London Hydro

APPENDIX C

Asset Sustainment Plan (ASP): 2026-2035

Electric Distribution System

Asset Sustainment Plan: 2026 to 2035

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Prepared By:



Cristina Terek, P.Eng.
Senior Engineer Asset Management

Reviewed By:



Ali Juma, P.Eng.
Manager System Reliability

Approved By:



Ismail Sheikh, P.Eng.
Director Systems Engineering

The author acknowledges that the asset demographics presented in this report for the various asset categories are based on a GIS data extract from the second quarter of 2024, and they correspond to the same data sets that the London Hydro's *2024 Asset Condition Assessment* is based on.

Many thanks go to London Hydro's Reliability team for their great contributions to the scope of the work within the report and their continued support to Asset Management.

Executive Summary

London Hydro publishes the Electric Distribution System Asset Sustainment Plan (ASP) with the purpose of providing a comprehensive understanding of the major distribution assets owned by London Hydro, ensuring the objectives outlined in the company's Asset Management Policies and Procedures (EI-31) are achieved.

Based on GIS data from the second quarter of 2024, the ASP report details the installation year, average age, health condition and expected lifespan of London Hydro's major distribution assets. This document also outlines London Hydro's inspection and maintenance activities for each major distribution asset, along with the strategies employed to optimize the lifecycle costs of these assets. Furthermore, a risk assessment enables the anticipation of potential performance issues and the forecasting of long-term spending patterns.

Before writing the ASP, London Hydro carried out a comprehensive Asset Condition Assessment (ACA) using ENGIN™, a third-party, cloud-based, asset management software. Throughout this process, the Health Index was calculated for approximately 65,000 distribution assets currently in service. For ease of reference, this ASP summarizes the overall condition of assets across 16 classes using five distinct health categories: 'Very Poor', 'Poor', 'Fair', 'Good', and 'Very Good'. It also provides the average Health Index for each asset category. Additionally, the maps included in the Appendices illustrate the geographical distribution of these assets.

To support an optimal pace of asset renewal, a 'Flag For Action' (FFA)[1] plan is developed as needed for each asset category. This plan outlines the number of assets to be addressed over a 10-year planning horizon. The average number of major assets that will need to be addressed per year over the next ten years, are summarized as follows:

[1] FFA does not necessarily equate to replacement of the specific asset unit, but also means monitoring, testing, maintaining or refurbishing.

- 181 Pad Mounted Transformers
- 1 Network Transformer and Protector
- 3 Distribution Switchgears
- 46 km Polymeric Cable
- 26 Civil Structures
- 95 Pole Mounted Transformers
- 3 Overhead Switches
- 1 Recloser
- 561 Wood Poles
- 1 Substation Transformer

Further condition assessments – such as cable testing, switch maintenance, or transformer oil analysis – are expected to be conducted which may reveal that some assets can remain in service longer. While these types of condition assessments can contribute to meeting FFA targets and help defer costs, a balanced and steady approach is essential to prevent a backlog of aging assets that will ultimately need to be replaced. By implementing the asset specific sustainment strategies, risks can be kept within acceptable levels while maintaining system reliability. With a well-managed plan, London Hydro can make informed decisions about aging assets – specifically, whether to maintain, refurbish, or replace them, and the appropriate timing for each action.

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Overview

Regulated electric utilities face increasing pressure from stakeholders to do more with less, bringing continued improvement to the reliability of the distribution system while keeping the distribution rates low. To meet this challenge, investments need to prioritize infrastructure assets in greatest need. This requires ongoing infrastructure condition assessment activities and a current, well defined asset sustainment plan, to evaluate asset health and the risk of in-service failure.

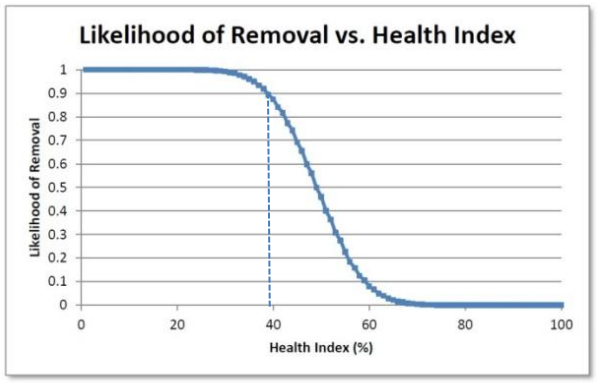
London Hydro's technical staff prepares the annual Capital Expenditure Plan and the Operating & Maintenance (O&M) budgets, which are then reviewed by the Executive Committee before receiving approval from London Hydro's Board of Directors. A team of experienced engineers write the Asset Sustainment Plan (ASP), which outlines strategies for replacement, maintenance, as well as the refurbishment of deteriorated or obsolete assets. It serves as one of the key inputs in the development and presentation of budgets for approval. Since the ASP considers long-term trends and proposes levelized spending, there is no direct one-to-one correlation between the assets recommended to be addressed in the ASP and the capital or operating budgets for any specific year. The ASP is a valuable tool to help project the overall levels of future expenditures that will be needed to maintain the distribution system to operate reliably and safely.

London Hydro developed this ASP after first completing a comprehensive Asset Condition Assessment (ACA)[2] study in 2024. The Asset Condition Assessment (ACA) is a structured process for identifying and justifying long-term asset sustainment requirements. London Hydro utilized a third-party, cloud-based, asset management software platform (ENGIN™) to develop Health Indexing and risk assessment that form the basis of the ACA process. The 2024 ACA involved the determination of an asset Health Index (HI), as well as development of condition-based 'Flag For Action' (FFA) plans for each major asset group.

Similar to the 2019 ACA methodology, the health of an asset is known to correlate to its condition following a *likelihood of removal* curve. The lower the HI, the higher the probability of removal from service. When the HI is 100, the asset is like new, with no or extremely low probability of removal.

[2] London Hydro 2024 Asset Condition Assessment

When the HI is less than 40 for example in the figure below, it is more likely the asset will be removed from service, ideally before failure. The FFA plan estimates the number of units expected to require attention in a given year based on their probability of removal.



The ASP is developed to optimize the lifecycle of physical distribution assets. As a component of the broader Distribution System Plan (DSP), it offers important guidance and insights for ensuring safe and reliable service using existing assets or equipment, while minimizing long-term costs.

The discussions in this report related to asset replacement and refurbishment plans rely on dynamic information such as asset age, condition and risk. As such, any proposed replacement plans presented here may not account for the evolving nature of this information. The ASP is regarded as a *living document* and will be regularly updated as new data on asset age and condition become available. These updates may result in minor adjustments to the overall plan.

1 Pad Mounted Transformer (Single-Phase and Three-Phase)

London Hydro has 8421 in-service pad mounted transformers on its distribution system:

- 6954 single-phase units and
- 1467 three-phase units

The single-phase pad mounted transformers are used mainly in residential subdivisions, where they are located in the front or back yard of the property: close to 99% of the units are installed on the 27.6 kV system while 1% supply customers on the 4.16 kV and 8.32 kV systems.

The majority of the three-phase pad mounted transformers are used for commercial services and are supplied at 27.6 kV as primary voltage (>97%). A combination of 4.16 kV and 8.32 kV units account for less than 3% of the total three-phase units in service.

Both single-phase and three-phase transformers are discussed in this section.

1.1 Life Expectancy and Age Distribution

Pad mounted transformers are assigned 40 years as anticipated service life based on best industry practice and empirical data. Approximately 5% of all units are past this threshold and another 13% will reach it in the next 10 years. To determine an FFA plan, it was considered based on the methodology of the original 2019 ACA, that the likelihood of asset removal at 35 years is 20% and that at 50 years the likelihood of removal is 95%. Transformers are expected to operate without major maintenance or refurbishment before they reach life expectancy.

The distribution of pad mounted transformers by year of installation and according to their system voltage is shown in Figure 1-1 for single-phase units and in Figure 1-2 for three-phase units. The average age of single-phase pad mounted transformers is 18 years and for the three-phase pad mounted transformers it is 19 years.

