.0 | 12.1 | 12.1 |
| | Wendover TS | 15 | TBD | 10.1 | 11.7 | 11.1 | 7.4 | 7.4 | 9.0 | 9.1 | 9.4 | 9.4 | 9.4 | 9.4 | 9.5 | 9.5 | 9.5 | 9.5 | 9.2 | 9.5 | 9.5 | 9.6 | 9.8 | 9.9 | 13.7 |
| | Hawkesbury MTS | TBD | TBD | 9.5 | 10.9 | 10.9 | 10.9 | 11.0 | 11.0 | 11.1 | 11.1 | 11.1 | 11.2 | 11.2 | 10.9 | 10.9 | 10.9 | 10.9 | 10.9 | 10.9 | 10.9 | 10.9 | 10.9 | 10.9 | 10.9 |
| **Hawthorne Pocket TOTAL** | | | | | **315** | **323** | **323** | **329** | **348** | **365** | **375** | **381** | **386** | **393** | **400** | **407** | **411** | **418** | **420** | **424** | **428** | **432** | **437** | **441** | **444** |
| **Ottawa Area Sub-region TOTAL** | | | | | **1740** | **1761** | **1787** | **1824** | **1864** | **1927** | **1954** | **2005** | **2035** | **2059** | **2086** | **2107** | **2122** | **2139** | **2154** | **2165** | **2178** | **2192** | **2209** | **2222** | **2233** |

*Outer Ottawa Sub-Region stations are included for reference only and are excluded from the totals.

| Sub-Region | Station | Effective Capacity | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *2017* | *2018* | *2019* | *2020* | *2021* | *2022* | *2023* | *2024* | *2025* | *2026* | *2027* | *2028* | *2029* | *2030* | *2031* | *2032* | *2033* | *2034* | *2035* | *2036* | *2037* |
| West Side of Ottawa (Merivale Pocket) | Bridlewood MTS | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.0 | 0.0 | 0.0 |
| | Marchwood MTS | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Fallowfield DS | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Manotick DS | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Richmond DS | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Manordale MTS | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 |
| | Limebank MTS | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Marionville DS | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Uplands MTS | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | South Gloucester DS | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Greely DS | 0.1 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.0 |
| | Russell DS | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Centerpoint MTS | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Merivale TS | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | National Aeronautical CTS | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Kanata MTS | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | South March TS | 0.5 | 0.6 | 0.6 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.5 | 0.4 | 0.4 | 0.4 | 0.1 | 0.1 | 0.1 |
| | Nepean TS | 0.5 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.4 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 |
| | Terry Fox MTS | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | South Nepean TS | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Outer Ottawa West* | Almonte | 10.4 | 10.8 | 10.9 | 10.9 | 10.9 | 10.9 | 10.9 | 10.9 | 10.9 | 10.9 | 10.9 | 8.0 | 8.0 | 1.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Merivale Pocket TOTAL** | | **2.0** | **2.3** | **2.3** | **2.4** | **2.4** | **2.4** | **2.4** | **2.4** | **2.4** | **2.4** | **2.4** | **2.4** | **2.4** | **2.4** | **1.6** | **1.0** | **1.0** | **1.0** | **0.4** | **0.4** | **0.1** |
| Downtown | Nepean Epworth TS | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Carling TS | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Lincoln Hights TS | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Woodroffe TS | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 |
| | Hinchey TS | 0.0 | 0.0 | 0.0 | 16.7 | 16.7 | 16.7 | 16.7 | 16.7 | 16.7 | 16.7 | 16.7 | 16.7 | 16.7 | 16.7 | 16.7 | 16.7 | 16.7 | 16.7 | 16.7 | 16.7 | 16.7 |
| | Slater TS | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Lisgar TS | 0.0 | 0.0 | 0.0 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 |
| | King Edward TS | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Russell TS | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.5 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 |
| | Overbrook TS | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Riverdale TS | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Albion TS | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 |
| | Ellwood TS | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 |
| **Downtown TOTAL** | | **1.4** | **1.5** | **1.6** | **25.8** | **25.8** | **25.8** | **25.8** | **25.8** | **25.8** | **25.8** | **25.8** | **25.8** | **25.8** | **25.8** | **25.3** | **24.6** | **24.6** | **24.6** | **24.4** | **24.4** | **24.3** |
| East Side of Ottawa (Hawthorne Pocket) | Bilberry Creek TS | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Orleans TS | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Cyrville MTS | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Moulton MTS | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Wilhaven DS | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.2 | 0.2 | 0.2 | 0.2 | 0.0 | 0.0 | 0.0 |
| | Navan DS | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.4 | 0.4 | 0.4 | 0.4 | 0.2 | 0.0 | 0.0 |
| | Cumberland DS | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Hawthorne TS | 3.6 | 3.7 | 3.7 | 3.8 | 3.8 | 3.8 | 3.8 | 3.8 | 3.8 | 3.8 | 3.8 | 3.8 | 0.8 | 0.6 | 0.5 | 0.5 | 0.5 | 0.4 | 0.2 | 0.2 | 0.0 |
| | National Research TS | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Outer Ottawa East* | Clarence DS | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Rockland DS | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Rockland East DS | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Wendover TS | 0.2 | 0.2 | 3.8 | 3.8 | 3.8 | 3.8 | 3.8 | 3.8 | 3.8 | 3.8 | 3.8 | 3.8 | 3.8 | 3.8 | 4.1 | 3.8 | 3.8 | 3.8 | 3.7 | 3.7 | 0.0 |
| | Hawkesbury MTS | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Hawthorne Pocket TOTAL** | | **5.4** | **5.5** | **5.5** | **5.6** | **5.6** | **5.6** | **5.6** | **5.6** | **5.6** | **5.6** | **5.6** | **5.6** | **2.6** | **2.4** | **1.4** | **1.0** | **1.0** | **0.9** | **0.4** | **0.2** | **0.0** |
| **Ottawa Area Sub-region TOTAL** | | **8.8** | **9.3** | **9.3** | **33.7** | **33.7** | **33.7** | **33.7** | **33.7** | **33.7** | **33.7** | **33.7** | **33.7** | **30.7** | **30.6** | **28.3** | **26.7** | **26.7** | **26.6** | **25.1** | **25.0** | **24.4** |

*Outer Ottawa Sub-Region stations are included for reference only and are excluded from the totals.