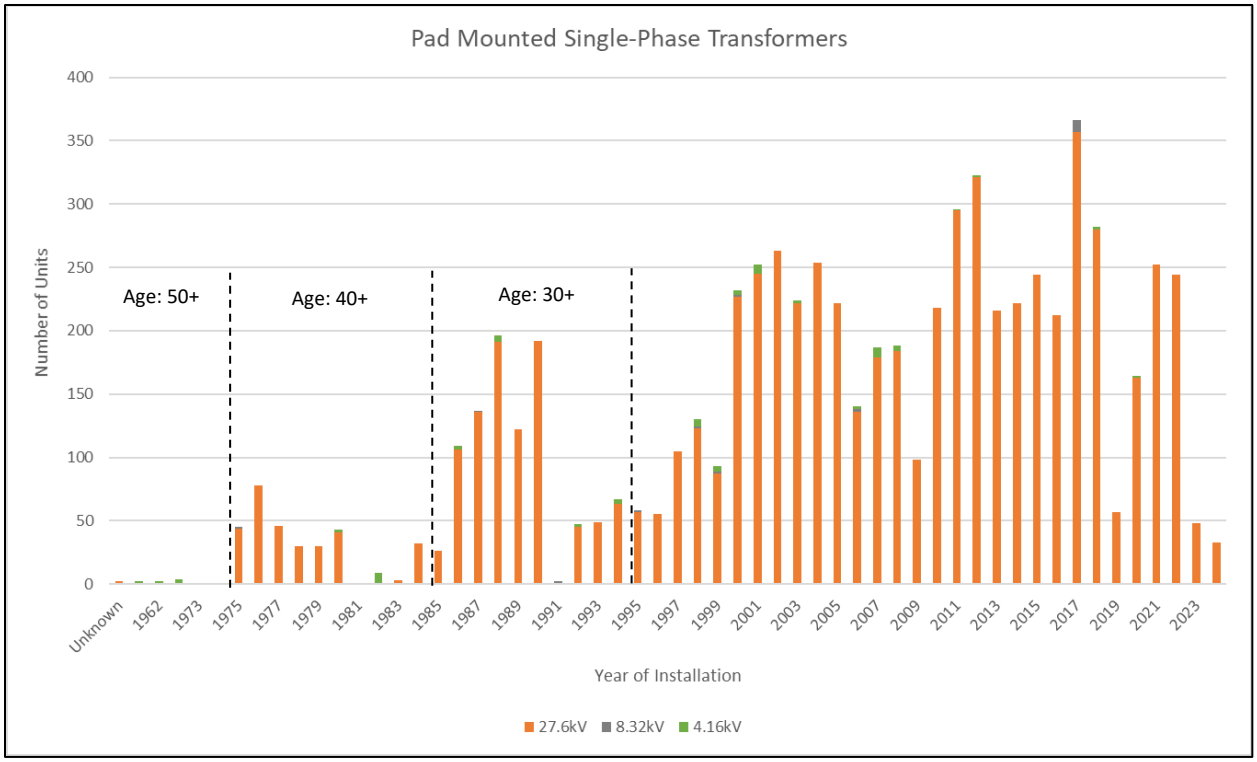


Figure 1-1. Age Distribution of Pad Mounted Single-Phase Transformers

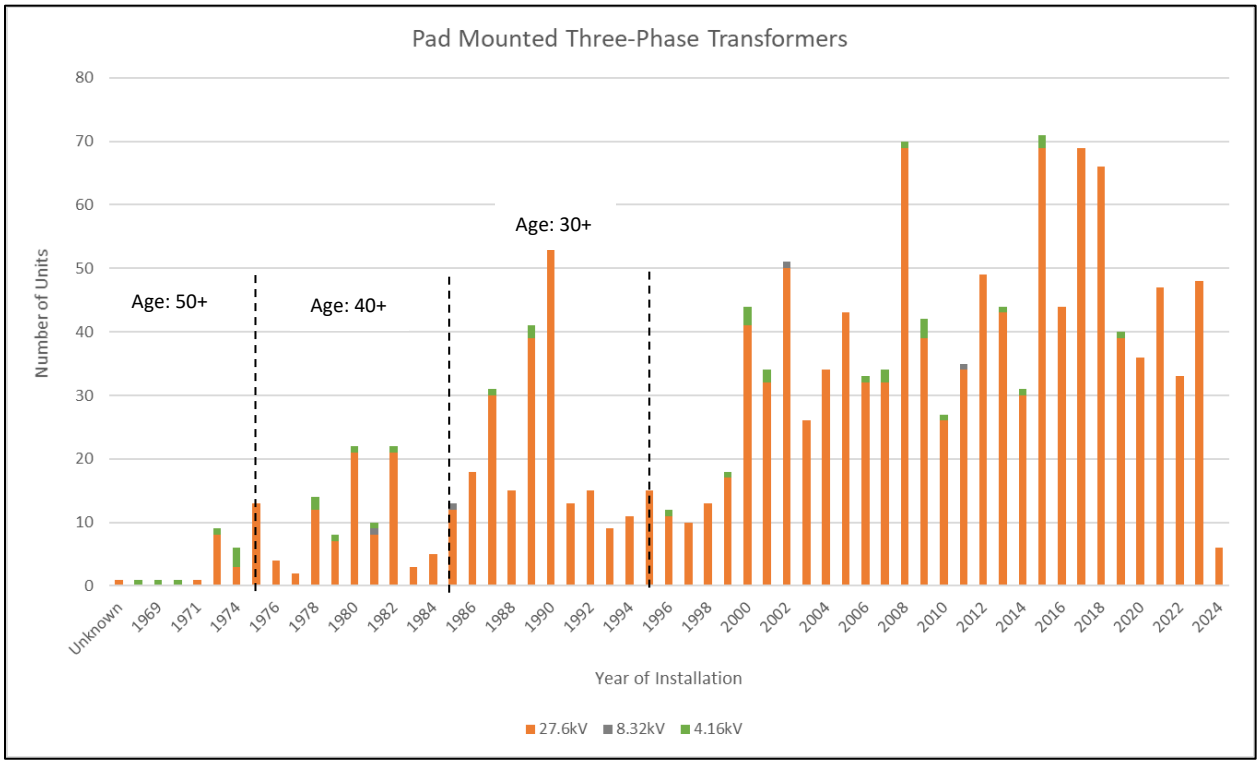


Figure 1-2. Age Distribution of Pad Mounted Three-Phase Transformers

1.2 Inspection and Condition

London Hydro conducts a thorough visual inspection on all pad mounted transformers once every three years[3]. Below are digital forms from the Mobile Workforce platform utilized for inspections, showing the type of data collected on each asset during the audit (Figure 1-3 and Figure 1-4). Any deficiencies found are recorded, and equipment that requires urgent attention is scheduled for replacement / repair.

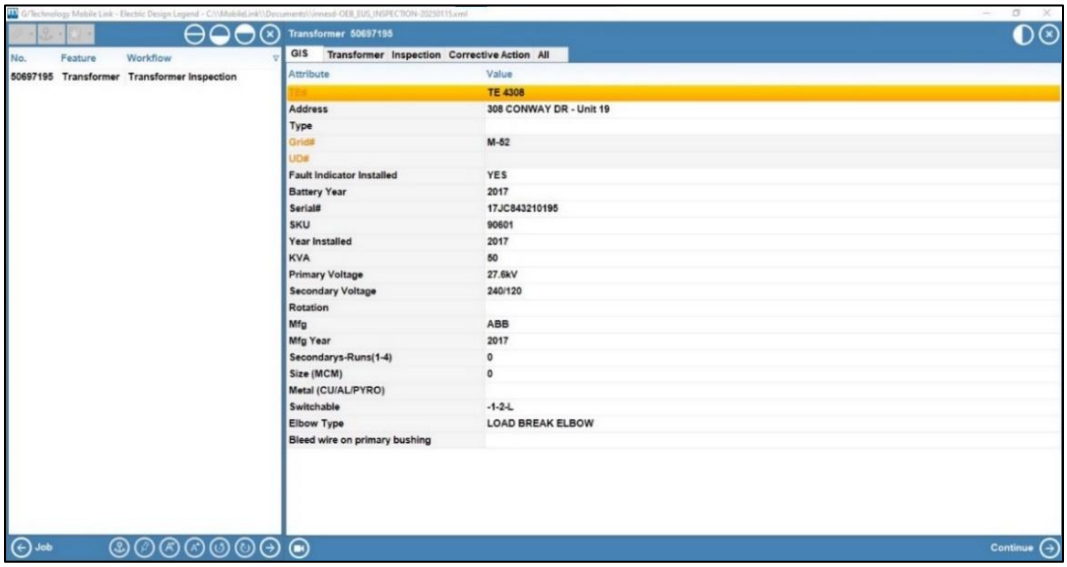


Figure 1-3. Inspection Checklist – Pad Mounted Transformers (GIS tab)

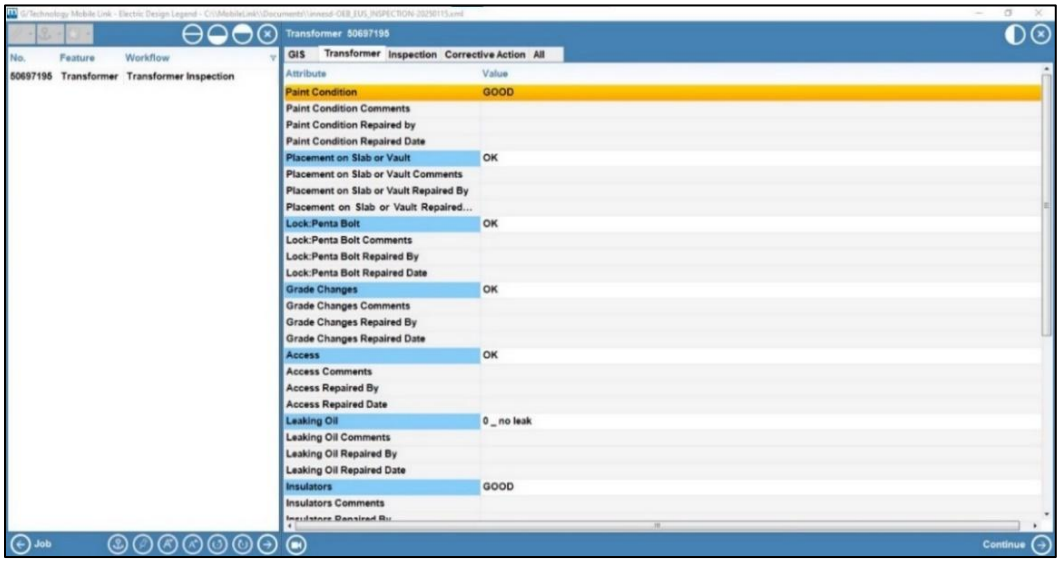


Figure 1-4. Inspection Checklist – Pad Mounted Transformers (Inspection)

[3] A 2023 risk assessment study of deteriorated/leaking transformers – considering industry best practice – resulted in an increase to the frequency of inspections for transformers that are over 35 years of age (reinspect every 2 years), and for transformers that scored poorly for leaking oil (reinspect next year).

A Corrective Action Priority (i.e., Urgent, Timely, All OK, No Access) is assigned at the end of each inspection and supervisors follow up depending on the urgency of the refurbishment / repair needed.

Table 1-1 illustrates the general condition of nearly 8500 pad mounted transformers inspected during the last three years. Corrosion and peeling paint account for the majority of the problems reported. Transformers that exhibit corrosion are more likely to leak oil in the near future. Based on the annual inspections and other ad-hoc field observations, in 2024 alone more than half of the total transformer replacements (63 out of 118 units single and three-phase units) were due to deterioration, that would otherwise have not lasted longer in service before an unplanned outage would occur.

Table 1-1. Inspection Results from Pad Mounted Transformer Audits (~8500 units)

	Corrosion/Paint	Placement on Slab	Grade Change	Oil Leakage (Y/N)
Good	73%	98%	96%	99%
Fair	22%	--	--	--
Poor	4%	1%	3%	1%

Since 2024 London Hydro uses a four-point ranking system (0-3) to grade the severity of an oil leak[4]. Units ranking zero (0) have no leak, units ranking one (1) indicate minor problems (ex. minimal drip) that do not pose an immediate concern, those receiving a score of two (2) are attempted maintenance and are monitored[5], and transformers that receive a ranking of three (3) are replaced within the year based on urgency.

London Hydro maintains a very large population of dead-front transformers, which design became standard in the mid to late 1970's for both single-phase and three-phase units. Live-front transformers (Figure 1-5) still exist and are among the oldest type (usually in very poor or poor condition), as well as very few Positek units (with canister fuses) which remain in service.

[4] Asset Management Enhancement - Inspection of Pad Mounted Transformers Report, March 2023

[5] These results are noted and the transformers are scheduled for re-inspection in a time frame shorter than the three-year period.



Figure 1-5. Pad Mounted Live-front Transformer

The following are derived from the demographics of the various pad mounted transformer types:

Dead-front Transformers

- Single-phase: there are 6938 units out of which 4.5% (315) have reached the 40-year threshold.
- Three-phase: there are 1426 units out of which 5.8% (84) have reached the 40-year threshold.

These transformers will likely remain in service until their condition assessment deems them in need of replacement, or a capital program addresses them based on a specific criterion.

Live-front Transformers

- Single-phase: there are only 12 units (10 of them are past life expectancy). Some of these transformers have been in service for 50+ years.
- Three-phase: 41 units remain in service (39 of them are past life expectancy), with the oldest being 56 years old.

These transformers may continue to score poorly on corrosion levels and barriers and insulators failure during the annual audits, and will also likely remain in service until their condition assessment deems them in need of replacement, or a capital program addresses them based on a specific criterion.

Positek Transformers

- Four single-phase units remain at 4.16 kV[6] and all of them are over 60 years of age. These will be scheduled to be replaced in conjunction with the underground cable supplying them which is of the same age.

As per the 2024 ACA the average Health Index of all the single-phase pad mounted transformers is 94% and that of the three-phase transformers is 92%.

When considering the calculated Health Index of each unit per the 2024 ACA, the following distribution is observed for the single-phase transformers (Table 1-2):

Table 1-2. Condition Assessment of Pad Mounted Single-Phase Transformers

	Health Index Distribution by Number of Units				
	Very Poor	Poor	Fair	Good	Very Good
Quantities	(<25%)	(25% - <50%)	(50% - <70%)	(70% - < 85%)	(>=85% - 100%)
Units	1	241	82	511	6119
Percentage	< 1%	3%	1%	7%	88%

The three-phase transformers Health Index distribution is as follows (Table 1-3):

Table 1-3. Condition Assessment of Pad Mounted Three-Phase Transformers

	Health Index Distribution by Number of Units				
	Very Poor	Poor	Fair	Good	Very Good
Quantities	(<25%)	(25% - <50%)	(50% - <70%)	(70% - < 85%)	(>=85% - 100%)
Units	5	60	58	97	1246
Percentage	< 1%	4%	4%	7%	85%

Figure 1-6 presents the pad mounted transformer distribution according to the year of installation and associated Health Index.

[6] These units are supplied from a portion of SUB-35 which is outside Zone D conversion.

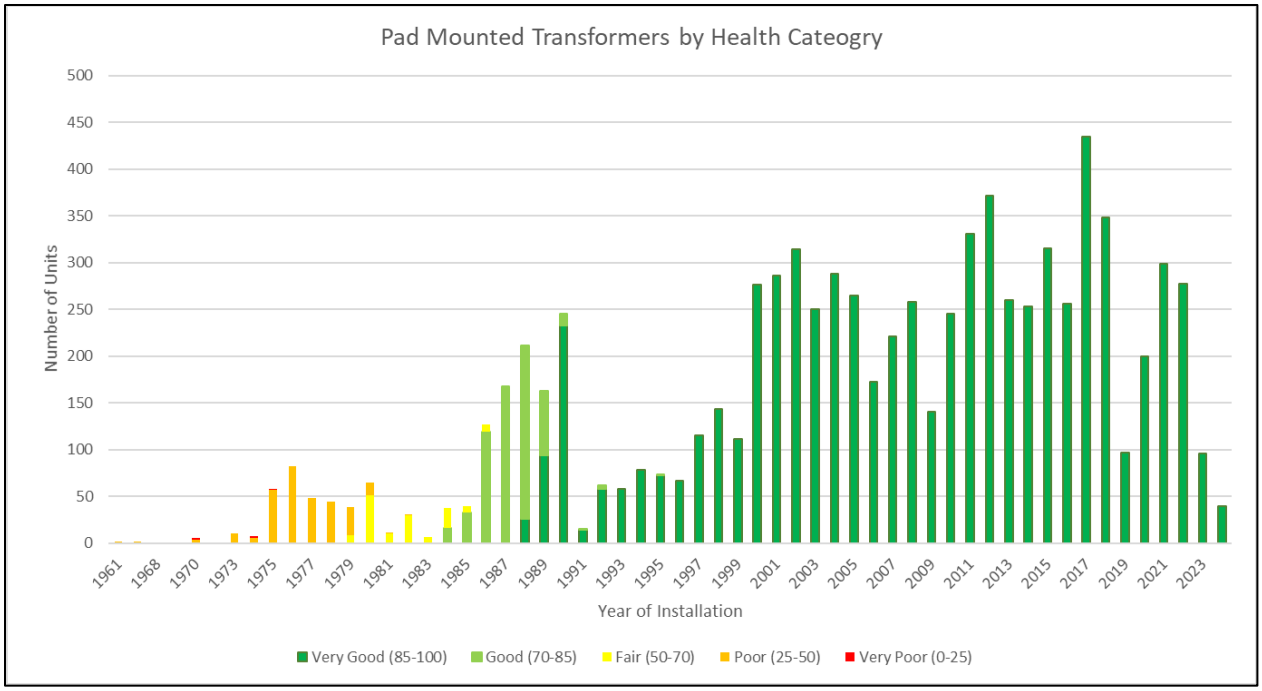


Figure 1-6. Health Categories of Pad Mounted Transformers

The map in Appendix A illustrates the geographical distribution of the pad mounted transformers according to their Health Index.

1.3 Risk Assessment

Single-phase transformer failures usually pose a small risk to system reliability when they fail. Since each transformer supplies only a limited number of customers (14-16 typical residential), the impact on SAIFI and SAIDI from the failure of one individual transformer is very low. Although the SAIFI / SAIDI impact of three-phase transformers are also low, they typically supply commercial / industrial customers, so there is greater impact to their operation and an inherent increased risk to the continuity of supply to businesses.

While live-front transformers have become obsolete, they continue to pose a safety risk in the field to employees inspecting and maintaining them. Fuse mounts can fall apart while being operated, and there is always a risk of flashover as with any live-front equipment. Similarly, Positek transformers with canister fuses also pose a safety risk; they have not been purchased since the advent of dead-front equipment.

The dead-front transformer design incorporates an under-oil current limiting fuse that, together with the bayonet fuse for secondary faults, protects the transformers from any catastrophic in-service failure.

As mentioned throughout this section, pad mounted transformers usually remain in service until failure occurs. Exceptions are units leaking prematurely that pose environmental hazards and are replaced reactively, or when replacement is prompted proactively by large scale rehabilitation of a residential area, or three-phase customer supply rebuilds, to increase operability, safety and reliability performance, leading to increased customer satisfaction. The practical life of a pad mounted transformer can be expected to surpass its life expectancy of 40 years; however, environmental conditions or other considerations such as vehicle accidents can greatly reduce the like expectancy as well. Figure 1-7 shows oil leaking prematurely from a three-phase pad mounted transformer that has been in service for only 18 years.



Figure 1-7. Pad Mounted Transformer Leaking Oil (manufactured in 2007)

As mentioned above, pad mounted transformer failures have a minor impact on the overall system reliability. Over the past five years, London Hydro has experienced an average of 15 related interruptions per year with over 630,000 customer minutes of interruption on average. Figure 1-8 below illustrates the number of customers minutes of interruption and the failure counts for the past five years. Those events can also be attributed to external component failures, such as live-front transformer barriers, elbow terminations, bushing inserts, or the mechanical failure of a switch or tap changer, which ultimately resulted in the replacement of the pad mounted transformer.

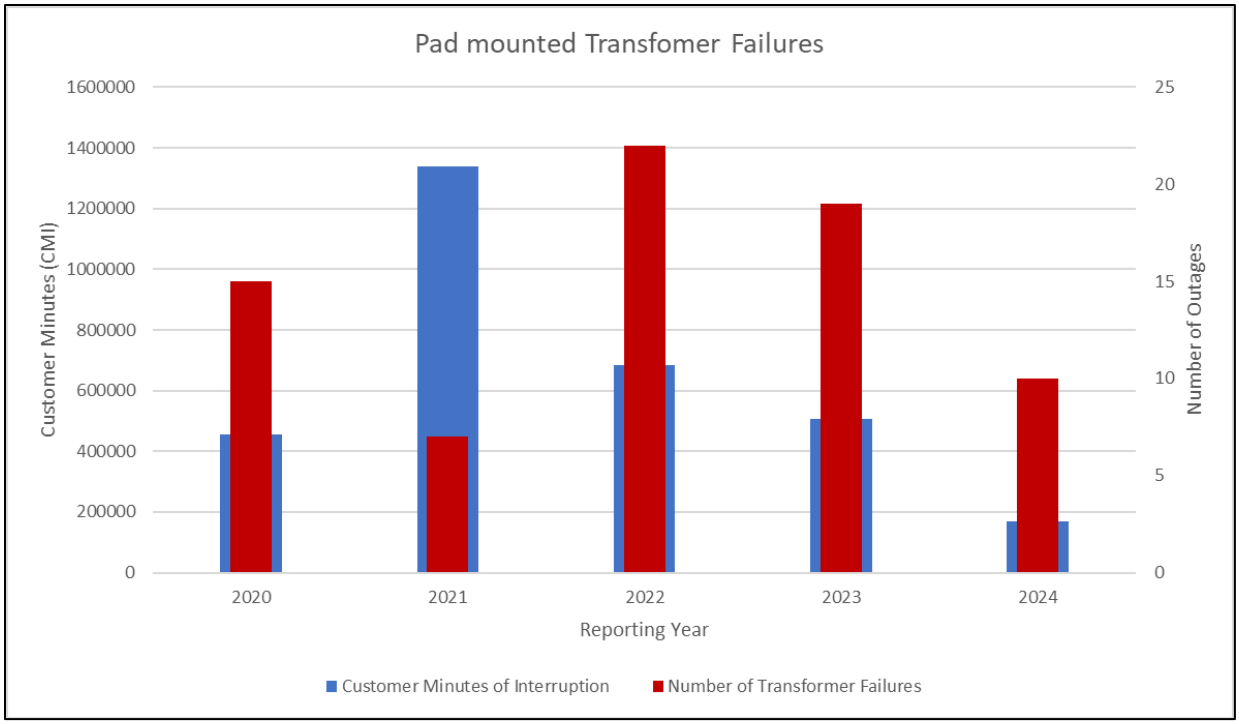


Figure 1-8. Failure Impact from Pad Mounted Transformers

1.4 Asset Sustainment Strategy

Unless changed out under a specific capital budget section (such as subdivision rehabilitation), transformers have generally been allowed to run to failure because the customer interruption is minimal, and regular inspections often detect deficiencies before a failure occurs.

Pad mounted transformers in the very poor or poor health categories represent 5% of the total population or 307 units. Not all of these units will be replaced in the time horizon of this report. A number of elements are considered when determining which transformers will be replaced in a given budget cycle; of these, age, condition and type[7] are a few considerations.

In order to sustain the pad mounted transformer assets, London Hydro should continue to monitor the reliability performance of the entire population, and plan to refurbish / replace a minimum number of units per year. In addition, replacements also occur as a result of inspections, as it was presented earlier. The pad mounted transformer replacement ACA forecast includes related work taking place in the underground supplied subdivisions. Given that London Hydro is conducting annual cable rehabilitation work in the

[7] Live-front units as well as non-switchable transformers are replaced in limited quantities every year.

residential underground system, many single-phase units and some three-phase units are being replaced simultaneously. This replacement strategy follows the cable replacement process and, as a result, the newer transformers installed have dual load-break switches, which helps reduce the duration of future interruptions for customers affected.

The Flag for Action (FFA) plan is based on the condition assessment from the 2024 ACA. Figure 1-9 proposes the replacement rate of pad mounted transformers for the ten years of the planning horizon. It equates to 181 units per year (single-phase and three-phase combined). These numbers are a combination of planned replacements, for example combined with cable rebuild programs and 4.16 kV conversion programs, together with other replacements due to deteriorated transformers, car accidents, etc. Historical ratios would amount to about 50% of the replacements being due to deterioration or other external factors (ex. damage from car accident), and another 50% changed out by other criteria, such as associated capital work.

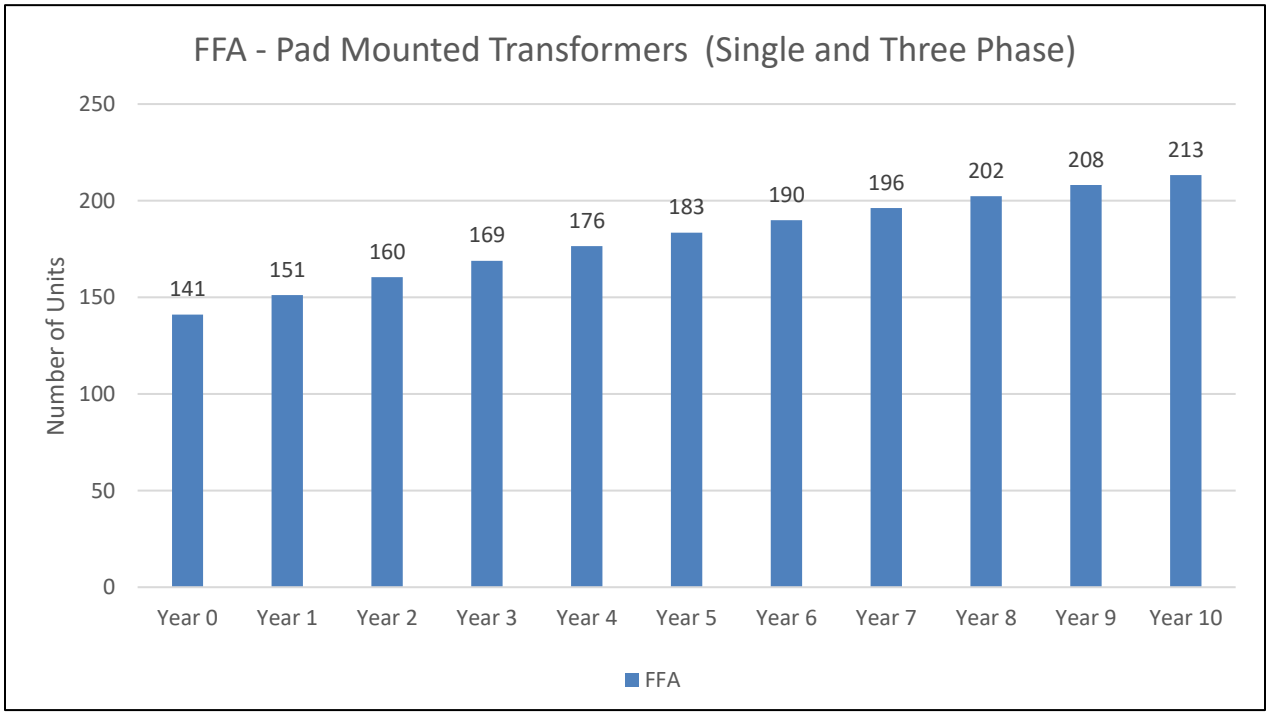


Figure 1-9. FFA Rate for Pad Mounted Transformers

2 Vault Transformer

In the early 1960's London Hydro introduced a supply system that involved installing dry-type transformers inside customer-owned vaults, mainly in schools and apartment buildings. This type of transformer is considered obsolete, as more recent transformer designs no longer use air as an insulating medium.