| Sub-Region | Station | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| West Side of Ottawa (Merivale Pocket) | Bridlewood MTS | 0.3 | 0.4 | 0.5 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 | 1.2 | 1.6 | 1.8 | 2.0 | 2.1 | 2.3 | 2.4 | 2.4 | 2.5 | 2.5 | 2.5 | 2.5 |
| | Marchwood MTS | 1.9 | 2.4 | 2.8 | 2.8 | 3.0 | 3.2 | 3.6 | 4.2 | 4.8 | 5.4 | 6.0 | 6.6 | 7.1 | 7.5 | 7.9 | 8.2 | 8.2 | 8.2 | 8.2 | 8.2 |
| | Fallowfield DS | 1.9 | 2.1 | 2.4 | 2.5 | 1.6 | 1.8 | 1.9 | 2.0 | 2.3 | 2.5 | 2.8 | 3.2 | 3.4 | 3.7 | 3.8 | 4.1 | 4.0 | 4.0 | 4.0 | 4.0 |
| | Manotick DS | 0.2 | 0.4 | 0.5 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 | 1.1 | 1.2 | 1.4 | 1.5 | 1.5 | 1.6 | 1.7 | 1.7 | 1.8 | 1.8 | 1.8 | 1.8 |
| | Richmond DS | 0.2 | 0.4 | 0.6 | 0.7 | 0.9 | 1.2 | 1.4 | 1.7 | 2.1 | 2.4 | 2.5 | 2.8 | 3.1 | 3.3 | 3.5 | 3.6 | 3.6 | 3.7 | 3.7 | 3.7 |
| | Manordale MTS | 0.3 | 0.4 | 0.5 | 0.6 | 0.6 | 0.6 | 0.5 | 0.5 | 0.5 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| | Limebank MTS | 2.0 | 2.5 | 3.2 | 3.2 | 3.5 | 3.6 | 4.3 | 4.6 | 5.3 | 6.3 | 7.5 | 8.7 | 9.9 | 11.1 | 12.2 | 12.8 | 13.2 | 13.6 | 13.9 | 14.1 |
| | Marionville DS | 0.5 | 0.6 | 0.8 | 0.8 | 0.9 | 0.9 | 1.0 | 1.0 | 1.2 | 1.4 | 1.6 | 1.7 | 1.9 | 2.0 | 2.2 | 2.1 | 2.2 | 2.2 | 2.2 | 2.2 |
| | Uplands MTS | 0.9 | 1.2 | 1.4 | 1.4 | 1.7 | 2.0 | 2.4 | 3.3 | 3.9 | 4.4 | 5.0 | 5.6 | 6.1 | 6.6 | 7.0 | 7.2 | 7.3 | 7.4 | 7.5 | 7.4 |
| | South Gloucester DS | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 | 0.3 | 0.4 | 0.4 | 0.5 | 0.5 | 0.5 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 |
| | Greely DS | 0.8 | 1.0 | 1.1 | 1.2 | 1.1 | 1.2 | 1.4 | 1.5 | 1.7 | 1.9 | 2.2 | 2.3 | 2.5 | 2.7 | 2.9 | 3.0 | 3.0 | 3.0 | 3.1 | 3.1 |
| | Russell DS | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.5 | 0.5 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 |
| | Centerpoint MTS | 0.6 | 0.7 | 0.8 | 0.8 | 0.8 | 0.8 | 0.9 | 1.1 | 1.2 | 1.4 | 1.4 | 1.6 | 1.7 | 1.8 | 1.9 | 2.0 | 1.9 | 1.9 | 1.9 | 1.9 |
| | Merivale TS | 0.6 | 0.8 | 1.2 | 1.2 | 1.2 | 1.3 | 1.5 | 1.6 | 1.9 | 2.3 | 2.6 | 2.8 | 3.1 | 3.3 | 3.5 | 3.4 | 3.5 | 3.7 | 3.7 | 3.7 |
| | National Aeronautical CTS | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Kanata MTS | 2.3 | 2.8 | 3.3 | 3.3 | 3.3 | 3.6 | 4.1 | 4.4 | 5.1 | 5.7 | 6.3 | 7.0 | 7.5 | 7.9 | 8.4 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 |
| | South March TS | 3.7 | 4.7 | 5.5 | 5.6 | 5.9 | 6.2 | 6.8 | 7.6 | 8.7 | 9.8 | 10.6 | 11.3 | 12.2 | 12.9 | 13.6 | 13.9 | 14.1 | 14.1 | 14.2 | 14.2 |
| | Nepean TS | 5.9 | 7.2 | 7.8 | 7.9 | 7.5 | 7.9 | 8.7 | 9.5 | 10.7 | 12.0 | 13.1 | 14.2 | 15.1 | 15.9 | 16.8 | 17.0 | 17.1 | 17.0 | 17.0 | 16.9 |
| | Terry Fox MTS | 2.3 | 2.8 | 3.2 | 3.2 | 3.3 | 3.6 | 4.1 | 4.7 | 5.3 | 6.2 | 7.0 | 7.8 | 8.6 | 9.4 | 10.1 | 10.3 | 10.3 | 10.4 | 10.3 | 10.3 |
| | South Nepean TS | 0.0 | 0.0 | 0.0 | 0.0 | 1.4 | 1.7 | 2.2 | 2.7 | 3.5 | 4.3 | 5.1 | 5.9 | 6.9 | 7.7 | 8.3 | 8.8 | 9.3 | 9.9 | 9.9 | 9.8 |
| Outer Ottawa West* | Almonte | 0.5 | 1.0 | 1.5 | 1.5 | 1.5 | 1.6 | 1.7 | 1.8 | 1.6 | 1.4 | 1.2 | 1.3 | 1.3 | 1.4 | 1.5 | 1.5 | 1.5 | 1.5 | 1.4 | 1.4 |
| **Merivale Pocket TOTAL** | | **25.4** | **32.1** | **37.8** | **38.4** | **39.9** | **42.8** | **48.6** | **54.7** | **62.6** | **71.3** | **79.2** | **87.5** | **95.5** | **102.5** | **109.0** | **111.9** | **113.6** | **115.1** | **115.4** | **115.2** |
| Downtown | Nepean Epworth TS | 0.4 | 0.5 | 0.6 | 0.6 | 0.7 | 0.6 | 0.7 | 0.8 | 0.9 | 1.0 | 1.2 | 1.3 | 1.4 | 1.4 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 |
| | Carling TS | 3.6 | 4.4 | 5.1 | 5.0 | 5.1 | 5.3 | 6.2 | 6.8 | 7.7 | 8.7 | 9.6 | 10.5 | 11.3 | 12.0 | 12.6 | 12.8 | 13.0 | 12.9 | 12.9 | 12.9 |
| | Lincoln Hights TS | 1.7 | 2.1 | 2.3 | 2.4 | 2.4 | 2.5 | 2.8 | 3.6 | 4.0 | 4.6 | 5.0 | 5.4 | 5.9 | 6.2 | 6.6 | 6.8 | 6.8 | 6.8 | 6.8 | 6.7 |
| | Woodroffe TS | 1.2 | 1.4 | 1.7 | 1.7 | 1.7 | 1.9 | 2.8 | 3.2 | 3.7 | 4.1 | 4.6 | 4.9 | 5.4 | 5.7 | 6.0 | 6.2 | 6.3 | 6.2 | 6.2 | 6.2 |
| | Hinchey TS | 1.9 | 2.4 | 2.9 | 3.0 | 3.2 | 3.4 | 3.9 | 4.5 | 5.3 | 6.1 | 6.9 | 7.7 | 8.5 | 9.1 | 9.9 | 10.3 | 10.5 | 10.7 | 10.9 | 11.0 |
| | Slater TS | 5.0 | 6.5 | 7.7 | 7.8 | 7.7 | 7.9 | 8.7 | 9.7 | 10.9 | 12.3 | 13.7 | 14.7 | 15.8 | 16.8 | 17.8 | 18.0 | 18.1 | 18.2 | 18.1 | 18.1 |
| | Lisgar TS | 2.6 | 3.3 | 3.8 | 3.8 | 4.1 | 4.3 | 4.8 | 5.4 | 6.2 | 7.3 | 8.1 | 8.9 | 9.7 | 10.4 | 11.0 | 11.2 | 11.4 | 11.5 | 11.6 | 11.6 |
| | King Edward TS | 3.5 | 4.4 | 5.1 | 5.1 | 5.1 | 5.4 | 6.0 | 6.7 | 7.6 | 8.6 | 9.6 | 10.5 | 11.3 | 12.0 | 12.6 | 12.8 | 12.9 | 12.9 | 12.9 | 12.9 |
| | Russell TS | 3.2 | 4.1 | 5.0 | 5.0 | 5.0 | 5.2 | 5.7 | 6.4 | 7.2 | 8.1 | 9.0 | 9.7 | 10.5 | 11.1 | 11.7 | 11.8 | 11.9 | 11.9 | 11.9 | 11.9 |
| | Overbrook TS | 2.6 | 3.2 | 3.8 | 3.9 | 3.9 | 4.3 | 4.9 | 5.6 | 6.4 | 7.4 | 8.2 | 9.1 | 9.9 | 10.6 | 11.3 | 11.6 | 11.8 | 12.0 | 12.1 | 12.2 |
| | Riverdale TS | 3.3 | 4.0 | 4.6 | 4.6 | 4.6 | 5.0 | 5.6 | 6.2 | 7.0 | 7.9 | 8.8 | 9.6 | 10.5 | 11.3 | 12.0 | 12.3 | 12.4 | 12.6 | 12.6 | 12.7 |
| | Albion TS | 2.4 | 2.7 | 3.1 | 3.1 | 3.0 | 3.2 | 3.7 | 4.0 | 4.5 | 5.0 | 5.5 | 6.1 | 6.5 | 6.9 | 7.3 | 7.4 | 7.4 | 7.4 | 7.4 | 7.4 |
| | Ellwood TS | 1.5 | 1.8 | 2.1 | 2.1 | 2.1 | 2.2 | 2.6 | 2.8 | 3.2 | 3.5 | 3.9 | 4.2 | 4.5 | 4.8 | 5.1 | 5.1 | 5.2 | 5.1 | 5.1 | 5.2 |
| **Downtown TOTAL** | | **32.9** | **40.9** | **47.8** | **48.2** | **48.6** | **51.3** | **58.2** | **65.7** | **74.8** | **84.8** | **94.1** | **102.6** | **111.3** | **118.2** | **125.1** | **127.7** | **129.1** | **129.9** | **130.2** | **130.2** |
| East Side of Ottawa (Hawthorne Pocket) | Bilberry Creek TS | 1.8 | 2.1 | 2.4 | 2.4 | 2.6 | 2.7 | 3.1 | 3.4 | 3.8 | 4.3 | 4.7 | 5.2 | 5.6 | 5.9 | 6.2 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 |
| | Orleans TS | 4.4 | 5.9 | 7.2 | 7.6 | 7.5 | 7.7 | 8.7 | 9.8 | 11.6 | 13.4 | 15.0 | 16.3 | 17.8 | 18.9 | 20.1 | 20.5 | 20.8 | 21.1 | 21.1 | 21.1 |
| | Cyrville MTS | 1.0 | 1.2 | 1.4 | 1.6 | 1.7 | 1.9 | 2.3 | 2.7 | 3.1 | 3.6 | 4.2 | 4.6 | 5.1 | 5.5 | 5.9 | 6.1 | 6.4 | 6.5 | 6.6 | 6.7 |
| | Moulton MTS | 1.0 | 1.2 | 1.4 | 1.5 | 1.5 | 1.7 | 1.9 | 2.2 | 2.5 | 2.7 | 3.1 | 3.4 | 3.6 | 3.8 | 4.0 | 4.2 | 4.1 | 4.2 | 4.2 | 4.2 |
| | Wilhaven DS | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 | 0.5 | 0.5 | 0.5 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 |
| | Navan DS | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 | 0.3 | 0.4 | 0.4 | 0.5 | 0.5 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 |
| | Cumberland DS | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| | Hawthorne TS | 4.5 | 5.7 | 6.6 | 6.8 | 7.0 | 7.5 | 8.5 | 9.6 | 11.1 | 12.8 | 14.5 | 16.1 | 17.7 | 19.0 | 20.3 | 21.0 | 21.6 | 22.0 | 22.3 | 22.4 |
| | National Research TS | 0.2 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.5 | 0.4 | 0.4 | 0.3 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| Outer Ottawa East* | Clarence DS | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.5 | 0.5 | 0.5 | 0.5 |
| | Rockland DS | 0.2 | 0.3 | 0.4 | 0.5 | 0.5 | 0.5 | 0.6 | 0.6 | 0.8 | 0.9 | 1.0 | 1.1 | 1.2 | 1.3 | 1.4 | 1.4 | 1.5 | 1.5 | 1.5 | 1.5 |
| | Rockland East DS | 0.2 | 0.4 | 0.5 | 0.5 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 | 1.1 | 1.2 | 1.4 | 1.5 | 1.6 | 1.7 | 1.7 | 1.8 | 1.8 | 1.8 | 1.8 |
| | Wendover TS | 0.2 | 0.4 | 0.5 | 0.6 | 0.6 | 0.7 | 0.8 | 0.9 | 1.1 | 1.2 | 1.4 | 1.6 | 1.7 | 1.8 | 2.0 | 2.0 | 2.1 | 2.1 | 2.1 | 2.1 |
| | Hawkesbury MTS | 0.1 | 0.2 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.5 | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 |
| **Hawthorne Pocket TOTAL** | | **14.2** | **18.5** | **22.2** | **23.1** | **23.6** | **25.2** | **28.4** | **32.1** | **36.9** | **42.1** | **47.0** | **51.7** | **56.3** | **60.1** | **63.9** | **65.8** | **67.1** | **68.1** | **68.6** | **68.6** |
| **Ottawa Area Sub-region TOTAL** | | **72.6** | **91.5** | **107.7** | **109.7** | **112.2** | **119.3** | **135.3** | **152.6** | **174.3** | **198.2** | **220.3** | **241.8** | **263.1** | **280.8** | **297.9** | **305.5** | **309.8** | **313.1** | **314.2** | **314.0** |

*Outer Ottawa Sub-Region stations are included for reference only and are excluded from the totals.