Over the past five years, there have been proactive vault transformer removals due to voltage conversion in several distinct conversion zones[8] and as a result, the number of vault transformers has dropped significantly. The number of vault transformers was reduced from 74 in 2020 to only 44 vault transformers (a combination of single-phase and three-phase installations): 73% operate at 27.6 kV and 27% at 4.16 kV.

Only 12 dry-type units[9] were remaining in-service at the time of the 2024 ACA, installed exclusively on the 4.16 kV system. The remaining 32 vault transformers, all operating at 27.6 kV, are insulated with a flame-resistant fluid (usually R-TEMP or FR3).

2.1 Life Expectancy and Age Distribution

Vault transformers are assigned 50 years as anticipated service life based on best industry practice and empirical data. Approximately 27% of all units (a total of 12 units, all dry-type installed on the 4.16kV system) are past this threshold.

Most of the customer-owned vaults located underground have developed problems associated with water ingress. Whenever possible, when dry-type transformers are removed, London Hydro attempts to completely decommission the customer-owned vault and supply the customer from a pad mounted transformer external to the vault, and to convert to 27.6 kV. Where it is not practical to install a pad mounted transformer outside, an alternative is to replace the dry-type transformer(s) with new FR3 filled transformer(s) inside the vault.

Figure 2-1 shows the distribution of all the vault transformers by year of installation and voltage system. The average age of the vault transformers is 33 years old.

[8] 4.16kV Conversion Progress Report – 2022 Update
[9] Six out of the 12 units are being addressed at the time of writing this report.

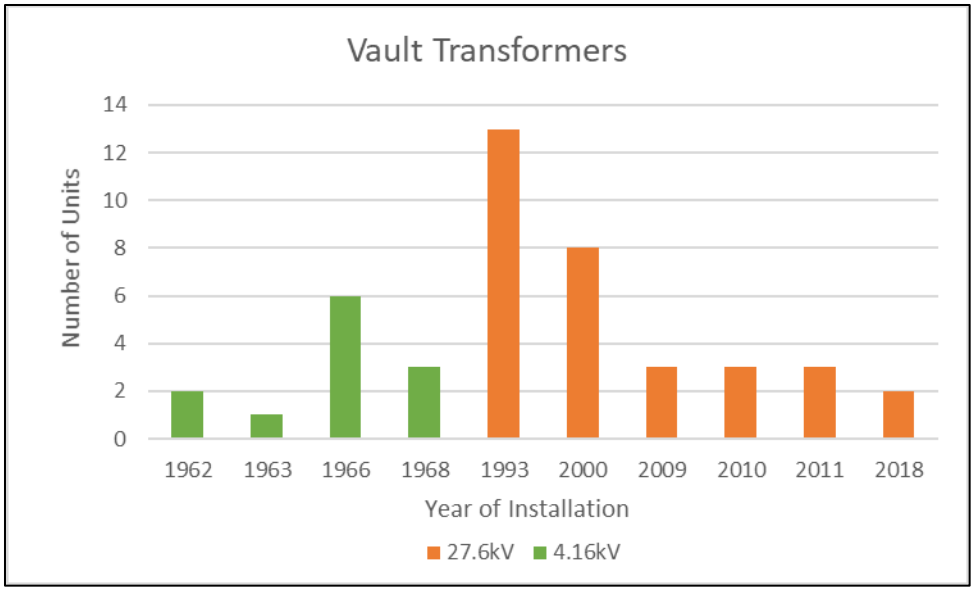


Figure 2-1. Age Distribution of Vault Transformers

2.2 Inspection and Condition

The vault transformers being London Hydro equipment, although located in customer-owned vaults, are inspected yearly. Since most vaults are in basements, it is an ongoing task to keep the sites clean and safely secured in addition to inspecting the transformers.



Figure 2-2. Condition of Dry-Type Transformers in Vault

A new inspection form in Mobile Workforce was launched in 2024 and can be viewed in Figure 2-3. The inspection checks mainly for damage to the arrestors or to the electric cables, connections, and grounding. During inspections, London Hydro may vacuum the electrical components inside the vault and ensure there

is adequate ventilation for the dry-type transformers. London Hydro's inspection also confirms that the site is secure, properly signed, well-lit, and accessible.

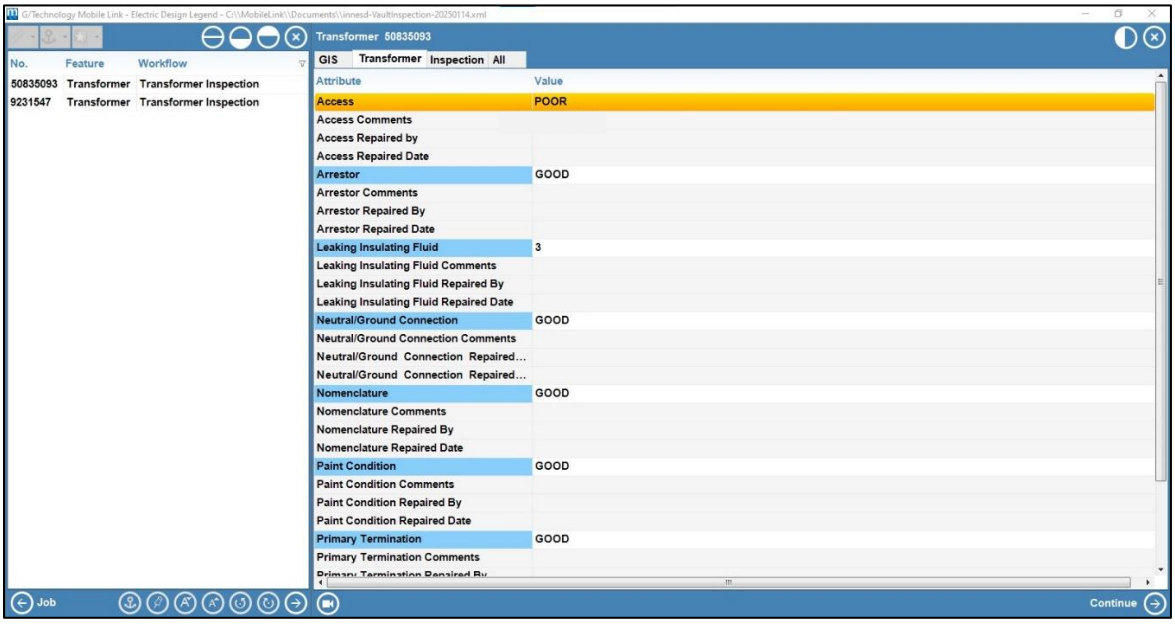


Figure 2-3. Inspection Checklist – Vault Transformers

The dry-type transformers, exclusively on the 4.16 kV system, are in very poor condition being over 60 years of age; their age and condition will warrant removal in a timely manner due to the associated risk of failure. Transformers filled with FR3 or R-TEMP are relatively new and all in very good condition, and will be maintained as long as the vaults are kept in service.

The average Health Index of vault transformers is 71% which is the lowest among all asset categories. The distribution of the Health Index for the vault transformers is given in Table 2-1:

Table 2-1. Condition Assessment of Vault Transformers

	Health Index Distribution by Number of Units				
	Very Poor	Poor	Fair	Good	Very Good
Quantities	(<25%)	(25% - <50%)	(50% - <70%)	(70% - < 85%)	(>=85% - 100%)
Units	12	0	0	0	32
Percentage	27%	0%	0%	0%	73%

Figure 2-4 presents the vault transformer distribution according to the year of installation and associated Health Index.

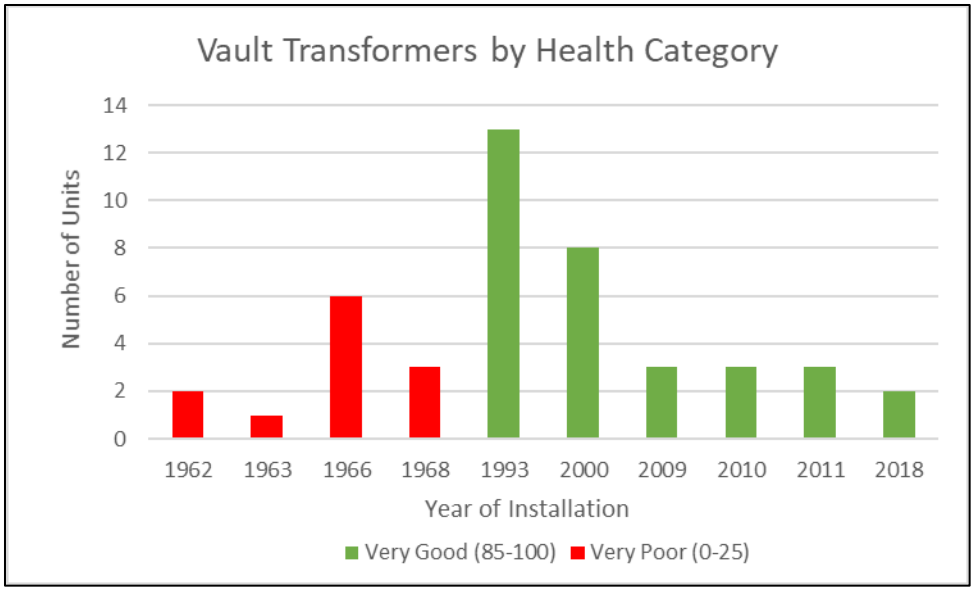


Figure 2-4. Health Categories of Vault Transformers

The map in Appendix B illustrates the geographical distribution of the vault transformers according to their Health Index, and the boundaries of the 4.16 kV conversion zones.

2.3 Risk Assessment

Due to the location of most vault transformers being housed inside buildings owned by customers, there is an additional risk posed by the fact that London Hydro has little control over site security and the structural condition of the rooms. Some spaces occupied by electrical equipment are separated from the rest of the basement only by a chain-link fence; some basements also house customer-owned equipment in various states of repair.

To address the aged vault transformers in customer-owned vaults, London Hydro's practice continues to involve installing a new service outdoors to remove its own equipment from the vault whenever possible. All the remaining dry-type vault transformers are inside conversion zones on the 4.16 kV system, and will have to be addressed in a timely manner.

2.4 Asset Sustainment Strategy

London Hydro has had an annual budget for vault transformer conversions for many years. It will eliminate the last 12 dry-type transformers in conjunction with 4.16 kV conversion, as illustrated in Figure 2-5. Additional vault transformers (R-TEMP or FR3) are not forecasted to be addressed in the planning horizon.

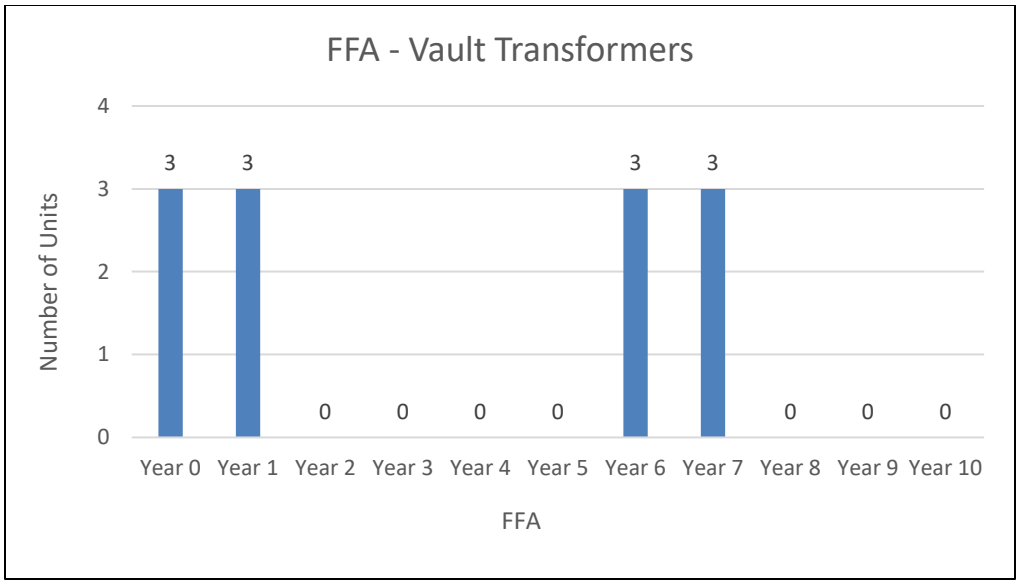


Figure 2-5. FFA Rate for Vault Transformers

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3 Network Transformer

At the time of writing the 2024 ACA report, a total of 64 network transformers (NTs)[10], primarily operating at 13.8 kV, were supplying the interconnected secondary network serving downtown customers, most of them at 208Y/120 Volts. A number of spot network transformers (seven NTs) provide power to customers at 600Y/347 Volts. A *mini-grid* network of 12 NTs operating at 27.6 kV serves businesses along Dundas Street. London Hydro maintains four sizes of NTs: 500 kVA, 750 kVA, 1000 kVA and 1500 kVA.

All the network transformers (with the exception of the mini-grid) are supplied from the "ring bus" via nine (9) step-down transformers from 27.6 kV to 13.8 kV and five (5) 600 Amp Load Centres (LCs), installed at three substations: Sub-10, Sub-11 and Sub-12. The high voltage cables that are associated with the network system are covered in Section 6.

3.1 Life Expectancy and Age Distribution

Network transformers are assigned 45 years as anticipated service life based on best industry practice and empirical data. All the NTs are below this threshold.

The compact, stacked core design of the network transformers allows them to fit in below grade vaults under the downtown sidewalks. The design of the older units, in particular, has contributed to their long service life. The oldest network transformer dates from 1989, making it 36 years old.

Figure 3-1 below shows the distribution of all the NTs according to their year of installation. The average age of the NTs is 20 years old. The age distribution indicates that the bulk of the units are relatively new (20-30 years or less). However, over the planning horizon, it may be necessary to continue to invest in the existing 13.8 kV NTs in order to maintain the network overall. The replacement or refurbishment of older units may be required due to failure of older PILC primary cables, thereby requiring new triplex EPR cable to be terminated at the transformer's high voltage chamber.

[10] Three of the 64 NTs were eliminated by the end of 2024 due to demolition of the London Free Press.

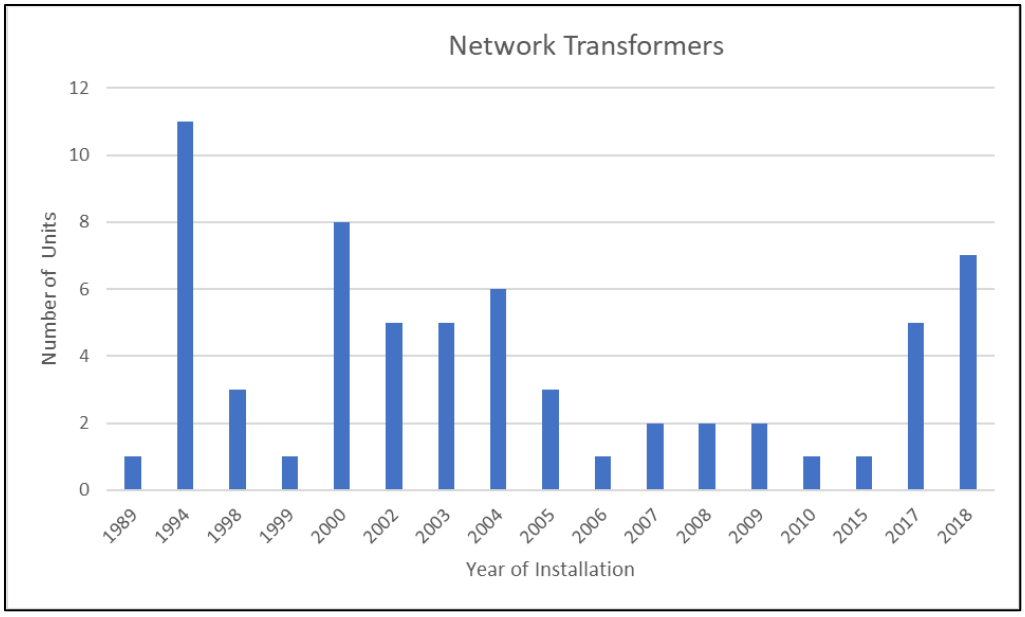


Figure 3-1. Age Distribution of Network Transformers

3.2 Inspection and Condition

London Hydro's network system supplies power to the core area of the city, and because of the economic significance of the city core London Hydro inspects all its network transformers at least once a year, but the regular interval is every six months. The Mobile Workforce checklist below (Figure 3-2) is used for the inspection of NTs.

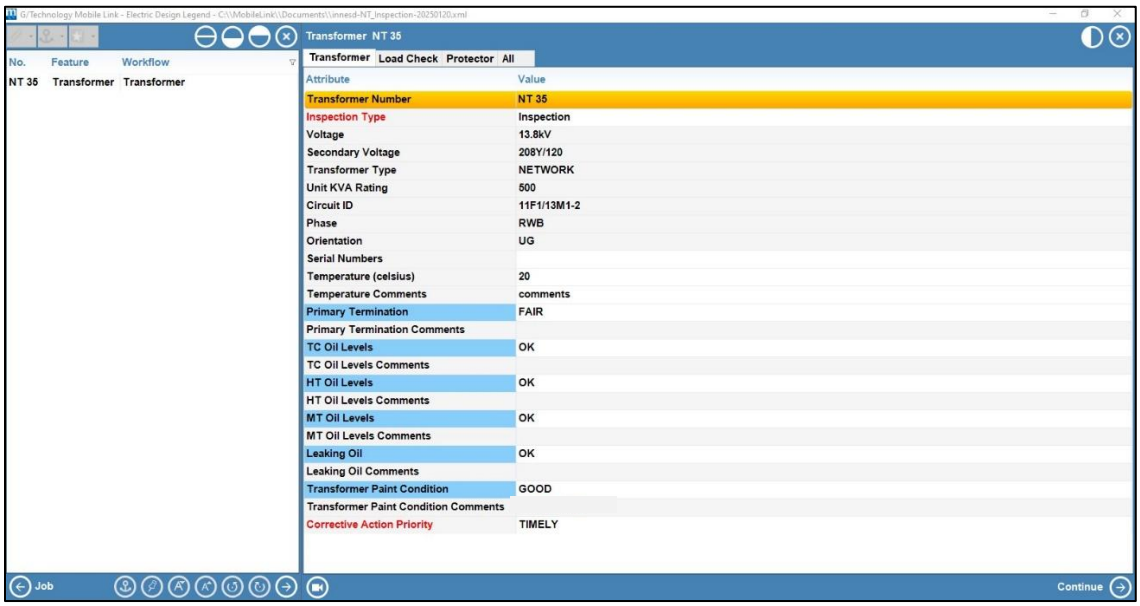


Figure 3-2. Inspection Checklist – Network Transformers

When problems are identified, they are ranked according to their Corrective Action Priority assigned at the time of the inspection. When urgent repairs are required, work proceeds as soon as possible. Deficiencies that are not urgent are addressed through refurbishment or replacement plans.

The condition of the NTs is very good all across. The average Health Index of the network transformers is 100%. The distribution of the Health Index is found in Table 3-1:

Table 3-1. Condition Assessment of Network Transformers

	Health Index Distribution by Number of Units				
	Very Poor	Poor	Fair	Good	Very Good
Quantities	(<25%)	(25% - <50%)	(50% - <70%)	(70% - < 85%)	(>=85% - 100%)
Units	0	0	0	0	64
Percentage	0%	0%	0%	0%	100%

The map in Appendix C illustrates the geographical locations of the network transformers and protectors across downtown.

3.3 Risk Assessment

In secondary network distribution systems, transformers are supplied from multiple primary feeders and are interconnected on the low voltage side, so that the loads can be supplied from the secondaries of any nearby NT. Failure of an individual transformer or feeder usually does not cause a power outage since the remaining NTs can provide enough power to service the entire network load. In the case of the spot networks[11], the interconnection of the secondary conductors is limited to the spot. If one transformer or its protector fails when another NT from the same spot network is out of service, an outage could occur.

NT failures pose a relatively small risk to reliability. However, due to their positioning under sidewalks and open grates, these transformers could pose a serious safety hazard to the public and employees if the failure were to result in a fire or an explosion inside the vault.

As NTs age, common issues include corrosion and oil leaks. To reduce the environmental risks of these leaks, London Hydro has switched to using FR3, a fire-resistant, natural ester-based coolant. Made from

[11] All of London Hydro's spot networks have been connected to the SCADA system so that the status of the protectors and loads is monitored in real time to minimize the chance of an outage.

edible oils and free of petroleum, FR3 is biodegradable and has a much higher flash point (330°C) and fire point (360°C) compared to conventional transformer oil, which has a flash point of 147°C and a fire point of 165°C.

More recently, London Hydro uses real-time visibility into its network grid to assess the condition of its assets and troubleshoot remotely. Two solutions were implemented in pilot projects to establish communication between transformer vault locations and London Hydro's SCADA system. In the mini-grid, an optical fibre backbone was installed for collecting sensor data, such as vault liquid level, ambient temperature and transformer oil temperature. Eaton's vault monitoring (TRTL) interfaces directly with NT protector relays to enable remote monitoring and control. In the remaining vaults, London Hydro piloted a Power-Line Carrier (PLC)-based vault monitoring, Digital Grid, which also offered remote control of the protector relay as well as sensors to monitor vault conditions. The pilot phase is complete and the technologies have been deployed system wide.

3.4 Asset Sustainment Strategy

Although the overall asset condition is very good, assessment of the network transformers must continue, so deterioration does not occur faster than expected. A conservative forecast would include one network transformer replacement or refurbishment every couple of years for the next planning horizon, to address high-voltage termination chamber upgrades due to PILC cable failures, or upgrades due to corrosive environment inside network vaults in order to extend the asset's life.