| Sub-Region | Station | *2018* | *2019* | *2020* | *2021* | *2022* | *2023* | *2024* | *2025* | *2026* | *2027* | *2028* | *2029* | *2030* | *2031* | *2032* | *2033* | *2034* | *2035* | *2036* | *2037* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| West Side of Ottawa (Merivale Pocket) | Bridlewood MTS | 0.3 | 0.4 | 0.5 | 0.5 | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 | 1.1 | 1.2 | 1.3 | 1.3 | 1.4 | 1.5 | 1.5 | 1.6 | 1.6 | 1.6 | 1.6 |
| | Marchwood MTS | 1.9 | 2.4 | 2.8 | 2.5 | 2.7 | 2.9 | 3.1 | 3.5 | 3.6 | 3.8 | 3.9 | 4.3 | 4.5 | 4.7 | 5.0 | 5.2 | 5.2 | 5.2 | 5.2 | 5.1 |
| | Fallowfield DS | 1.9 | 2.1 | 2.4 | 2.3 | 1.5 | 1.7 | 1.7 | 1.7 | 1.8 | 1.9 | 2.0 | 2.2 | 2.2 | 2.4 | 2.5 | 2.7 | 2.6 | 2.5 | 2.5 | 2.5 |
| | Manotick DS | 0.2 | 0.4 | 0.5 | 0.5 | 0.5 | 0.6 | 0.6 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| | Richmond DS | 0.2 | 0.4 | 0.6 | 0.6 | 0.8 | 1.0 | 1.2 | 1.3 | 1.4 | 1.5 | 1.5 | 1.6 | 1.7 | 1.8 | 1.9 | 2.0 | 2.0 | 2.1 | 2.1 | 2.0 |
| | Manordale MTS | 0.3 | 0.4 | 0.5 | 0.5 | 0.5 | 0.5 | 0.4 | 0.4 | 0.3 | 0.2 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Limebank MTS | 2.0 | 2.5 | 3.2 | 2.9 | 3.2 | 3.3 | 3.7 | 3.8 | 4.1 | 4.5 | 5.0 | 5.6 | 6.3 | 7.1 | 7.8 | 8.2 | 8.5 | 8.7 | 8.8 | 8.9 |
| | Marionville DS | 0.5 | 0.6 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.9 | 0.9 | 1.0 | 1.0 | 0.9 | 0.9 | 1.0 | 1.0 | 1.0 |
| | Uplands MTS | 0.9 | 1.2 | 1.4 | 1.3 | 1.5 | 1.8 | 2.1 | 2.7 | 2.9 | 2.9 | 3.1 | 3.5 | 3.6 | 3.9 | 4.2 | 4.4 | 4.4 | 4.5 | 4.5 | 4.5 |
| | South Gloucester DS | 0.2 | 0.2 | 0.3 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 |
| | Greely DS | 0.8 | 1.0 | 1.1 | 1.1 | 1.0 | 1.1 | 1.2 | 1.2 | 1.2 | 1.3 | 1.3 | 1.3 | 1.4 | 1.5 | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 |
| | Russell DS | 0.2 | 0.2 | 0.3 | 0.2 | 0.2 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| | Centerpoint MTS | 0.6 | 0.7 | 0.8 | 0.7 | 0.8 | 0.7 | 0.8 | 0.9 | 0.9 | 1.0 | 0.9 | 1.0 | 1.1 | 1.1 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 |
| | Merivale TS | 0.6 | 0.8 | 1.2 | 1.1 | 1.1 | 1.1 | 1.2 | 1.2 | 1.2 | 1.3 | 1.3 | 1.4 | 1.4 | 1.5 | 1.5 | 1.5 | 1.5 | 1.6 | 1.6 | 1.6 |
| | National Aeronautical CTS | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Kanata MTS | 2.3 | 2.8 | 3.3 | 3.0 | 3.1 | 3.3 | 3.5 | 3.6 | 3.9 | 4.0 | 4.1 | 4.5 | 4.7 | 4.9 | 5.2 | 5.3 | 5.3 | 5.2 | 5.2 | 5.2 |
| | South March TS | 3.7 | 4.7 | 5.5 | 5.1 | 5.3 | 5.6 | 5.7 | 6.0 | 6.2 | 6.3 | 6.2 | 6.4 | 6.7 | 6.9 | 7.2 | 7.4 | 7.4 | 7.3 | 7.3 | 7.3 |
| | Nepean TS | 5.9 | 7.2 | 7.8 | 7.2 | 6.9 | 7.2 | 7.5 | 7.8 | 8.0 | 8.3 | 8.4 | 8.8 | 9.1 | 9.4 | 9.9 | 10.0 | 10.0 | 9.8 | 9.8 | 9.7 |
| | Terry Fox MTS | 2.3 | 2.8 | 3.2 | 2.9 | 3.0 | 3.3 | 3.5 | 3.8 | 4.1 | 4.4 | 4.6 | 5.0 | 5.4 | 5.9 | 6.4 | 6.5 | 6.6 | 6.5 | 6.5 | 6.5 |
| | South Nepean TS | 0.0 | 0.0 | 0.0 | 0.0 | 1.2 | 1.5 | 1.8 | 2.1 | 2.4 | 2.7 | 3.0 | 3.5 | 3.9 | 4.4 | 4.8 | 5.1 | 5.4 | 5.7 | 5.7 | 5.7 |
| Outer Ottawa West* | Almonte | 0.5 | 1.0 | 1.5 | 1.4 | 1.4 | 1.4 | 1.4 | 1.4 | 1.0 | 0.6 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 |
| **Merivale Pocket TOTAL** | | **25.4** | **32.1** | **37.8** | **35.0** | **36.3** | **39.2** | **41.6** | **44.1** | **46.0** | **47.9** | **49.0** | **52.6** | **55.7** | **59.4** | **63.1** | **65.0** | **65.7** | **66.0** | **66.2** | **65.8** |
| Downtown | Nepean Epworth TS | 0.4 | 0.5 | 0.6 | 0.6 | 0.6 | 0.5 | 0.6 | 0.6 | 0.7 | 0.7 | 0.7 | 0.8 | 0.8 | 0.7 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 | 0.8 |
| | Carling TS | 3.6 | 4.4 | 5.1 | 4.6 | 4.6 | 4.9 | 5.3 | 5.5 | 5.7 | 5.9 | 6.1 | 6.5 | 6.7 | 7.0 | 7.4 | 7.6 | 7.6 | 7.5 | 7.5 | 7.4 |
| | Lincoln Hights TS | 1.7 | 2.1 | 2.3 | 2.2 | 2.2 | 2.3 | 2.4 | 3.0 | 3.0 | 3.2 | 3.2 | 3.4 | 3.7 | 3.8 | 4.0 | 4.1 | 4.1 | 4.1 | 4.1 | 4.0 |
| | Woodroffe TS | 1.2 | 1.4 | 1.7 | 1.5 | 1.5 | 1.7 | 2.4 | 2.6 | 2.7 | 2.8 | 2.9 | 3.0 | 3.2 | 3.4 | 3.5 | 3.7 | 3.8 | 3.7 | 3.7 | 3.7 |
| | Hinchey TS | 1.9 | 2.4 | 2.9 | 2.8 | 2.9 | 3.1 | 3.3 | 3.6 | 3.9 | 4.0 | 4.2 | 4.5 | 4.9 | 5.1 | 5.5 | 5.8 | 5.9 | 6.0 | 6.1 | 6.1 |
| | Slater TS | 5.0 | 6.5 | 7.7 | 7.1 | 6.9 | 7.2 | 7.3 | 7.5 | 7.6 | 7.8 | 7.8 | 8.0 | 8.2 | 8.6 | 9.0 | 9.0 | 9.0 | 8.9 | 8.9 | 8.8 |
| | Lisgar TS | 2.6 | 3.3 | 3.8 | 3.5 | 3.7 | 3.9 | 4.1 | 4.3 | 4.5 | 4.9 | 5.0 | 5.3 | 5.6 | 5.9 | 6.2 | 6.4 | 6.4 | 6.4 | 6.5 | 6.5 |
| | King Edward TS | 3.5 | 4.4 | 5.1 | 4.7 | 4.6 | 4.9 | 5.2 | 5.4 | 5.6 | 5.8 | 5.9 | 6.2 | 6.5 | 6.8 | 7.1 | 7.2 | 7.3 | 7.2 | 7.1 | 7.1 |
| | Russell TS | 3.2 | 4.1 | 5.0 | 4.6 | 4.5 | 4.8 | 4.8 | 5.0 | 5.2 | 5.2 | 5.3 | 5.5 | 5.7 | 5.9 | 6.2 | 6.3 | 6.2 | 6.2 | 6.2 | 6.1 |
| | Overbrook TS | 2.6 | 3.2 | 3.8 | 3.5 | 3.6 | 3.9 | 4.2 | 4.5 | 4.7 | 5.0 | 5.1 | 5.5 | 5.8 | 6.2 | 6.6 | 6.8 | 6.9 | 7.0 | 7.0 | 7.1 |
| | Riverdale TS | 3.3 | 4.0 | 4.6 | 4.2 | 4.2 | 4.5 | 4.8 | 5.0 | 5.2 | 5.4 | 5.5 | 5.9 | 6.2 | 6.7 | 7.0 | 7.2 | 7.2 | 7.3 | 7.3 | 7.3 |
| | Albion TS | 2.4 | 2.7 | 3.1 | 2.8 | 2.8 | 3.0 | 3.2 | 3.3 | 3.4 | 3.5 | 3.5 | 3.8 | 4.0 | 4.2 | 4.4 | 4.5 | 4.5 | 4.4 | 4.4 | 4.4 |
| | Ellwood TS | 1.5 | 1.8 | 2.1 | 1.9 | 2.0 | 2.1 | 2.2 | 2.3 | 2.4 | 2.4 | 2.6 | 2.7 | 2.7 | 2.9 | 3.1 | 3.1 | 3.2 | 3.1 | 3.1 | 3.1 |
| **Downtown TOTAL** | | **32.9** | **40.9** | **47.8** | **43.9** | **44.2** | **46.8** | **49.6** | **52.6** | **54.6** | **56.6** | **57.8** | **61.0** | **64.1** | **67.2** | **70.9** | **72.5** | **72.9** | **72.5** | **72.6** | **72.3** |
| East Side of Ottawa (Hawthorne Pocket) | Bilberry Creek TS | 1.8 | 2.1 | 2.4 | 2.2 | 2.4 | 2.5 | 2.7 | 2.8 | 2.9 | 3.0 | 3.0 | 3.3 | 3.4 | 3.5 | 3.7 | 3.8 | 3.8 | 3.8 | 3.7 | 3.7 |
| | Orleans TS | 4.4 | 5.9 | 7.2 | 6.8 | 6.7 | 6.9 | 7.1 | 7.4 | 7.8 | 8.0 | 7.9 | 8.2 | 8.4 | 8.7 | 9.1 | 9.3 | 9.3 | 9.3 | 9.3 | 9.3 |
| | Cyrville MTS | 1.0 | 1.2 | 1.4 | 1.4 | 1.5 | 1.8 | 2.0 | 2.2 | 2.3 | 2.5 | 2.7 | 2.9 | 3.2 | 3.4 | 3.7 | 3.9 | 4.0 | 4.0 | 4.1 | 4.2 |
| | Moulton MTS | 1.0 | 1.2 | 1.4 | 1.3 | 1.4 | 1.6 | 1.6 | 1.8 | 1.9 | 1.9 | 1.9 | 2.1 | 2.2 | 2.3 | 2.4 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 |
| | Wilhaven DS | 0.2 | 0.2 | 0.3 | 0.2 | 0.2 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| | Navan DS | 0.2 | 0.2 | 0.3 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 | 0.4 |
| | Cumberland DS | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | Hawthorne TS | 4.5 | 5.7 | 6.6 | 6.1 | 6.3 | 6.8 | 7.1 | 7.6 | 8.0 | 8.4 | 8.7 | 9.3 | 9.9 | 10.5 | 11.1 | 11.6 | 11.9 | 12.0 | 12.1 | 12.1 |
| | National Research TS | 0.2 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.2 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Outer Ottawa East* | Clarence DS | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 |
| | Rockland DS | 0.2 | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 | 0.6 |
| | Rockland East DS | 0.2 | 0.4 | 0.5 | 0.4 | 0.4 | 0.5 | 0.5 | 0.6 | 0.6 | 0.7 | 0.7 | 0.7 | 0.8 | 0.9 | 0.9 | 0.9 | 1.0 | 1.0 | 1.0 | 1.0 |
| | Wendover TS | 0.2 | 0.4 | 0.5 | 0.5 | 0.5 | 0.6 | 0.6 | 0.7 | 0.7 | 0.7 | 0.8 | 0.8 | 0.9 | 0.9 | 1.0 | 1.0 | 1.0 | 1.1 | 1.1 | 1.1 |
| | Hawkesbury MTS | 0.1 | 0.2 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.3 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Hawthorne Pocket TOTAL** | | **14.2** | **18.5** | **22.2** | **20.9** | **21.3** | **22.8** | **23.9** | **25.2** | **26.0** | **26.8** | **27.1** | **28.7** | **30.1** | **31.6** | **33.4** | **34.6** | **35.0** | **35.1** | **35.3** | **35.2** |
| **Ottawa Area Sub-region TOTAL** | | **72.6** | **91.5** | **107.7** | **99.7** | **101.8** | **108.8** | **115.1** | **121.9** | **126.7** | **131.3** | **133.9** | **142.3** | **149.9** | **158.2** | **167.3** | **172.1** | **173.6** | **173.6** | **174.1** | **173.4** |

*Outer Ottawa Sub-Region stations are included for reference only and are excluded from the totals.

| Pocket | Station | 10-Day LTR (MVA) | 10-Day LTR (MW) | 2017 Net Coincident Demand UPDATED | Starting Point of Forecast (Gross, Median Weather) | Gross Demand Forecast with Median Weather Conditions | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | *2018* | *2019* | *2020* | *2021* | *2022* | *2023* | *2024* | *2025* | *2026* | *2027* | *2028* | *2029* | *2030* | *2031* | *2032* | *2033* | *2034* | *2035* | *2036* | *2037* |
| West Side of Ottawa (Merivale Pocket) | Bridlewood MTS | 25 | 22.5 | 9.8 | 11.2 | 14.0 | 14.0 | 14.0 | 14.9 | 14.9 | 15.9 | 15.9 | 16.5 | 19.0 | 21.0 | 21.8 | 21.8 | 21.8 | 21.8 | 21.8 | 21.8 | 21.8 | 21.8 | 21.8 | 21.8 |
| | Marchwood MTS | 33 | 29.7 | 39.2 | 44.8 | 56.8 | 62.4 | 64.6 | 66.0 | 67.3 | 68.2 | 69.1 | 70.0 | 70.7 | 70.7 | 70.7 | 70.7 | 70.7 | 70.7 | 70.7 | 70.7 | 70.7 | 70.7 | 70.7 | 70.7 |
| | Fallowfield DS | 25 | 22.5 | 39.5 | 47.1 | 46.8 | 41.7 | 48.4 | 51.4 | 23.1 | 26.3 | 26.8 | 27.8 | 28.3 | 29.3 | 29.8 | 31.8 | 32.3 | 33.6 | 33.6 | 34.6 | 34.6 | 34.6 | 34.6 | 34.6 |
| | Manotick DS | 8.6 | 7.7 | 5.6 | 6.5 | 6.6 | 7.5 | 8.4 | 9.2 | 10.1 | 10.9 | 11.8 | 11.8 | 11.9 | 11.8 | 12.0 | 11.9 | 12.1 | 12.0 | 12.1 | 12.1 | 12.2 | 12.2 | 12.3 | 12.2 |
| | Richmond DS | 75 | 67.5 | 4.5 | 5.1 | 7.1 | 12.1 | 13.8 | 17.9 | 21.9 | 25.1 | 26.9 | 26.9 | 28.7 | 28.7 | 28.7 | 28.7 | 28.7 | 28.7 | 28.7 | 28.7 | 28.7 | 28.7 | 28.7 | 28.7 |
| | Manordale MTS | 10 | 9.0 | 8.5 | 9.7 | 9.7 | 9.7 | 9.8 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 |
| | Limebank MTS | 66 | 59.4 | 46.8 | 53.5 | 53.5 | 59.7 | 72.0 | 74.7 | 82.0 | 75.8 | 79.3 | 75.5 | 79.0 | 84.2 | 89.4 | 94.6 | 99.8 | 105.0 | 109.2 | 112.7 | 115.3 | 118.0 | 120.6 | 123.3 |
| | Marionville DS | 15 | 13.5 | 10.3 | 11.8 | 12.1 | 12.3 | 12.6 | 12.8 | 12.9 | 13.1 | 13.2 | 13.3 | 13.4 | 13.5 | 13.6 | 13.7 | 13.8 | 13.9 | 14.0 | 14.0 | 14.1 | 14.2 | 14.3 | 14.3 |
| | Uplands MTS | 33 | 29.7 | 19.8 | 22.6 | 23.5 | 26.7 | 28.9 | 30.4 | 36.7 | 41.8 | 46.8 | 56.2 | 56.7 | 57.1 | 58.0 | 58.9 | 59.4 | 59.8 | 60.3 | 60.7 | 61.2 | 61.6 | 62.1 | 62.1 |
| | South Gloucester DS | 7.5 | 6.8 | 3.8 | 4.3 | 4.4 | 4.5 | 4.6 | 4.7 | 4.7 | 4.7 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 5.0 | 5.0 | 5.0 | 5.0 |
| | Greely DS | 30 | 27.0 | 16.0 | 18.2 | 18.7 | 19.2 | 19.7 | 20.0 | 20.3 | 20.6 | 20.9 | 21.1 | 21.3 | 21.5 | 21.8 | 22.0 | 22.1 | 22.3 | 22.5 | 22.7 | 22.9 | 23.1 | 23.3 | 23.5 |
| | Russell DS | 7.5 | 6.8 | 3.4 | 3.9 | 4.0 | 4.1 | 4.2 | 4.2 | 4.3 | 4.3 | 4.3 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.6 | 4.6 | 4.6 |
| | Centerpoint MTS | 14 | 12.6 | 13.8 | 15.8 | 15.9 | 16.2 | 16.2 | 16.2 | 16.2 | 16.2 | 16.2 | 16.2 | 16.2 | 16.2 | 16.2 | 16.2 | 16.2 | 16.2 | 16.2 | 16.2 | 16.2 | 16.2 | 16.2 | 16.2 |
| | Merivale TS | 25 | 22.5 | 14.4 | 16.5 | 16.6 | 16.6 | 19.5 | 19.7 | 19.7 | 19.9 | 20.5 | 20.9 | 21.1 | 21.7 | 22.2 | 22.2 | 22.2 | 22.2 | 22.2 | 22.2 | 22.2 | 23.1 | 23.1 | 23.1 |
| | National Aeronautical CTS | 1.2 | 1.1 | 0.4 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| | Kanata MTS | 54.2 | 48.8 | 51.6 | 59.0 | 62.3 | 64.9 | 67.0 | 70.4 | 70.4 | 70.4 | 70.4 | 70.4 | 70.4 | 71.3 | 71.7 | 71.7 | 71.7 | 71.7 | 71.7 | 71.7 | 71.7 | 71.7 | 71.7 | 71.7 |
| | South March TS | 122.3 | 110.1 | 78.0 | 89.2 | 90.7 | 92.2 | 93.8 | 94.5 | 104.4 | 104.5 | 104.1 | 104.6 | 105.1 | 104.9 | 103.6 | 102.4 | 102.0 | 102.5 | 102.9 | 103.4 | 103.9 | 104.3 | 104.7 | 105.2 |
| | Nepean TS | 160.6 | 144.5 | 131.9 | 150.8 | 151.9 | 152.6 | 139.6 | 143.6 | 135.5 | 135.5 | 136.4 | 136.4 | 136.4 | 136.4 | 136.4 | 136.4 | 136.4 | 136.4 | 136.4 | 136.4 | 136.4 | 136.4 | 136.4 | 136.4 |
| | Terry Fox MTS | 90 | 81.0 | 49.7 | 56.8 | 60.7 | 65.8 | 67.6 | 69.4 | 71.2 | 73.0 | 74.8 | 76.6 | 78.4 | 80.2 | 82.0 | 83.8 | 85.6 | 87.4 | 89.2 | 89.2 | 89.2 | 89.2 | 89.2 | 89.2 |
| | South Nepean TS | #REF! | #REF! | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 37.5 | 41.5 | 45.5 | 48.5 | 52.5 | 56.2 | 59.2 | 62.2 | 65.7 | 68.7 | 70.7 | 72.7 | 75.7 | 79.2 | 79.2 | 79.2 |
| Outer Ottawa West* | Almonte | TBD | 90.0 | 0.0 | N/A | 44.1 | 44.1 | 46.1 | 42.5 | 43.3 | 43.8 | 44.2 | 44.2 | 44.1 | 44.0 | 44.0 | 44.0 | 44.0 | 44.0 | 44.0 | 44.0 | 44.0 | 44.0 | 44.0 | 44.0 |
| **Merivale Pocket TOTAL** | | | | **547** | **627** | **656** | **683** | **705** | **730** | **764** | **778** | **798** | **812** | **829** | **844** | **857** | **869** | **880** | **893** | **902** | **910** | **917** | **925** | **929** | **932** |
| Downtown | Nepean Epworth TS | 14 | 12.6 | 10.5 | 11.7 | 11.7 | 11.7 | 11.7 | 11.7 | 11.7 | 11.7 | 11.7 | 11.7 | 11.7 | 11.7 | 11.7 | 11.7 | 11.7 | 11.7 | 11.7 | 11.7 | 11.7 | 11.7 | 11.7 | 11.7 |
| | Carling TS | 106 | 95.4 | 78.9 | 88.1 | 91.8 | 93.6 | 95.7 | 96.7 | 97.3 | 97.3 | 102.3 | 102.7 | 102.7 | 102.9 | 103.3 | 103.8 | 104.0 | 104.0 | 104.0 | 104.0 | 104.0 | 104.0 | 104.0 | 104.0 |
| | Lincoln Hights TS | 79.8 | 71.8 | 38.1 | 42.5 | 44.3 | 44.9 | 44.9 | 47.1 | 47.1 | 47.1 | 47.1 | 56.1 | 56.1 | 56.1 | 56.1 | 56.1 | 56.1 | 56.1 | 56.1 | 56.1 | 56.1 | 56.1 | 56.1 | 56.1 |
| | Woodroffe TS | 101 | 90.9 | 26.7 | 29.8 | 32.1 | 32.1 | 32.8 | 33.6 | 34.2 | 34.7 | 51.0 | 51.0 | 51.0 | 51.0 | 51.0 | 51.0 | 51.0 | 51.0 | 51.0 | 51.0 | 51.0 | 51.0 | 51.0 | 51.0 |
| | Hinchey TS | 96 | 86.4 | 42.4 | 47.3 | 48.5 | 50.6 | 55.2 | 58.1 | 60.2 | 62.0 | 64.9 | 67.8 | 69.5 | 71.2 | 72.9 | 74.6 | 76.3 | 77.6 | 79.7 | 80.9 | 82.2 | 83.4 | 84.7 | 86.0 |
| | Slater TS | 215 | 193.5 | 102.1 | 114.0 | 124.6 | 126.0 | 126.0 | 126.0 | 126.0 | 126.0 | 126.0 | 126.0 | 126.0 | 126.0 | 126.0 | 126.0 | 126.0 | 127.0 | 127.0 | 127.0 | 127.0 | 127.0 | 127.0 | 127.0 |
| | Lisgar TS | 83 | 74.7 | 55.6 | 62.1 | 70.3 | 70.3 | 71.1 | 71.8 | 78.2 | 78.7 | 80.1 | 80.6 | 81.2 | 84.6 | 85.1 | 85.7 | 86.2 | 87.7 | 88.2 | 88.7 | 89.3 | 89.8 | 90.4 | 90.9 |
| | King Edward TS | 91.5 | 82.4 | 75.8 | 84.6 | 90.9 | 91.0 | 92.9 | 93.6 | 94.3 | 95.0 | 95.7 | 96.5 | 97.2 | 97.9 | 98.6 | 99.3 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| | Russell TS | 77.8 | 70.0 | 68.8 | 76.8 | 79.5 | 82.2 | 86.7 | 86.7 | 86.9 | 87.1 | 87.3 | 87.3 | 87.3 | 87.3 | 87.3 | 87.3 | 87.3 | 87.3 | 87.3 | 87.3 | 87.3 | 87.3 | 87.3 | 87.3 |
| | Overbrook TS | 105.6 | 95.0 | 57.8 | 64.5 | 67.2 | 71.8 | 75.4 | 77.6 | 79.2 | 81.6 | 83.9 | 86.0 | 86.9 | 88.1 | 89.0 | 90.3 | 91.1 | 92.4 | 93.2 | 94.5 | 95.3 | 96.6 | 97.5 | 98.7 |
| | Riverdale TS | 117.6 | 105.8 | 70.8 | 79.1 | 85.0 | 84.7 | 86.1 | 88.0 | 89.7 | 90.9 | 91.6 | 92.4 | 93.1 | 93.8 | 94.5 | 95.2 | 96.0 | 97.9 | 98.6 | 99.3 | 100.1 | 100.8 | 101.5 | 102.2 |
| | Albion TS | 99.4 | 89.5 | 52.2 | 58.3 | 58.6 | 58.7 | 58.8 | 59.0 | 59.1 | 59.2 | 59.4 | 59.5 | 59.7 | 59.8 | 59.9 | 60.1 | 60.2 | 60.3 | 60.5 | 60.6 | 60.7 | 60.9 | 61.0 | 61.0 |
| | Ellwood TS | 50 | 45.0 | 34.4 | 38.4 | 38.4 | 39.3 | 39.9 | 41.0 | 41.8 | 42.4 | 42.5 | 42.5 | 42.5 | 42.5 | 42.5 | 42.5 | 42.5 | 42.5 | 42.5 | 42.5 | 42.5 | 42.5 | 42.5 | 43.0 |
| **Downtown TOTAL** | | | | **714** | **797** | **843** | **857** | **877** | **891** | **906** | **914** | **944** | **960** | **965** | **973** | **978** | **984** | **988** | **996** | **1000** | **1004** | **1007** | **1011** | **1015** | **1019** |
| East Side of Ottawa (Hawthorne Pocket) | Bilberry Creek TS | 94.9 | 85.4 | 35.3 | 40.6 | 41.6 | 41.7 | 42.3 | 48.2 | 51.9 | 51.9 | 51.9 | 51.9 | 51.9 | 51.9 | 51.9 | 51.9 | 51.9 | 51.9 | 51.9 | 51.9 | 51.9 | 51.9 | 51.9 | 52.0 |
| | Orleans TS | 130.3 | 117.3 | 88.2 | 101.5 | 102.4 | 105.4 | 109.0 | 111.1 | 113.5 | 115.9 | 118.1 | 120.6 | 124.3 | 127.3 | 128.9 | 130.2 | 131.5 | 132.4 | 133.3 | 134.1 | 135.0 | 135.8 | 136.3 | 136.6 |
| | Cyrville MTS | 50 | 45.0 | 20.9 | 24.0 | 24.0 | 24.5 | 27.5 | 32.7 | 35.8 | 38.8 | 43.0 | 44.4 | 46.1 | 47.3 | 48.4 | 49.4 | 50.3 | 51.3 | 52.2 | 53.2 | 54.2 | 55.4 | 56.5 | 57.5 |
| | Moulton MTS | 33 | 29.7 | 23.6 | 27.2 | 27.2 | 27.2 | 29.0 | 30.8 | 32.6 | 34.4 | 34.4 | 34.4 | 34.4 | 34.4 | 34.4 | 34.4 | 34.4 | 34.4 | 34.4 | 34.4 | 34.4 | 34.4 | 34.4 | 34.4 |
| | Wilhaven DS | 20 | 18.0 | 3.3 | 3.9 | 3.9 | 3.9 | 4.0 | 4.1 | 4.1 | 4.1 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.3 | 4.3 | 4.3 | 4.3 | 4.3 | 4.3 | 4.4 | 4.4 | 4.4 |
| | Navan DS | 15 | 13.5 | 3.6 | 4.2 | 4.2 | 4.3 | 4.4 | 4.5 | 4.5 | 4.6 | 4.6 | 4.6 | 4.7 | 4.7 | 4.7 | 4.8 | 4.8 | 4.8 | 4.9 | 4.9 | 4.9 | 5.0 | 5.0 | 5.0 |
| | Cumberland DS | 7.5 | 6.8 | 4.7 | 5.4 | 5.4 | 5.5 | 5.6 | 5.7 | 5.8 | 5.8 | 5.9 | 5.9 | 6.0 | 6.0 | 6.1 | 6.1 | 6.2 | 6.2 | 6.3 | 6.3 | 6.4 | 6.4 | 6.5 | 6.5 |
| | Hawthorne TS | 152 | 136.8 | 88.6 | 102.0 | 124.7 | 124.4 | 124.5 | 126.8 | 133.4 | 136.9 | 137.9 | 140.0 | 142.1 | 146.0 | 150.1 | 152.9 | 155.6 | 157.7 | 159.8 | 162.4 | 165.6 | 168.0 | 170.4 | 171.8 |
| | National Research TS | 28 | 25.2 | 5.7 | 6.5 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 | 8.8 |
| Outer Ottawa East* | Clarence DS | 3.7 | 3.3 | 2.4 | 2.8 | 2.8 | 2.9 | 3.0 | 3.0 | 3.0 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.2 | 3.2 | 3.2 | 3.2 | 3.2 | 3.2 | 3.3 | 3.3 | 3.3 | 3.3 |
| | Rockland DS | 14.3 | 12.9 | 6.9 | 8.0 | 8.1 | 8.2 | 8.4 | 8.5 | 8.6 | 8.7 | 8.7 | 8.8 | 8.8 | 8.9 | 8.9 | 9.0 | 9.0 | 9.1 | 9.1 | 9.2 | 9.2 | 9.3 | 9.3 | 9.4 |
| | Rockland East DS | 8.6 | 7.7 | 10.3 | 11.9 | 12.1 | 12.3 | 12.6 | 12.7 | 12.8 | 13.0 | 13.1 | 13.1 | 13.2 | 13.3 | 13.4 | 13.5 | 13.5 | 13.6 | 13.7 | 13.7 | 13.8 | 13.9 | 13.9 | 14.0 |
| | Wendover TS | 15 | 13.5 | 10.1 | 11.7 | 11.9 | 12.1 | 12.4 | 14.0 | 14.1 | 14.4 | 14.5 | 14.6 | 14.7 | 14.8 | 14.9 | 15.1 | 15.1 | 15.2 | 15.3 | 15.4 | 15.5 | 15.6 | 15.7 | 15.8 |
| | Hawkesbury MTS | TBD | #VALUE! | 9.5 | 10.9 | 10.9 | 10.9 | 11.0 | 11.0 | 11.1 | 11.1 | 11.1 | 11.2 | 11.2 | 10.9 | 10.9 | 10.9 | 10.9 | 10.9 | 10.9 | 10.9 | 10.9 | 10.9 | 10.9 | 10.9 |
| **Hawthorne Pocket TOTAL** | | | | **274** | **315** | **342** | **346** | **355** | **373** | **390** | **401** | **409** | **415** | **422** | **431** | **438** | **443** | **448** | **452** | **456** | **460** | **465** | **470** | **474** | **477** |
| **Ottawa Area Sub-region TOTAL** | | | | **1535** | **1740** | **1841** | **1885** | **1937** | **1994** | **2059** | **2093** | **2150** | **2187** | **2216** | **2248** | **2272** | **2295** | **2317** | **2340** | **2358** | **2374** | **2389** | **2406** | **2418** | **2428** |

*Outer Ottawa Sub-Region stations are included for reference only and are excluded from the totals. As well, these stations may or may not reflect DG and CDM impacts.