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4 Network Protector

In network systems, a special protector with directional relays is required on the low side of network transformers to prevent reversed power flow during faults on the primary cable or transformer. These relays detect reversed current and small voltage variations, ensuring faulted equipment is isolated from other power sources.

Based on the 2024 ACA report, 64 network protectors are in-service. Network protectors have different current ratings to match the transformer size, i.e. 1200, 1600, 1800 and 2500 Amps.

4.1 Life Expectancy and Age Distribution

For the purpose of this report, the same service life of 45 years is adopted, similar to that of the network transformers. For the ACA, it was assumed that the protectors are as old as their respective network transformers. None of the protectors have reached life expectancy, averaging only 20 years old.

The network protector has a practical life expectancy similar to a circuit breaker and can last a long time if spare parts are available and the housings are maintained to prevent water ingress and rust. All protectors have submersible enclosures.

As part of previous GIS enhancements, the network protector was modeled as a field device on the system so that age and maintenance history of each protector can be tracked independent of the network transformer.

4.2 Inspection and Condition

During annual network transformer inspections, London Hydro performs a basic inspection of the protector, checking that it is in the closed position and ensuring cables and load limiters are in good condition. The housing is checked for rust, but the cover is only lifted during scheduled maintenance. If a protector is found open regularly, calibration may be needed, especially since they can open automatically under light load conditions as per design. As part of protector maintenance in the past, all the mechanical relays have been replaced with electronic relays.

The inspection checklist was enhanced in 2024 in Mobile Workforce and the most recent digital form is found in Figure 4-1. The asset year of the protector is now collected at the time of inspection, so after one complete cycle of inspections the age of all the network protectors should be collected if available.

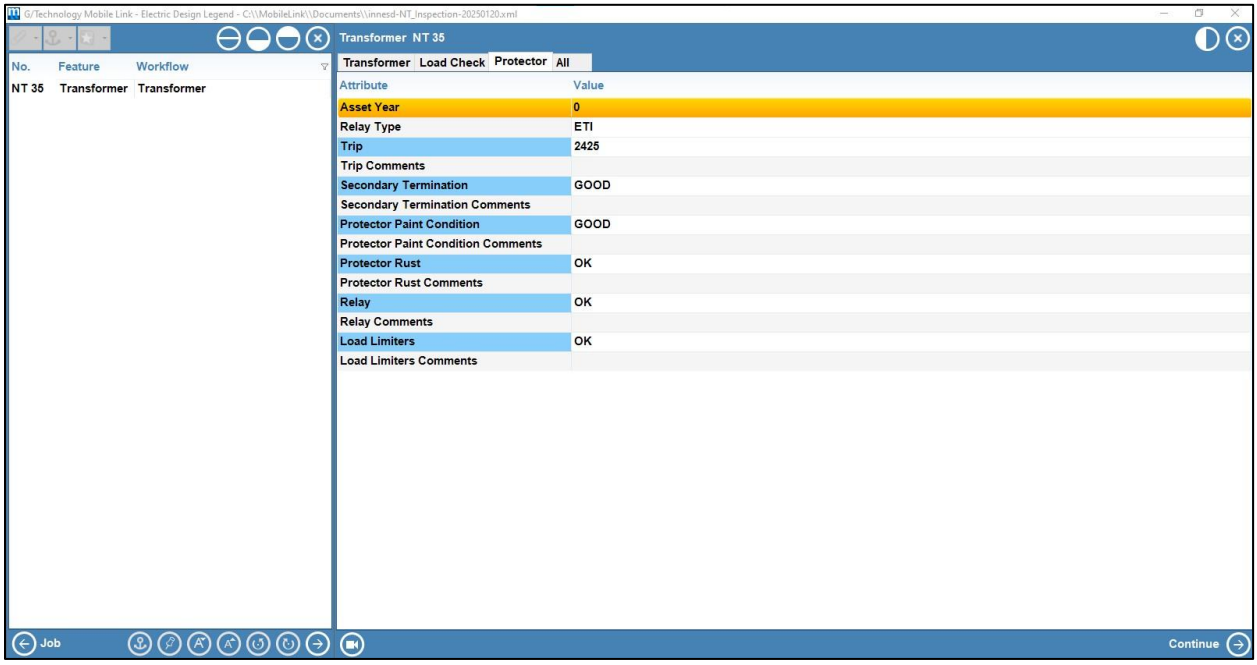


Figure 4-1. Inspection Checklist – Network Protectors

London Hydro has replaced or refurbished many network protectors in the last 15-20 years. Any remaining old protector will be changed out when the transformer is replaced.

The average Health Index of the network protectors is considered to be 100%. The distribution of the Health Index for all the units is given in Table 4-1 below:

Table 4-1. Condition Assessment of Network Protectors

	Health Index Distribution by Number of Units				
	Very Poor	Poor	Fair	Good	Very Good
Quantities	(<25%)	(25% - <50%)	(50% - <70%)	(70% - < 85%)	(>=85% - 100%)
Units	0	0	0	0	64
Percentage	0%	0%	0%	0%	100%

The map of the network protectors is found in Appendix C.

4.3 Risk Assessment

Like network transformers, the failure of a single protector rarely causes a power outage, so the reliability risk is low. However, the main risk is the arc flash hazard it poses to field staff, as workers must remove bolts, fuses, and links for isolation while the protector remains energized. The technology implemented recently for protector relays communication to SCADA was described in the previous section.

4.4 Asset Sustainment Strategy

London Hydro has a maintenance program that includes regular testing and calibration of protector relays, along with cleaning, lubrication, and testing of moving parts. While relays may occasionally fail, complete protector failure is rare. Protectors are not replaced due to age alone; instead, they are replaced or refurbished considering both age and condition. Typically, London Hydro replaces or refurbishes network transformers and protectors at the same time, or it may, on occasion, reuse a good protector when a network transformer is refurbished. The same replacement rate as for the NTs is forecasted for network protectors with one unit refurbished / replaced every year over the planning horizon.

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5 Distribution Switchgear

Three-phase pad mounted distribution switchgear includes one electrical bus per phase and multiple bays for distributing power in multiple directions. Each bay connects to the main bus through a switch, fuse, or interrupter, allowing multiple switching points. Apart from acting as distribution load centres (LC) and providing isolation points, switchgears have a second purpose being used for protecting system components from abnormal conditions, such as cable or transformer faults. Modern interrupters (or fuses in the live-front units) operate when a fault current is sensed downstream of the switchgear. Unlike fuses, the interrupters are capable of tripping all three phases when supplying a three-phase load, even if the fault was sensed on one phase only. One-phase tripping is available for single-phase residential load and it helps maintain the power supply to adjacent healthy phases connecting other customers for improved reliability.

Pad mounted switchgear units are typically located in residential, commercial, or industrial areas and are powered by underground distribution cable. They can be connected in series, with multiple sources of supply, creating a large loop with open points. This setup allows for flexible system reconfiguration to provide backup power in case of an equipment failure.

There are 180 distribution switchgear units on London Hydro's system; they come in two sizes, 200 Amps and 600 Amps. Approximately three quarters of the units are 200 Amps, with the remaining units being 600 Amps (most of them are SCADA connected). Also, distribution switchgear can be categorized by the type of insulating medium. Live-front switchgear (air-insulated), has been actively removed from the system over the last 15 years leaving very few units in service that will be decommissioned with the earliest opportunity. Dead-front switchgear includes solid-dielectric units, SF6 units and junctions[12] with separable elbow terminations. The breakdown of the number of units by insulating medium is found below:

- 4 air-insulated units
- 127 solid-dielectric units
- 31 SF6 units
- 18 junctions

[12] These are obsolete units but they are maintained as legacy equipment until system reconfigurations render them redundant, or until inspections reveal deficiencies that could impact safety or reliability.

Appendix D illustrates the geographical representation of all the switchgear in the system.

Most of the air-insulated switchgear, due to the exposure of the live parts in often contaminated environments, have experienced significant underperformance, and have been replaced system-wide through consolidated annual capital programs. Solid-dielectric switchgear was introduced at London Hydro in early 2000's. Switchgear using SF6 has been in service for a while, mainly downtown, with units as old as 35 years of age. Newer, five-way SF6 units were deployed on the 27.6 kV looped system downtown a few years ago. Application of more SF6 units for the critical loads downtown recently was decided after several premature failures experienced with the solid-dielectric technology supplying commercial loads. Junctions are mostly legacy equipment still in-service but sometimes they are installed in vaults where SF6 switchgear exists.

5.1 Life Expectancy and Age Distribution

Distribution switchgears are assigned two different service life intervals based on best industry practice and empirical data: 40 years for all pad mounted switchgear types, except SF6 which is 45 years. To determine an FFA plan, it was considered based on the methodology of the original 2019 ACA, that the likelihood of asset removal at 30 years is 20% and that at 45 years the likelihood of removal is 95%.

Only 2% (3 units) are past their life expectancy, while an additional 3% (6 units) will exceed it in the next ten years. The distribution of all the switchgear according to the year of installation and insulating medium is given in Figure 5-1. The average age of all switchgear is 14 years old.

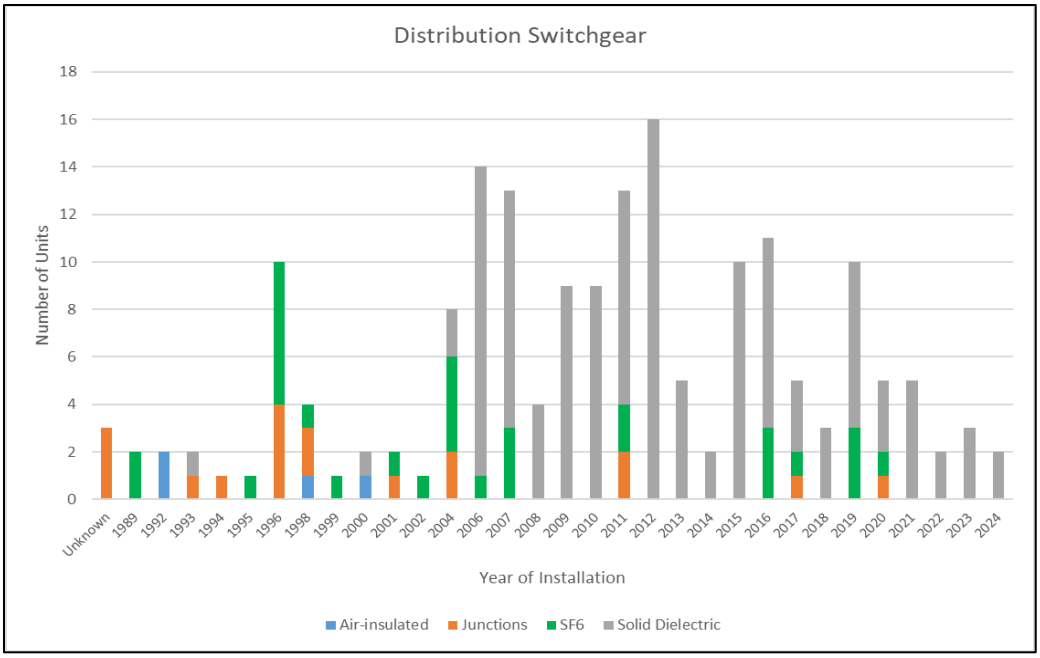


Figure 5-1. Age Distribution of Distribution Switchgear

5.2 Inspection and Condition

Most distribution switchgear units are inspected on a three-year cycle except for the 600 Amp units which are inspected yearly and SF6 units which are inspected twice a year. London Hydro uses an infrared camera during the inspection to search for hot spots. Two inspection forms from Mobile Workforce, one including the checklist, are presented below.