| Sub-Region | Station | 10-Day LTR (MVA) | 10-Day LTR (MW) | 2017 Net Coincident Demand UPDATED | Starting Point of Forecast (Gross, Median Weather) | Gross Demand Forecast with Median Weather Conditions | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 |
| West Side of Ottawa (Merivale Pocket) | Bridlewood MTS | 25 | 22.5 | 9.8 | 11.2 | 14.0 | 14.0 | 14.0 | 14.9 | 14.9 | 15.9 | 15.9 | 16.5 | 19.0 | 21.0 | 21.8 | 21.8 | 21.8 | 21.8 | 21.8 | 21.8 | 21.8 | 21.8 | 21.8 | 21.8 |
| | Marchwood MTS | 33 | 29.7 | 39.2 | 44.8 | 56.8 | 62.4 | 64.6 | 66.0 | 67.3 | 68.2 | 69.1 | 70.0 | 70.7 | 70.7 | 70.7 | 70.7 | 70.7 | 70.7 | 70.7 | 70.7 | 70.7 | 70.7 | 70.7 | 70.7 |
| | Fallowfield DS | 25 | 22.5 | 39.5 | 47.1 | 46.8 | 41.7 | 48.4 | 51.4 | 23.1 | 26.3 | 26.8 | 27.8 | 28.3 | 29.3 | 29.8 | 31.8 | 32.3 | 33.6 | 33.6 | 34.6 | 34.6 | 34.6 | 34.6 | 34.6 |
| | Manotick DS | 8.6 | 7.7 | 5.6 | 6.5 | | | | | | | | | | | | | | | | | | | | |
| | Richmond DS | 75 | 67.5 | 4.5 | 5.1 | 7.1 | 12.1 | 13.8 | 17.9 | 21.9 | 25.1 | 26.9 | 26.9 | 28.7 | 28.7 | 28.7 | 28.7 | 28.7 | 28.7 | 28.7 | 28.7 | 28.7 | 28.7 | 28.7 | 28.7 |
| | Manordale MTS | 10 | 9.0 | 8.5 | 9.7 | 9.7 | 9.7 | 9.8 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 | 9.9 |
| | Limebank MTS | 66 | 59.4 | 46.8 | 53.5 | 53.5 | 59.7 | 72.0 | 74.7 | 82.0 | 75.8 | 79.3 | 75.5 | 79.0 | 84.2 | 89.4 | 94.6 | 99.8 | 105.0 | 109.2 | 112.7 | 115.3 | 118.0 | 120.6 | 123.3 |
| | Marionville DS | 15 | 13.5 | 10.3 | 11.8 | | | | | | | | | | | | | | | | | | | | |
| | Uplands MTS | 33 | 29.7 | 19.8 | 22.6 | 23.5 | 26.7 | 28.9 | 30.4 | 36.7 | 41.8 | 46.8 | 56.2 | 56.7 | 57.1 | 58.0 | 58.9 | 59.4 | 59.8 | 60.3 | 60.7 | 61.2 | 61.6 | 62.1 | 62.1 |
| | South Gloucester DS | 7.5 | 6.8 | 3.8 | 4.3 | | | | | | | | | | | | | | | | | | | | |
| | Greely DS | 30 | 27.0 | 16.0 | 18.2 | | | | | | | | | | | | | | | | | | | | |
| | Russell DS | 7.5 | 6.8 | 3.4 | 3.9 | | | | | | | | | | | | | | | | | | | | |
| | Centerpoint MTS | 14 | 12.6 | 13.8 | 15.8 | 15.9 | 16.2 | 16.2 | 16.2 | 16.2 | 16.2 | 16.2 | 16.2 | 16.2 | 16.2 | 16.2 | 16.2 | 16.2 | 16.2 | 16.2 | 16.2 | 16.2 | 16.2 | 16.2 | 16.2 |
| | Merivale TS | 25 | 22.5 | 14.4 | 16.5 | 16.6 | 16.6 | 19.5 | 19.7 | 19.7 | 19.9 | 20.5 | 20.9 | 21.1 | 21.7 | 22.2 | 22.2 | 22.2 | 22.2 | 22.2 | 22.2 | 22.2 | 23.1 | 23.1 | 23.1 |
| | National Aeronautical CTS | 1.2 | 1.1 | 0.4 | 0.5 | | | | | | | | | | | | | | | | | | | | |
| | Kanata MTS | 54.2 | 48.8 | 51.6 | 59.0 | 62.3 | 64.9 | 67.0 | 70.4 | 70.4 | 70.4 | 70.4 | 70.4 | 70.4 | 71.3 | 71.7 | 71.7 | 71.7 | 71.7 | 71.7 | 71.7 | 71.7 | 71.7 | 71.7 | 71.7 |
| | South March TS | 122.3 | 110.1 | 78.0 | 89.2 | 28.1 | 28.1 | 28.1 | 28.1 | 37.1 | 36.2 | 35.3 | 35.3 | 35.3 | 34.4 | 32.6 | 30.8 | 29.9 | 29.9 | 29.9 | 29.9 | 29.9 | 29.9 | 29.9 | 29.9 |
| | Nepean TS | 160.6 | 144.5 | 131.9 | 150.8 | 151.9 | 152.6 | 139.6 | 143.6 | 135.5 | 135.5 | 136.4 | 136.4 | 136.4 | 136.4 | 136.4 | 136.4 | 136.4 | 136.4 | 136.4 | 136.4 | 136.4 | 136.4 | 136.4 | 136.4 |
| | Terry Fox MTS | 90 | 81.0 | 49.7 | 56.8 | 60.7 | 65.8 | 67.6 | 69.4 | 71.2 | 73.0 | 74.8 | 76.6 | 78.4 | 80.2 | 82.0 | 83.8 | 85.6 | 87.4 | 89.2 | 89.2 | 89.2 | 89.2 | 89.2 | 89.2 |
| | South Nepean TS | #REF! | #REF! | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 37.5 | 41.5 | 45.5 | 48.5 | 52.5 | 56.2 | 59.2 | 62.2 | 65.7 | 68.7 | 70.7 | 72.7 | 75.7 | 79.2 | 79.2 | 79.2 |
| Outer Ottawa West* | Almonte | TBD | 90.0 | 0.0 | N/A | 44.1 | 44.1 | 46.1 | 42.5 | 43.3 | 43.8 | 44.2 | 44.2 | 44.1 | 44.0 | 44.0 | 44.0 | 44.0 | 44.0 | 44.0 | 44.0 | 44.0 | 44.0 | 44.0 | 44.0 |
| **Merivale Pocket TOTAL** | | | | **547** | **627** | **547** | **570** | **590** | **613** | **643** | **656** | **674** | **687** | **703** | **717** | **729** | **740** | **750** | **762** | **771** | **777** | **784** | **791** | **794** | **797** |
| Downtown | Nepean Epworth TS | 14 | 12.6 | 10.5 | 11.7 | 11.7 | 11.7 | 11.7 | 11.7 | 11.7 | 11.7 | 11.7 | 11.7 | 11.7 | 11.7 | 11.7 | 11.7 | 11.7 | 11.7 | 11.7 | 11.7 | 11.7 | 11.7 | 11.7 | 11.7 |
| | Carling TS | 106 | 95.4 | 78.9 | 88.1 | 91.8 | 93.6 | 95.7 | 96.7 | 97.3 | 97.3 | 102.3 | 102.7 | 102.7 | 102.9 | 103.3 | 103.8 | 104.0 | 104.0 | 104.0 | 104.0 | 104.0 | 104.0 | 104.0 | 104.0 |
| | Lincoln Hights TS | 79.8 | 71.8 | 38.1 | 42.5 | 44.3 | 44.9 | 44.9 | 47.1 | 47.1 | 47.1 | 47.1 | 56.1 | 56.1 | 56.1 | 56.1 | 56.1 | 56.1 | 56.1 | 56.1 | 56.1 | 56.1 | 56.1 | 56.1 | 56.1 |
| | Woodroffe TS | 101 | 90.9 | 26.7 | 29.8 | 32.1 | 32.1 | 32.8 | 33.6 | 34.2 | 34.7 | 51.0 | 51.0 | 51.0 | 51.0 | 51.0 | 51.0 | 51.0 | 51.0 | 51.0 | 51.0 | 51.0 | 51.0 | 51.0 | 51.0 |
| | Hinchey TS | 96 | 86.4 | 42.4 | 47.3 | 48.5 | 50.6 | 55.2 | 58.1 | 60.2 | 62.0 | 64.9 | 67.8 | 69.5 | 71.2 | 72.9 | 74.6 | 76.3 | 77.6 | 79.7 | 80.9 | 82.2 | 83.4 | 84.7 | 86.0 |
| | Slater TS | 215 | 193.5 | 102.1 | 114.0 | 124.6 | 126.0 | 126.0 | 126.0 | 126.0 | 126.0 | 126.0 | 126.0 | 126.0 | 126.0 | 126.0 | 126.0 | 126.0 | 127.0 | 127.0 | 127.0 | 127.0 | 127.0 | 127.0 | 127.0 |
| | Lisgar TS | 83 | 74.7 | 55.6 | 62.1 | 70.3 | 70.3 | 71.1 | 71.8 | 78.2 | 78.7 | 80.1 | 80.6 | 81.2 | 84.6 | 85.1 | 85.7 | 86.2 | 87.7 | 88.2 | 88.7 | 89.3 | 89.8 | 90.4 | 90.9 |
| | King Edward TS | 91.5 | 82.4 | 75.8 | 84.6 | 90.9 | 91.0 | 92.9 | 93.6 | 94.3 | 95.0 | 95.7 | 96.5 | 97.2 | 97.9 | 98.6 | 99.3 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| | Russell TS | 77.8 | 70.0 | 68.8 | 76.8 | 79.5 | 82.2 | 86.7 | 86.7 | 86.9 | 87.1 | 87.3 | 87.3 | 87.3 | 87.3 | 87.3 | 87.3 | 87.3 | 87.3 | 87.3 | 87.3 | 87.3 | 87.3 | 87.3 | 87.3 |
| | Overbrook TS | 105.6 | 95.0 | 57.8 | 64.5 | 67.2 | 71.8 | 75.4 | 77.6 | 79.2 | 81.6 | 83.9 | 86.0 | 86.9 | 88.1 | 89.0 | 90.3 | 91.1 | 92.4 | 93.2 | 94.5 | 95.3 | 96.6 | 97.5 | 98.7 |
| | Riverdale TS | 117.6 | 105.8 | 70.8 | 79.1 | 85.0 | 84.7 | 86.1 | 88.0 | 89.7 | 90.9 | 91.6 | 92.4 | 93.1 | 93.8 | 94.5 | 95.2 | 96.0 | 97.9 | 98.6 | 99.3 | 100.1 | 100.8 | 101.5 | 102.2 |
| | Albion TS | 99.4 | 89.5 | 52.2 | 58.3 | 58.6 | 58.7 | 58.8 | 59.0 | 59.1 | 59.2 | 59.4 | 59.5 | 59.7 | 59.8 | 59.9 | 60.1 | 60.2 | 60.3 | 60.5 | 60.6 | 60.7 | 60.9 | 61.0 | 61.0 |
| | Ellwood TS | 50 | 45.0 | 34.4 | 38.4 | 38.4 | 39.3 | 39.9 | 41.0 | 41.8 | 42.4 | 42.5 | 42.5 | 42.5 | 42.5 | 42.5 | 42.5 | 42.5 | 42.5 | 42.5 | 42.5 | 42.5 | 42.5 | 42.5 | 43.0 |
| **Downtown TOTAL** | | | | **714** | **797** | **843** | **857** | **877** | **891** | **906** | **914** | **944** | **960** | **965** | **973** | **978** | **984** | **988** | **996** | **1000** | **1004** | **1007** | **1011** | **1015** | **1019** |
| East Side of Ottawa (Hawthorne Pocket) | Bilberry Creek TS | 94.9 | 85.4 | 35.3 | 40.6 | 40.6 | 40.7 | 41.2 | 47.2 | 50.8 | 50.8 | 50.8 | 50.8 | 50.8 | 50.8 | 50.8 | 50.8 | 50.8 | 50.8 | 50.8 | 50.8 | 50.8 | 50.8 | 50.8 | 50.8 |
| | Orleans TS | 130.3 | 117.3 | 88.2 | 101.5 | 8.2 | 9.2 | 10.6 | 11.9 | 13.1 | 14.4 | 16.1 | 18.0 | 21.1 | 23.5 | 24.5 | 25.2 | 26.0 | 26.4 | 26.8 | 27.2 | 27.6 | 28.0 | 28.0 | 28.0 |
| | Cyrville MTS | 50 | 45.0 | 20.9 | 24.0 | 24.0 | 24.5 | 27.5 | 32.7 | 35.8 | 38.8 | 43.0 | 44.4 | 46.1 | 47.3 | 48.4 | 49.4 | 50.3 | 51.3 | 52.2 | 53.2 | 54.2 | 55.4 | 56.5 | 57.5 |
| | Moulton MTS | 33 | 29.7 | 23.6 | 27.2 | 27.2 | 27.2 | 29.0 | 30.8 | 32.6 | 34.4 | 34.4 | 34.4 | 34.4 | 34.4 | 34.4 | 34.4 | 34.4 | 34.4 | 34.4 | 34.4 | 34.4 | 34.4 | 34.4 | 34.4 |
| | Wilhaven DS | 20 | 18.0 | 3.3 | 3.9 | | | | | | | | | | | | | | | | | | | | |
| | Navan DS | 15 | 13.5 | 3.6 | 4.2 | | | | | | | | | | | | | | | | | | | | |
| | Cumberland DS | 7.5 | 6.8 | 4.7 | 5.4 | | | | | | | | | | | | | | | | | | | | |
| | Hawthorne TS | 152 | 136.8 | 88.6 | 102.0 | 103.0 | 102.3 | 101.9 | 104.0 | 110.3 | 113.6 | 114.4 | 116.4 | 118.4 | 122.1 | 126.1 | 128.7 | 131.3 | 133.3 | 135.3 | 137.8 | 140.9 | 143.2 | 145.5 | 146.8 |
| | National Research TS | 28 | 25.2 | 5.7 | 6.5 | | | | | | | | | | | | | | | | | | | | |
| Outer Ottawa East* | Clarence DS | 3.7 | 3.3 | 2.4 | 2.8 | | | | | | | | | | | | | | | | | | | | |
| | Rockland DS | 14.3 | 12.9 | 6.9 | 8.0 | | | | | | | | | | | | | | | | | | | | |
| | Rockland East DS | 8.6 | 7.7 | 10.3 | 11.9 | | | | | | | | | | | | | | | | | | | | |
| | Wendover TS | 15 | 13.5 | 10.1 | 11.7 | | | | | | | | | | | | | | | | | | | | |
| | Hawkesbury MTS | TBD | #VALUE! | 9.5 | 10.9 | | | | | | | | | | | | | | | | | | | | |
| **Hawthorne Pocket TOTAL** | | | | **274** | **315** | **203** | **204** | **210** | **227** | **243** | **252** | **259** | **264** | **271** | **278** | **284** | **288** | **293** | **296** | **299** | **303** | **308** | **312** | **315** | **317** |
| **Ottawa Area Sub-region TOTAL** | | | | **1535** | **1740** | **1593** | **1631** | **1677** | **1730** | **1792** | **1821** | **1876** | **1911** | **1938** | **1968** | **1991** | **2012** | **2031** | **2054** | **2070** | **2084** | **2099** | **2114** | **2124** | **2133** |