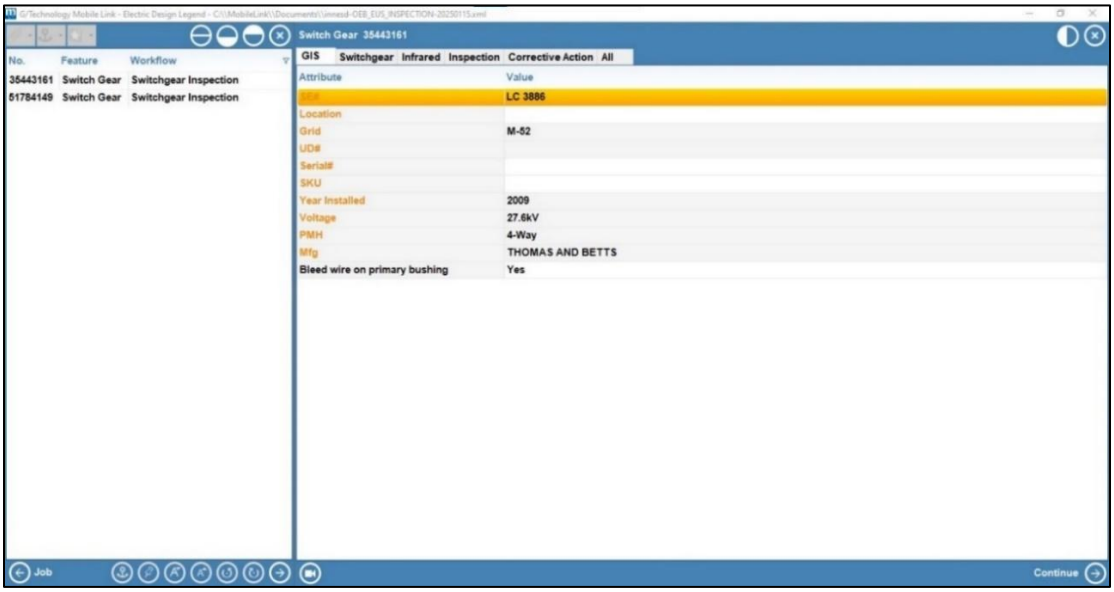


Figure 5-2. Inspection Checklist – Distribution Switchgear (GIS tab)

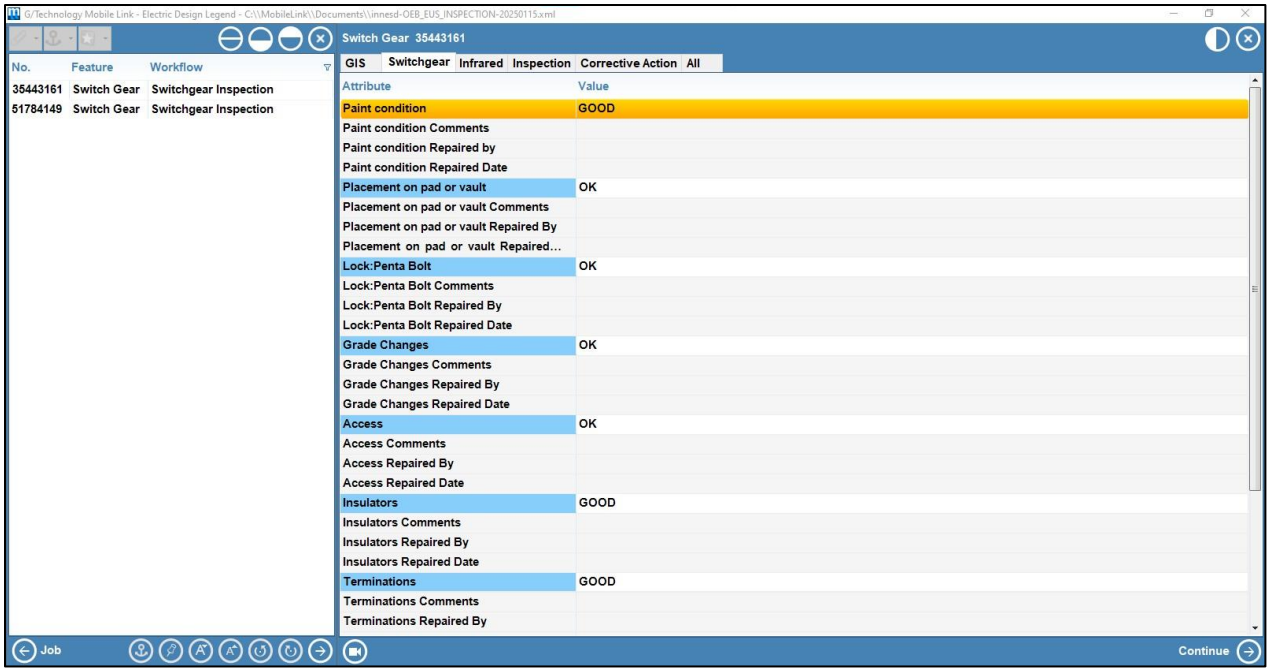


Figure 5-3. Inspection Checklist – Distribution Switchgear (Inspection)

Switchgear that uses SF6 as the insulating medium requires more specialized inspection, during which the pressure of the gas is recorded and, if there is a leak, the SF6 gas has to be topped up to the manufacturer's specifications. The SF6 switchgear cannot be operated (opening or closing a switch or interrupter) if the gas pressure is not within the specified range.

The inspection and maintenance plans will allow London Hydro to effectively monitor the distribution switchgear and address units with identified issues before failure occurs.

The average Health Index of all switchgear is 97% The Health Index distribution among all the units for which a Health Index was calculated (179 out of 180) is presented in Table 5-1.

Table 5-1. Condition Assessment of Distribution Switchgear

	Health Index Distribution by Number of Units				
	Very Poor	Poor	Fair	Good	Very Good
Quantities	(<25%)	(25% - <50%)	(50% - <70%)	(70% - < 85%)	(>=85% - 100%)
Units	0	2	0	6	171
Percentage	0%	1%	0%	3%	96%

5.3 Risk Assessment

The distribution switchgear is an essential component of the underground distribution system. It is used frequently for switching load or equipment isolation. When switchgear interrupters (or fuses) operate for protection, interruption of short-circuit currents typically occurs below the equipment rating. Modern interrupters are rated a minimum of 20 kA RMS asymmetrical and 12 kA RMS symmetrical fault rating.

For air-insulated switchgear (live-front), condition and end of life are often affected by mechanical failure, rusting of the enclosure, degradation of the insulating barriers, ingress of moisture and dirt into the air compartment leading to internal flashovers.

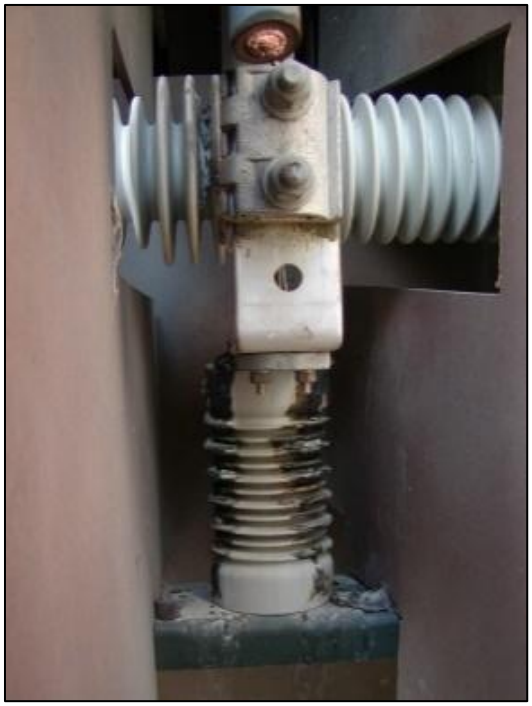


Figure 5-4. Internal Flashover

The failure impact from live-front switchgear is presented in Figure 5-5. Six related outages can be attributed to this equipment type in the last five years, with an average of 69,000 customer minutes per event. It is worthwhile noticing that with the major elimination of this equipment type from the system, the last three years have not seen any such failure. Based on the significance of the economics and customer impact involved from these failures, the replacement program will be completed after tackling the last four units over the next 2-3 years.

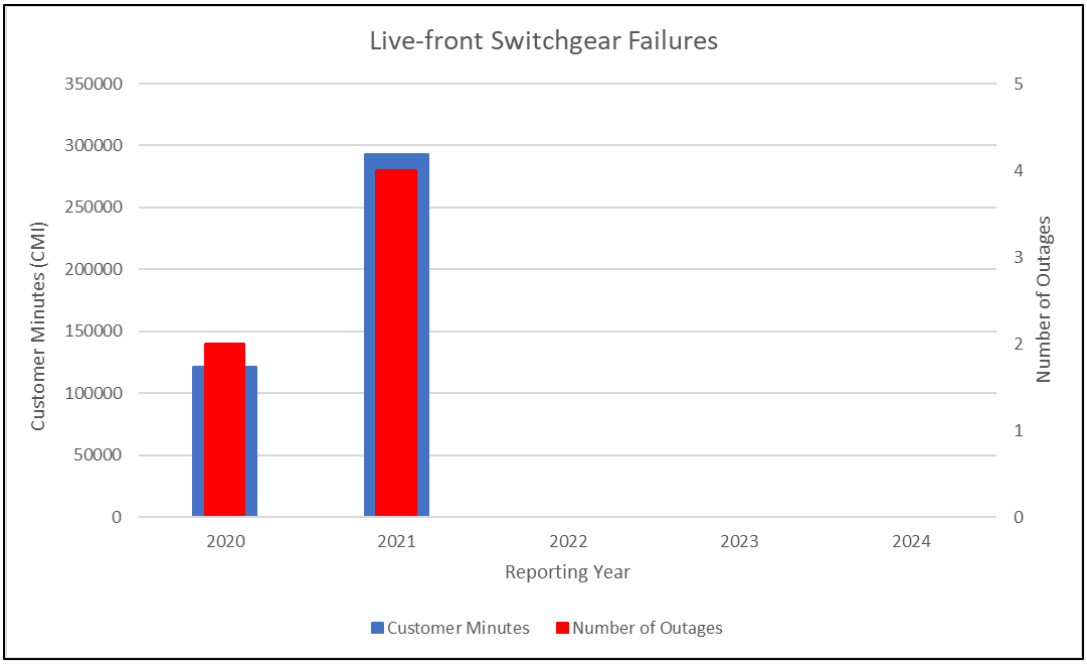


Figure 5-5. Failure Impact from Live-front Switchgear

London Hydro has experienced some premature failures with the solid-dielectric switchgear (LC) since originally introduced on the system. While the unexpected mis-operation of a few units led to a manufacturing recall more than 10 years ago, presented by moisture getting under the indicator lens cap, the technology has proven to work well in general. However, failures of solid-dielectric switchgear still continued to occur on the system from various causes, such as bus failure, vacuum bottle failure or due to the insulating plug voltage withstand capability. The investigation into the bus failure of multiple units revealed that the equipment was overstressed due to “voltage spikes outside the equipment rating”. London Hydro decided, as per the manufacturer’s recommendation, to install bushing style arrestors to address the suspected cause. There was a notable improvement when the bus was also upgraded from a rating of 29.3 kV to 38 kV, which translated in higher basic insulation level (BIL) rating.



Figure 5-6. LC New Bus (Left) versus Old Bus (Right)

An additional measure that London Hydro took to mitigate impact of switchgear failures was to install straps on all the units that had hinged roofs, to prevent the doors from coming off their hinges during failure events and endangering the public.