*Outer Ottawa Sub-Region stations are included for reference only and are excluded from the totals. As well, these stations may or may not reflect DG and CDM impacts.

| Sub-Region | Station | 10-Day LTR (MVA) | 10-Day LTR (MW) | 2017 Net Coincident Demand UPDATED | Starting Point of Forecast (Gross, Median Weather) | Gross Demand Forecast with Median Weather Conditions | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033 | 2034 | 2035 | 2036 | 2037 |
| West Side of Ottawa (Merivale Pocket) | Bridlewood MTS | 25 | 22.5 | 9.8 | 11.2 | | | | | | | | | | | | | | | | | | | | |
| | Marchwood MTS | 33 | 29.7 | 39.2 | 44.8 | | | | | | | | | | | | | | | | | | | | |
| | Fallowfield DS | 25 | 22.5 | 39.5 | 47.1 | | | | | | | | | | | | | | | | | | | | |
| | Manotick DS | 8.6 | 7.7 | 5.6 | 6.5 | 6.6 | 7.5 | 8.4 | 9.2 | 10.1 | 10.9 | 11.8 | 11.8 | 11.9 | 11.8 | 12.0 | 11.9 | 12.1 | 12.0 | 12.1 | 12.1 | 12.2 | 12.2 | 12.3 | 12.2 |
| | Richmond DS | 75 | 67.5 | 4.5 | 5.1 | | | | | | | | | | | | | | | | | | | | |
| | Manordale MTS | 10 | 9.0 | 8.5 | 9.7 | | | | | | | | | | | | | | | | | | | | |
| | Limebank MTS | 66 | 59.4 | 46.8 | 53.5 | | | | | | | | | | | | | | | | | | | | |
| | Marionville DS | 15 | 13.5 | 10.3 | 11.8 | 12.1 | 12.3 | 12.6 | 12.8 | 12.9 | 13.1 | 13.2 | 13.3 | 13.4 | 13.5 | 13.6 | 13.7 | 13.8 | 13.9 | 14.0 | 14.0 | 14.1 | 14.2 | 14.3 | 14.3 |
| | Uplands MTS | 33 | 29.7 | 19.8 | 22.6 | | | | | | | | | | | | | | | | | | | | |
| | South Gloucester DS | 7.5 | 6.8 | 3.8 | 4.3 | 4.4 | 4.5 | 4.6 | 4.7 | 4.7 | 4.7 | 4.8 | 4.8 | 4.8 | 4.8 | 4.8 | 4.9 | 4.9 | 4.9 | 4.9 | 4.9 | 5.0 | 5.0 | 5.0 | 5.0 |
| | Greely DS | 30 | 27.0 | 16.0 | 18.2 | 18.7 | 19.2 | 19.7 | 20.0 | 20.3 | 20.6 | 20.9 | 21.1 | 21.3 | 21.5 | 21.8 | 22.0 | 22.1 | 22.3 | 22.5 | 22.7 | 22.9 | 23.1 | 23.3 | 23.5 |
| | Russell DS | 7.5 | 6.8 | 3.4 | 3.9 | 4.0 | 4.1 | 4.2 | 4.2 | 4.3 | 4.3 | 4.3 | 4.4 | 4.4 | 4.4 | 4.4 | 4.4 | 4.5 | 4.5 | 4.5 | 4.5 | 4.5 | 4.6 | 4.6 | 4.6 |
| | Centerpoint MTS | 14 | 12.6 | 13.8 | 15.8 | | | | | | | | | | | | | | | | | | | | |
| | Merivale TS | 25 | 22.5 | 14.4 | 16.5 | | | | | | | | | | | | | | | | | | | | |
| | National Aeronautical CTS | 1.2 | 1.1 | 0.4 | 0.5 | | | | | | | | | | | | | | | | | | | | |
| | Kanata MTS | 54.2 | 48.8 | 51.6 | 59.0 | | | | | | | | | | | | | | | | | | | | |
| | South March TS | 122.3 | 110.1 | 78.0 | 89.2 | 62.6 | 64.1 | 65.7 | 66.4 | 67.3 | 68.3 | 68.8 | 69.3 | 69.8 | 70.5 | 71.0 | 71.6 | 72.1 | 72.6 | 73.0 | 73.5 | 74.0 | 74.4 | 74.8 | 75.3 |
| | Nepean TS | 160.6 | 144.5 | 131.9 | 150.8 | | | | | | | | | | | | | | | | | | | | |
| | Terry Fox MTS | 90 | 81.0 | 49.7 | 56.8 | | | | | | | | | | | | | | | | | | | | |
| | South Nepean TS | #REF! | #REF! | 0.0 | 0.0 | | | | | | | | | | | | | | | | | | | | |
| Outer Ottawa West* | Almonte | TBD | 90.0 | 0.0 | N/A | 44.1 | 44.1 | 46.1 | 42.5 | 43.3 | 43.8 | 44.2 | 44.2 | 44.1 | 44.0 | 44.0 | 44.0 | 44.0 | 44.0 | 44.0 | 44.0 | 44.0 | 44.0 | 44.0 | 44.0 |
| **Merivale Pocket TOTAL** | | | | **547** | **627** | **108** | **112** | **115** | **117** | **120** | **122** | **124** | **125** | **126** | **127** | **128** | **129** | **130** | **130** | **131** | **132** | **133** | **134** | **134** | **135** |
| Downtown | Nepean Epworth TS | 14 | 12.6 | 10.5 | 11.7 | | | | | | | | | | | | | | | | | | | | |
| | Carling TS | 106 | 95.4 | 78.9 | 88.1 | | | | | | | | | | | | | | | | | | | | |
| | Lincoln Hights TS | 79.8 | 71.8 | 38.1 | 42.5 | | | | | | | | | | | | | | | | | | | | |
| | Woodroffe TS | 101 | 90.9 | 26.7 | 29.8 | | | | | | | | | | | | | | | | | | | | |
| | Hinchey TS | 96 | 86.4 | 42.4 | 47.3 | | | | | | | | | | | | | | | | | | | | |
| | Slater TS | 215 | 193.5 | 102.1 | 114.0 | | | | | | | | | | | | | | | | | | | | |
| | Lisgar TS | 83 | 74.7 | 55.6 | 62.1 | | | | | | | | | | | | | | | | | | | | |
| | King Edward TS | 91.5 | 82.4 | 75.8 | 84.6 | | | | | | | | | | | | | | | | | | | | |
| | Russell TS | 77.8 | 70.0 | 68.8 | 76.8 | | | | | | | | | | | | | | | | | | | | |
| | Overbrook TS | 105.6 | 95.0 | 57.8 | 64.5 | | | | | | | | | | | | | | | | | | | | |
| | Riverdale TS | 117.6 | 105.8 | 70.8 | 79.1 | | | | | | | | | | | | | | | | | | | | |
| | Albion TS | 99.4 | 89.5 | 52.2 | 58.3 | | | | | | | | | | | | | | | | | | | | |
| | Ellwood TS | 50 | 45.0 | 34.4 | 38.4 | | | | | | | | | | | | | | | | | | | | |
| **Downtown TOTAL** | | | | **714** | **797** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| East Side of Ottawa (Hawthorne Pocket) | Bilberry Creek TS | 94.9 | 85.4 | 35.3 | 40.6 | 1.0 | 1.0 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 |
| | Orleans TS | 130.3 | 117.3 | 88.2 | 101.5 | 94.2 | 96.2 | 98.4 | 99.3 | 100.3 | 101.5 | 102.0 | 102.6 | 103.1 | 103.8 | 104.4 | 105.0 | 105.5 | 106.0 | 106.5 | 106.9 | 107.4 | 107.8 | 108.2 | 108.6 |
| | Cyrville MTS | 50 | 45.0 | 20.9 | 24.0 | | | | | | | | | | | | | | | | | | | | |
| | Moulton MTS | 33 | 29.7 | 23.6 | 27.2 | | | | | | | | | | | | | | | | | | | | |
| | Wilhaven DS | 20 | 18.0 | 3.3 | 3.9 | 3.9 | 3.9 | 4.0 | 4.1 | 4.1 | 4.1 | 4.2 | 4.2 | 4.2 | 4.2 | 4.2 | 4.3 | 4.3 | 4.3 | 4.3 | 4.3 | 4.3 | 4.4 | 4.4 | 4.4 |
| | Navan DS | 15 | 13.5 | 3.6 | 4.2 | 4.2 | 4.3 | 4.4 | 4.5 | 4.5 | 4.6 | 4.6 | 4.6 | 4.7 | 4.7 | 4.7 | 4.8 | 4.8 | 4.8 | 4.9 | 4.9 | 4.9 | 5.0 | 5.0 | 5.0 |
| | Cumberland DS | 7.5 | 6.8 | 4.7 | 5.4 | 5.4 | 5.5 | 5.6 | 5.7 | 5.8 | 5.8 | 5.9 | 5.9 | 6.0 | 6.0 | 6.1 | 6.1 | 6.2 | 6.2 | 6.3 | 6.3 | 6.4 | 6.4 | 6.5 | 6.5 |
| | Hawthorne TS | 152 | 136.8 | 88.6 | 102.0 | 21.7 | 22.1 | 22.6 | 22.8 | 23.1 | 23.3 | 23.5 | 23.6 | 23.7 | 23.9 | 24.0 | 24.2 | 24.3 | 24.4 | 24.5 | 24.6 | 24.7 | 24.8 | 24.9 | 25.0 |
| | National Research TS | 28 | 25.2 | 5.7 | 6.5 | | | | | | | | | | | | | | | | | | | | |
| Outer Ottawa East* | Clarence DS | 3.7 | 3.3 | 2.4 | 2.8 | | | | | | | | | | | | | | | | | | | | |
| | Rockland DS | 14.3 | 12.9 | 6.9 | 8.0 | | | | | | | | | | | | | | | | | | | | |
| | Rockland East DS | 8.6 | 7.7 | 10.3 | 11.9 | | | | | | | | | | | | | | | | | | | | |
| | Wendover TS | 15 | 13.5 | 10.1 | 11.7 | | | | | | | | | | | | | | | | | | | | |
| | Hawkesbury MTS | TBD | #VALUE! | 9.5 | 10.9 | | | | | | | | | | | | | | | | | | | | |
| **Hawthorne Pocket TOTAL** | | | | **274** | **315** | **130** | **133** | **136** | **137** | **139** | **140** | **141** | **142** | **143** | **144** | **145** | **146** | **146** | **147** | **148** | **148** | **149** | **150** | **150** | **151** |
| **Ottawa Area Sub-region TOTAL** | | | | **1535** | **1740** | **239** | **245** | **251** | **255** | **259** | **262** | **265** | **267** | **268** | **270** | **272** | **274** | **276** | **277** | **279** | **280** | **282** | **283** | **284** | **286** |

*Outer Ottawa Sub-Region stations are included for reference only and are excluded from the totals. As well, these stations may or may not reflect DG and CDM impacts.

## 1. Definition of Median and Extreme Weather Conditions

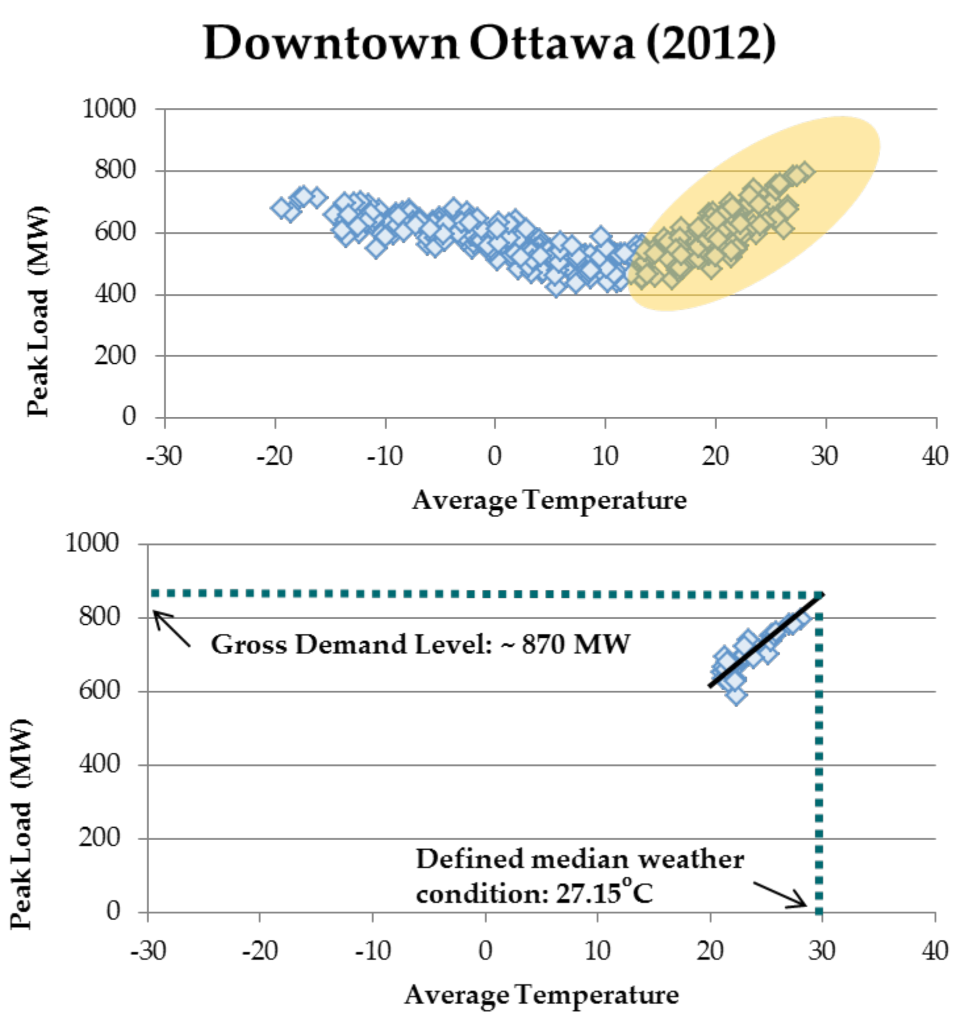
**Median Weather tempeaeture is defined as daily peak temperature of 33.3 °C, or daily average temperature of 27.2 °C (median temperature of the past 30 years weather data)**
**Extreme Weather temperature is defined as daily peak temperature of 36.9 °C, or daily average temperature of 29.2 °C (Max temperature in the past 30 years weather data)**

## 2. Pocket Level Demand and Temperature Correlation

| Demand / Temp. Correlation Factor | Hawthorne Pocket | Merivale Pocket | Downtown |
|---|---|---|---|
| 2012 | 0.82 | 0.88 | 0.86 |
| 2013 | 0.87 | 0.87 | 0.95 |
| 2014 | 0.57 | 0.56 | 0.66 |
| 2015 | 0.90 | 0.88 | 0.88 |
| 2016 | 0.75 | 0.80 | 0.85 |
| 2017 | 0.77 | 0.80 | 0.85 |

**Note: Correlation factors are established excluding data points for holidays and weekends**

**Example of Downtown area demand and temperature corelation (2012)**




## 3. Forecast Median Weather to Extreme Weather Adjustment Factor

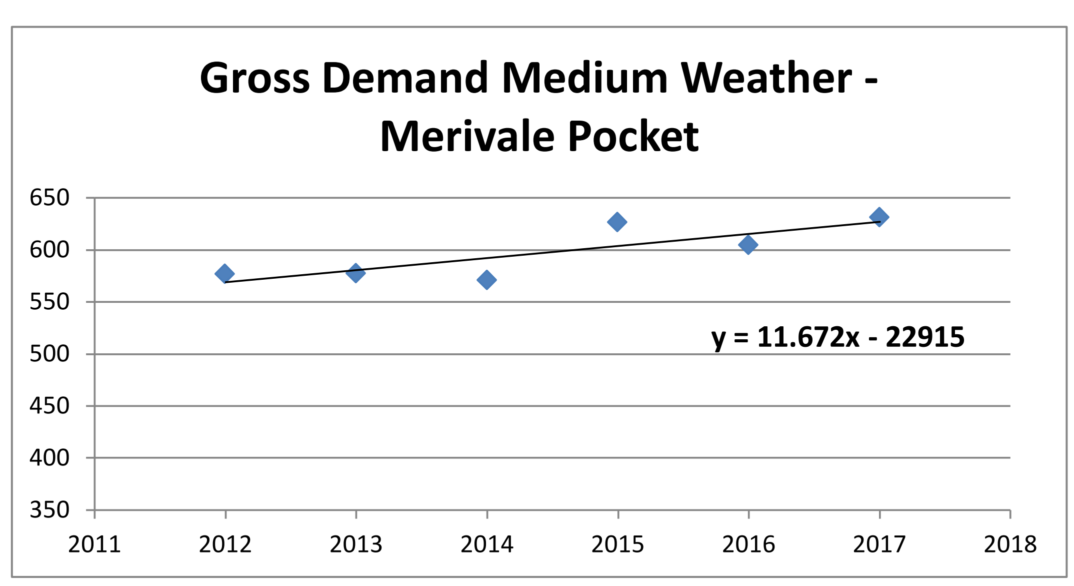
**Median to Extreme Weather Adjustment Factor**

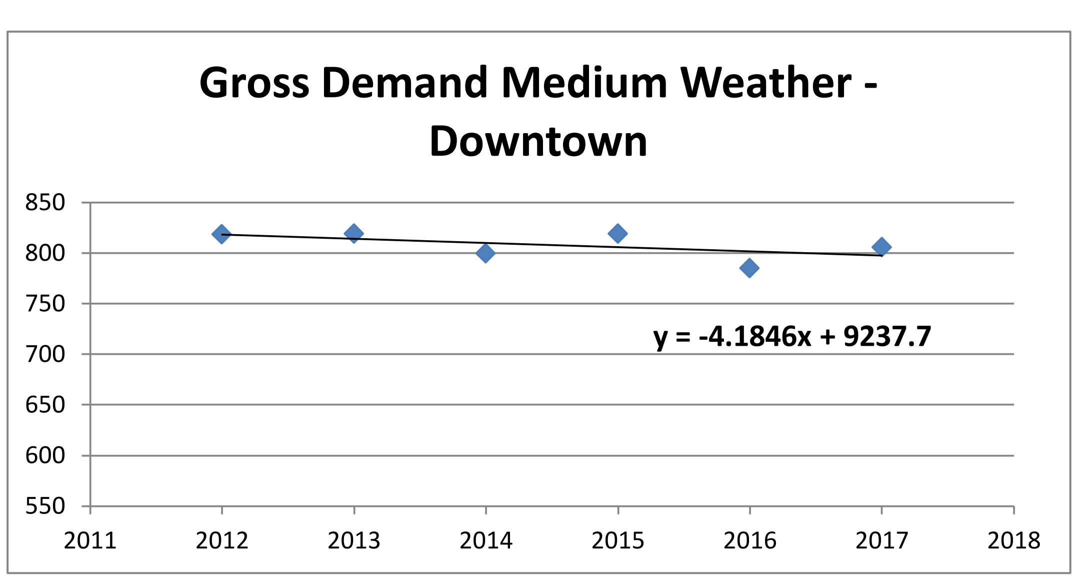
| Sub-Pocket | Historical | | | | | | Forecast |
|---|---|---|---|---|---|---|---|
| | *2012* | *2013* | *2014* | *2015* | *2016* | *2017* | *2018 - 2037* |
| **Merivale Pocket** | 1.10 | 1.09 | 1.07 | 1.11 | 1.07 | 1.09 | 1.09 |
| **Downtown** | 1.07 | 1.09 | 1.06 | 1.08 | 1.05 | 1.07 | 1.07 |
| **Hawthorne Pocket** | 1.08 | 1.09 | 1.07 | 1.10 | 1.06 | 1.10 | 1.08 |

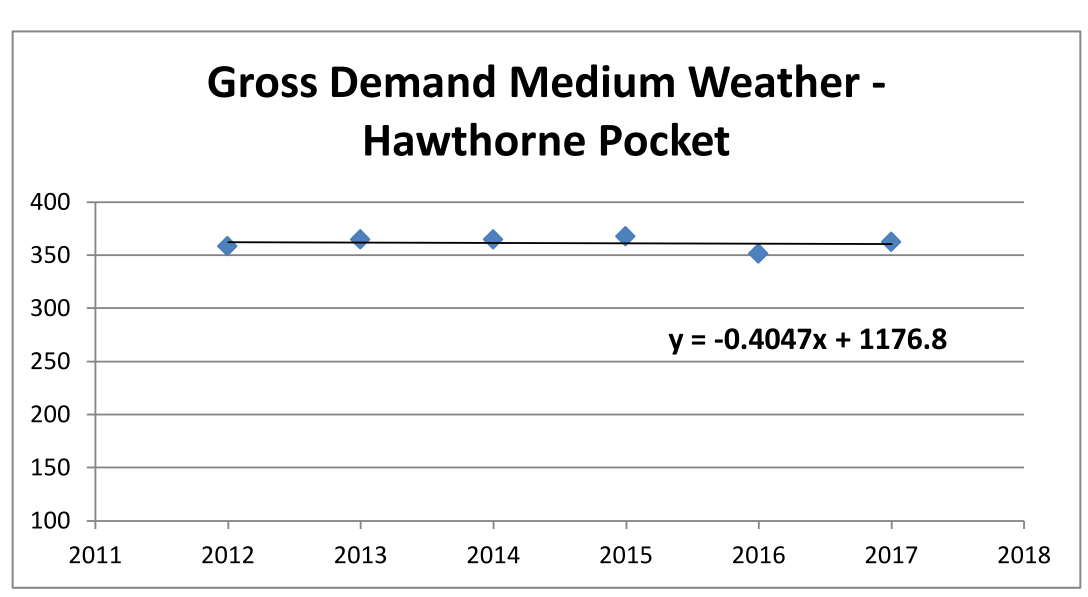
## 4. Establish the Starting Point of Forecast

**Base Year:** **2017**

| Year | Gross Demand under Median Weather | | |
|---|---|---|---|
| | Merivale Pocket | Downtown | Hawthorne Pocket |
| 2012 | 576.8 | 818.3 | 358.1 |
| 2013 | 577.5 | 819.1 | 364.5 |
| 2014 | 570.7 | 799.6 | 364.7 |
| 2015 | 626.6 | 819.2 | 367.6 |
| 2016 | 604.6 | 784.9 | 351.3 |
| 2017 | 631.1 | 805.6 | 362.7 |
| **STARTING POINT** | **627.4** | **797.4** | **360.5** |



| | Starting Point | | 20 year net median | | 20 year net extreme | | 20 year gross median | |
|---|---|---|---|---|---|---|---|---|
| | 2015 | 2019 | 2015 | 2019 | 2015 | 2019 | 2015 | 2019 |
| Merivale Area | | 627 | - | 818 | 707 | 888 | 782 | 932 |
| Downtown | | 797 | - | 864 | 1187 | 926 | 1314 | 1019 |
| Hawthorne Area | | 315 | - | 414 | 267 | 448 | 296 | 477 |
| Ottawa Area Sub-region | | 1740 | 0 | 2096.8733 | 2161 | 2262 | 2392 | 2428 |

| Version | Changes |
|---|---|
| 1.0 - 2.0 | Coordination with Ottawa IRRP working group to finalize demand forecast |
| 2.1 | Demand updates to South Nepean, Kanata, South March, and Terry Fox due to revised Terry Fox station rating (from 100 MVA to 90 MVA) |
| 2.1.1 | Updated CDM (as per Demand update and minor CDM changes at other stations) – by Humphrey<br>Updated DG (added in all Almonte DG and removed all Hawkesbury DG) – by Ben |
| 2.2 | New low CDM as per cancelled programs and policies |
| 2.3 | Additional Manotick Load by HONI Dx |
| 2.3.1 | Updated CDM for Manotick Load |
| 2.4 | Updated Orleans TS (one feeder was missing from load forecast), Bilberry Creek TS, Cyrville MTS, and Moulton MTS loads from HOL<br>Updated CDM to reflect load changes<br>Updated effective capacity factor of DGs (Hydro and Biomass) as per HOL input<br>Update Greely LTR from 20 MVA to 30 MVA as per HONI Dx update |
| 2.5 | Update Limebank, Uplands, and Hawthorne Loads<br>Update CDM as per load changes<br>Update DG at 115kV downtown stations<br>Added Tab for base CDM and low CDM |

## Appendix E: Ottawa Regional Planning Status Letter

**Hydro One Networks Inc.**
483 Bay Street
13th Floor, North Tower
Toronto, ON M5G 2P5
www.HydroOne.com

Tel: (416) 345-5420
Fax: (416) 345-4141
Ajay.Garg@HydroOne.com

December 11th, 2019
Ben Hazlett,
Hydro Ottawa Limited
2711 Hunt Club Road, P.O Box 8700
Ottawa ON
K1G 3S4

Dear Mr. Ben Hazlett
**Subject: Regional Planning Status Letter 2019**

As per your request, this Planning Status letter is provided to meet one of your requirements of cost of service application to the Ontario Energy Board (OEB).

The province of Ontario is divided into 21 Regions for the purpose of Regional Planning (RP), and these regions have been split into three (3) groups for the purposes of prioritizing and managing the RP process. A map of Ontario showing the 21 Regions and the list of LDCs in each of the Region are attached as Appendix A and B respectively. An overview of the RP process is available on Hydro One's RP homepage, which includes current status of each region in the RP process and all corresponding reports.

Hydro Ottawa Limited (HOL) is a LDC supplying electricity to customers in the Greater Ottawa region. The RP status of the Greater Ottawa region is summarized below:

### 1. Greater Ottawa Region

The first Regional Planning cycle for Greater Ottawa Region was completed in December 2015 and the current cycle of regional planning is in the Integrated Regional Resource Plan (IRRP) phase and RIP will be undertaken by Hydro One after the expected completion of IRRP in Q1 2020.

The previous regional planning cycle identified the following needs:

- **Merivale TS T22 – LTR exceeded:** The need is to increase the 230/115kV transformation capacity for the region. This will be further reviewed as part of the Regional Planning process. Cost allocation will be dependent on the proposed solution and will be consistent with the TSC.
- **Ottawa Centre 115kV Area – Station Capacity:** The following stations are a part of the Ottawa Centre 115kV area capacity increase:
  - **Russell TS & Riverdale TS:** Hydro Ottawa had plans to increase feeder ties between these two stations and other near-by stations to increase load transfer capability. These upgrades have been completed.
  - **King Edward TS – Station Capacity:** Existing transformer T3 is approaching end-of-Life and needs replacement. Consistent with the TSC, HOL will be responsible for incremental cost to upgrade the size of the transformer unit from 75MVA to 100MVA with expected in-service in 2021.

- **South West Area – Station and Transmission Capacity:** There was significant load growth anticipated in the southwest region of Ottawa. The following transmission and station upgrades are required to meet the growing demand:
  - **South Nepean MTS (Cambrian MTS):** HOL plans to construct a new municipal transformer station, to meet the growing demand in the south west region of Ottawa. The station is planned to be in-serviced by November 2021.
  - **South Nepean Transmission Reinforcement:** To supply the new station, South Nepean MTS, Hydro Ottawa has requested Hydro One to connect the station to 230kV circuit E34M and 115kV circuit S7M. HOL is expected to be required to pay a capital contribution of approximately $48.0M. The project is planned to be in-serviced by November 2021.
- **Bilberry Creek TS:** This need is discussed later in this section under the current Regional Planning cycle.

The Needs Assessment (NA) of the current cycle was completed in June 2018 with focus on the Outer Ottawa sub-region. The station and transmission supply capacities in the Outer Ottawa sub-region are sufficient for the duration of the study period with no system reliability or restoration issues. The following need have been identified by the study team:

- **Slater TS – EOL T2/T3 Replacement:** The existing transformers T2 and T3 at Slater TS are approaching end-of-life. The existing 45/75MVA transformer units will be replaced with new higher rated 60/80/100MVA units. Hydro One is coordinating with Hydro Ottawa to address this need. Cost allocation to HOL for this investment will be consistent with the Transmission System Code (TSC). The project is expected to be in-serviced by 2022.

The IESO led IRRP for the Ottawa Area sub-region is underway with an expected completion in Q1 2020. The following needs identified by the study team have cost implications to HOL:

- **27.6kV Supply – Station Capacity (Terry Fox MTS, Marchwood MTS, Kanata MTS):** HOL plans to perform load transfers between the three stations. However, the combined capacity of the stations will be exceed the available capacity under peak load conditions in the near term planning horizon. Hydro One will plan with Hydro Ottawa for any potential transmission infrastructure upgrades as part of the RIP phase of Regional Planning process. Cost allocation will be dependent on the proposed solution and will be consistent with the TSC.
- **Leitrim MS – Station Capacity:** There is growing demand in the southeast region of Ottawa. The demand forecast for Hydro Ottawa's Leitrim MS will exceed station capacity in the near term planning horizon. This need will be further assessed in the RIP phase.
- **Orleans TS – Station Capacity:** This need is tied with the Bilberry Creek TS end-of-life need discussed later in this section. Both needs require further assessment in the RIP phase. Cost allocation will be dependent on the proposed solution and will be consistent with the TSC.

End-of-Life Needs:

- **Bilberry Creek TS – EOL T1/T2 Replacement:** The transformers T1 and T2 at the station are approaching end-of-life. There was discussion whether Bilberry Creek TS can be retired and the existing load on the station can be transferred to Orleans TS. The working group recommends the alternative to refurbish the station with like-for-like transformers and addition of two breaker positions to accommodate HOL load. Cost allocation to HOL for this investment will be consistent with the TSC.

It is expected that there will be some cost implications for Hydro Ottawa to address some of the needs mentioned above.

Reference documents for this region can be found on the Hydro One website at the following link:
https://www.hydroone.com/about/corporate-information/regional-plans/greater-ottawa

The new planning process provides flexibility during the transition period to the new process, and will ensure that both distribution and transmission planning continue to address any short-term needs. Hydro One looks forward to working with Hydro Ottawa Limited in executing the regional planning process.

If you have any further questions, please feel free to contact me.

Sincerely,

Ajay Garg, Manager - Regional Planning Coordination
Hydro One Networks Inc.

# Appendix A: Map of Ontario's Planning Regions

## Northern Ontario

## Southern Ontario

## Greater Toronto Area (GTA)


| Group 1 | Group 2 | Group 3 |
|---|---|---|
| Burlington to Nanticoke | East Lake Superior | Chatham/Lambton/Sarnia |
| Greater Ottawa | London area | Greater Bruce/Huron |
| GTA East | Peterborough to Kingston | Niagara |
| GTA North | South Georgian Bay/Muskoka | North of Moosonee |
| GTA West | Sudbury/Algoma | North/East of Sudbury |
| Kitchener- Waterloo- Cambridge-Guelph (“KWCG”) | | Renfrew |
| Metro Toronto | | St. Lawrence |
| Northwest Ontario | | |
| Windsor-Essex | | |

# Appendix B: List of LDCs for Each Region

## [Hydro One as Upstream Transmitter]

| Region | LDCs |
|---|---|
| 1. Burlington to Nanticoke | • Energy+ Inc.<br>• Brantford Power Inc.<br>• Burlington Hydro Inc.<br>• Haldimand County Hydro Inc.**<br>• Alectra Utilities Corporation<br>• Hydro One Networks Inc.<br>• Norfolk Power Distribution Inc.**<br>• Oakville Hydro Electricity Distribution Inc. |
| 2. Greater Ottawa | • Hydro 2000 Inc.<br>• Hydro Hawkesbury Inc.<br>• Hydro One Networks Inc.<br>• Hydro Ottawa Limited<br>• Ottawa River Power Corporation<br>• Renfrew Hydro Inc. |
| 3. GTA North | • Alectra Utilities Corporation<br>• Hydro One Networks Inc.<br>• Newmarket-Tay Power Distribution Ltd.<br>• Toronto Hydro Electric System Limited<br>• Veridian Connections Inc. |
| 4. GTA West | • Burlington Hydro Inc.<br>• Alectra Utilities Corporation<br>• Halton Hills Hydro Inc.<br>• Hydro One Networks Inc.<br>• Milton Hydro Distribution Inc.<br>• Oakville Hydro Electricity Distribution Inc. |
| 5. Kitchener- Waterloo-Cambridge-Guelph ("KWCG") | • Energy+ Inc.<br>• Centre Wellington Hydro Ltd.<br>• Guelph Hydro Electric System - Rockwood Division<br>• Guelph Hydro Electric Systems Inc.<br>• Halton Hills Hydro Inc.<br>• Hydro One Networks Inc.<br>• Kitchener-Wilmot Hydro Inc.<br>• Milton Hydro Distribution Inc.<br>• Waterloo North Hydro Inc.<br>• Wellington North Power Inc. |

| | |
|---|---|
| 6. Metro Toronto | • Alectra Utilities Corporation<br>• Hydro One Networks Inc.<br>• Toronto Hydro Electric System Limited<br>• Veridian Connections Inc. |
| 7. Northwest Ontario | • Atikokan Hydro Inc.<br>• Chapleau Public Utilities Corporation<br>• Fort Frances Power Corporation<br>• Hydro One Networks Inc.<br>• Kenora Hydro Electric Corporation Ltd.<br>• Sioux Lookout Hydro Inc.<br>• Thunder Bay Hydro Electricity Distribution Inc. |
| 8. Windsor-Essex | • E.L.K. Energy Inc.<br>• Entegrus Power Lines Inc. [Chatham- Kent]<br>• EnWin Utilities Ltd.<br>• Essex Powerlines Corporation<br>• Hydro One Networks Inc. |
| 9. East Lake Superior | • Algoma Power Inc.<br>• Chapleau PUC<br>• Hydro One Networks Inc.<br>• PUC Services Inc |
| 10. GTA East | • Hydro One Networks Inc.<br>• Oshawa PUC Networks Inc.<br>• Veridian Connections Inc.<br>• Whitby Hydro Electric Corporation |
| 11. London area | • Entegrus Power Lines Inc. [Middlesex]<br>• Erie Thames Power Lines Corporation<br>• Hydro One Networks Inc.<br>• London Hydro Inc.<br>• Norfolk Power Distribution Inc.**<br>• St. Thomas Energy Inc.<br>• Tillsonburg Hydro Inc.<br>• Woodstock Hydro Services Inc.** |
| 12. Peterborough to Kingston | • Eastern Ontario Power Inc.<br>• Hydro One Networks Inc.<br>• Kingston Hydro Corporation<br>• Lakefront Utilities Inc.<br>• Peterborough Distribution Inc.<br>• Veridian Connections Inc. |

| | |
|---|---|
| 13. South Georgian Bay/Muskoka | • Collingwood PowerStream Utility Services Corp. (COLLUS PowerStream Corp.)<br>• Hydro One Networks Inc.<br>• InnPower Corporation<br>• Lakeland Power Distribution Ltd.<br>• Midland Power Utility Corporation<br>• Orangeville Hydro Limited<br>• Orillia Power Distribution Corporation<br>• Alectra Utilities Corporation<br>• Veridian Connections Inc.<br>• Veridian Connections Inc.<br>• Wasaga Distribution Inc. |
| 14. Sudbury/Algoma | • Espanola Regional Hydro Distribution Corp.<br>• Greater Sudbury Hydro Inc.<br>• Hydro One Networks Inc. |
| 15. Chatham/Lambton/Sarnia | • Bluewater Power Distribution Corporation<br>• Entegrus Power Lines Inc. [Chatham- Kent]<br>• Hydro One Networks Inc. |
| 16. Greater Bruce/Huron | • Entegrus Power Lines Inc. [Middlesex]<br>• Erie Thames Power Lines Corporation<br>• Festival Hydro Inc.<br>• Hydro One Networks Inc.<br>• Wellington North Power Inc.<br>• West Coast Huron Energy Inc.<br>• Westario Power Inc. |
| 17. Niagara | • Canadian Niagara Power Inc. [Port Colborne]<br>• Grimsby Power Inc.<br>• Haldimand County Hydro Inc.**<br>• Alectra Utilities Corporation<br>• Hydro One Networks Inc.<br>• Niagara Peninsula Energy Inc.<br>• Niagara-On-The-Lake Hydro Inc.<br>• Welland Hydro-Electric System Corp.<br>• Niagara West Transformation Corporation*<br><br>* Changes to the May 17, 2013 OEB Planning Process Working Group Report |
| 18. North of Moosonee | N/A → This region is not within Hydro One's territory |

| | |
|---|---|
| 19. North/East of Sudbury | • Greater Sudbury Hydro Inc.<br>• Hearst Power Distribution Company Limited<br>• Hydro One Networks Inc.<br>• North Bay Hydro Distribution Ltd.<br>• Northern Ontario Wires Inc. |
| 20. Renfrew | • Hydro One Networks Inc.<br>• Ottawa River Power Corporation<br>• Renfrew Hydro Inc. |
| 21. St. Lawrence | • Cooperative Hydro Embrun Inc.<br>• Hydro One Networks Inc.<br>• Rideau St. Lawrence Distribution Inc. |

**This Local Distribution Company (LDC) has been acquired by Hydro One Networks Inc.