Figure 5-7. Doors Blown off LC Cabinet

Given the relatively young age of the solid dielectric switchgear population, new failure modes are being encountered that vary in cause. With each failure mode uncovered, London Hydro works with the manufacturer to develop longer lasting solutions. It is hoped that the solid-dielectric technology has matured enough so that various defects have been addressed before the manufacturing process. The

concern due to the repeated failures of solid dielectric units led to the reintroduction of the SF6 technology for the more critical applications that require higher reliability, such as the downtown 27.6 kV primary supply for the secondary network system.

The failure impact from dead-front switchgear in the last five years is presented in Figure 5-8. A total of five related outages can be attributed to this type of equipment, with an average of 82,700 customer minutes per event. At the same time, the number of customers interrupted from sustained failures average 2700 per outage with as high as 7500 customers affected in one instance.

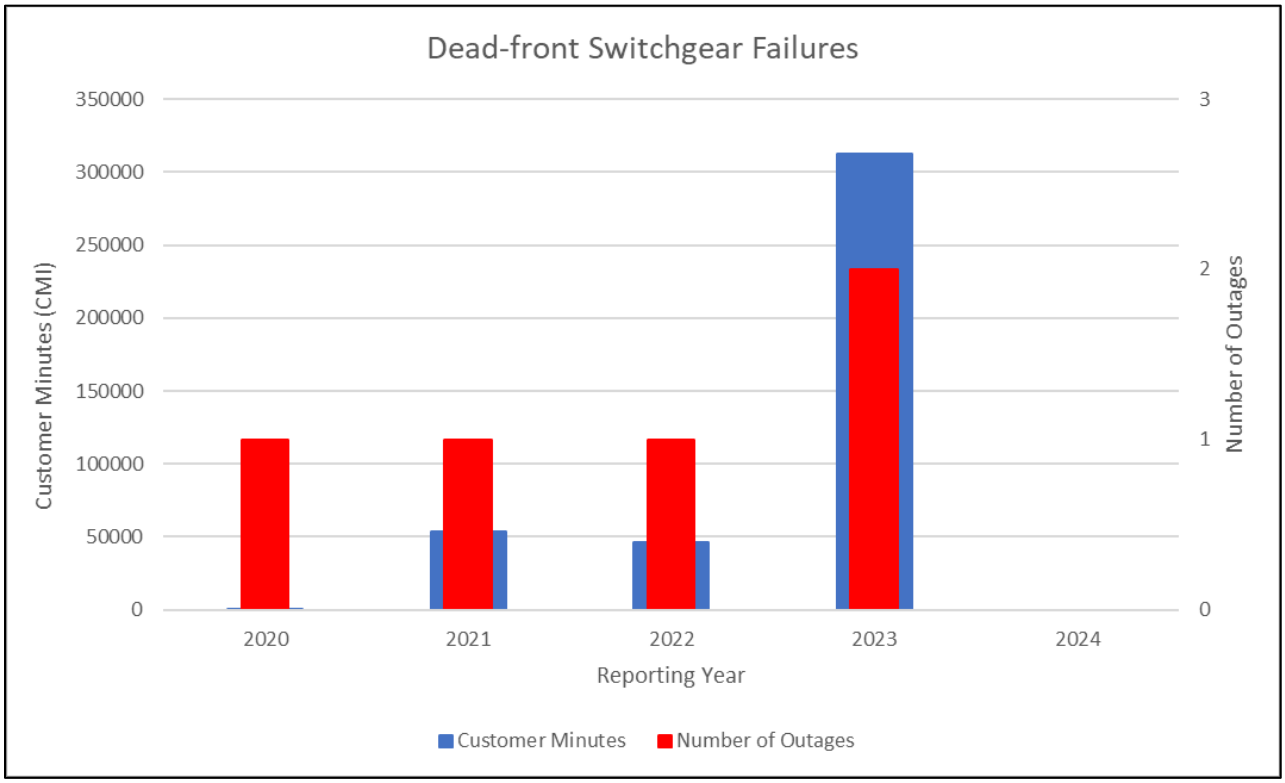


Figure 5-8. Failure Impact from Dead-front Switchgear

Another element that adds to the reliability risk is momentary interruptions, as a switchgear failure can have significant contributions to feeder breaker auto-reclosures (A/Rs). There were two instances in the last five years where switchgear deterioration resulted in minor flashovers that caused momentary interruptions in the months leading up to the eventual failure. In general, momentary interruptions affect business continuity more severely than residential customers, and for some customers, they disrupt business operations similarly to sustained interruptions.

The number of switchgears deployed on London Hydro's distribution system has not expanded much as so many live-front units are deemed redundant with the advent of switchable transformers and removed completely instead of being replaced, resulting in both capital and O&M efficiencies. In keeping with the City's load growth, both in the residential and commercial / industrial sectors, more dead-front switchgears will continue to be installed in the future.

5.4 Asset Sustainment Strategy

The live-front switchgear is almost completely eliminated with only four units remaining to be replaced within the planning horizon. In the previous ASP no replacement schedule was provided for the dead-front switchgear units. However, due to the relatively consistent unexpected failures of 1-2 units per year experienced, an average of three units are forecasted to be addressed every year, with two targeted for replacement and possible deferrals anticipated through testing / maintenance.

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6 Underground Cable

London Hydro's underground cable systems are comprised of primary (medium-voltage) and secondary (low-voltage) conductors. This section addresses only underground primary cable.

Underground primary conductor is used to distribute power across the entire London Hydro system at one of four medium voltages: 4.16 kV, 8.32 kV, 13.8 kV and 27.6 kV. The total circuit-km of the primary conductors is 1628 km. The total conductor-km[13] is 2208 km.

There are multiple conductor types from an insulation material standpoint that are collectively discussed in this section. The breakdown of lengths by voltage system where they are deployed is given in Table 6-1. Polymeric cable statistics will be provided in conductor-km throughout the rest of the section.

Table 6-1. Underground Cable by Voltage and Insulation Type

	Circuit-km				Total	Total
Insulation	**4.16kV**	**8.32kV**	**13.8kV**	**27.6kV**	**Circuit-km**	**Cond-km**
PILC[14]	2	0	4	0	**6**	**6**
EPR[15]	0	0	17	9	**26**	**26**
RUBBER	1	0	0	0	**1**	**2**
PE	2	0	0	0	**2**	**2**
XLPE[16]	9	1	0	380	**390**	**489**
TR-XLPE[17]	7	5	0	1190	**1202**	**1682**
Total	**21**	**6**	**20**	**1580**	**1628**	**2208**

From a utilization point of view the following conductor types are covered in this section:

- PILC cable (e.g. downtown and station egress)
- EPR cable (e.g. downtown and station egress)
- Large polymeric cable[18] (e.g. transformer station egress) – this is XLPE or TR-XLPE
- Polymeric cable (e.g. residential / commercial distribution) – this is RUBBER or PE or XLPE or TR-XLPE

[13] Conductor-km length = 3-phase conductors multiplied by 3 (except bundled primary & multi-core cable) + 1-phase conductors
[14] PILC is Paper Insulated Lead Cover
[15] EPR is Ethylene Propylene Rubber
[16] XLPE is Cross-Linked Polyethylene
[17] TR-XLPE is Tree-Retardant Cross-Linked Polyethylene
[18] Large polymeric cable is usually 1000 kcmil AL or 750 kcmil CU (higher ampacity conductors used on system backbone)

The PILC cable (6 circuit-km or cond-km) is primarily used in the downtown 13.8 kV network system which is of major importance since it supplies reliable power to high profile customers. Occasionally, PILC cable can still be found as egress cable at some of the oldest 4.16 kV municipal substations.

The EPR cable (26 circuit-km or cond-km) replaces the 3-conductor PILC cable in a single-conductor bundled cable construction. This cable's design allows London Hydro to replace old PILC cable using the same duct, due to its compact triplex construction at relatively similar current carrying capacity. It is extensively deployed by now for the primary of the downtown network.

Large polymeric cable (164 conductor-km) is used as egress cable from transformer stations mainly in 27.6 kV systems. These large polymeric cables are crucial as they are responsible for supplying entire 27.6 kV circuits that can serve thousands of customers.

Polymeric cable (2011 conductor-km) is largely used by London Hydro to distribute power to residential and commercial customers at various voltage classes. More than 99% of the cable has a 28 kV voltage rating or higher, as 4.16 kV underground conversions in recent years have removed a lot of the lower voltage class cable. It is also estimated that the largest majority of the polymeric cable is 1/0 Al conductor.

6.1 Life Expectancy and Age Distribution

Underground primary cable is assigned various anticipated service life intervals due to different insulation types, as follows:

- 40 years for EPR
- 40 years for PE, RUBBER and XLPE
- 50 years for TR-XLPE
- 65 years for PILC

To determine an FFA plan for polymeric and large polymeric cable, it was considered based on the methodology of the original 2019 ACA, that the likelihood of asset removal at 30 years is 20% and at 50 years is 95%.

Figure 6-1 shows the demographics of the remaining PILC cable in the system. The average age of this cable is 37 years old. For PILC cable, the likelihood of asset removal at 55 years is 20% and at 70 years is 95%.

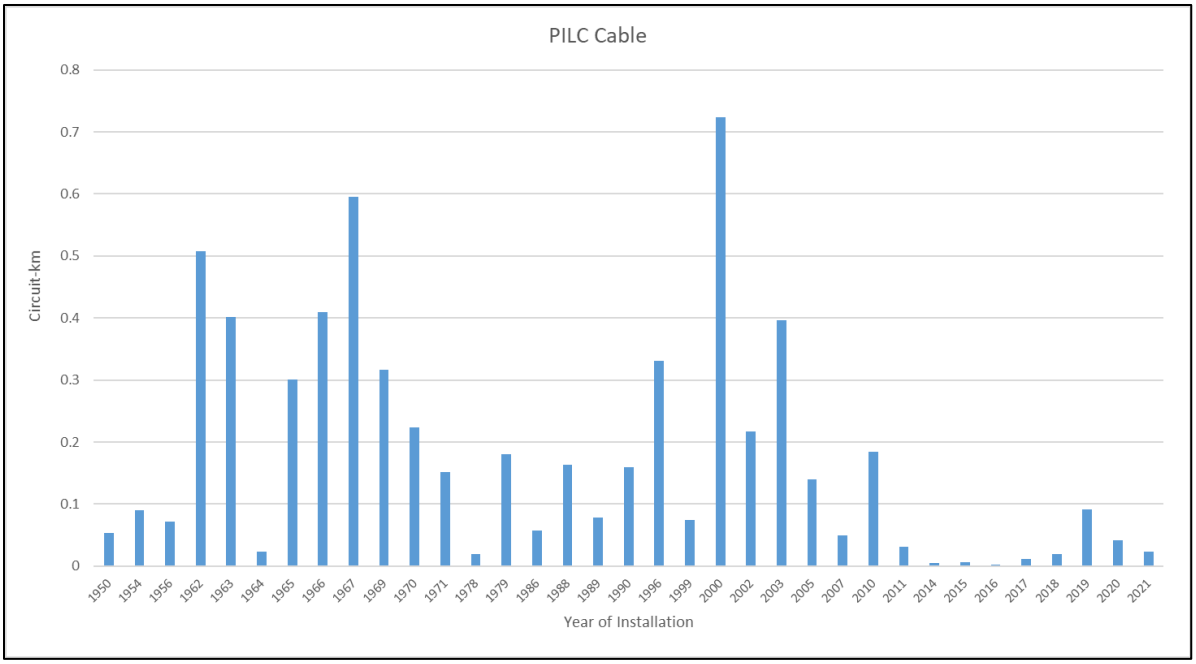


Figure 6-1. Age Distribution of PILC Cable

Figure 6-2 shows the demographics of the EPR cable installed. As indicated earlier, this cable is much newer with an average age of 6 years old.

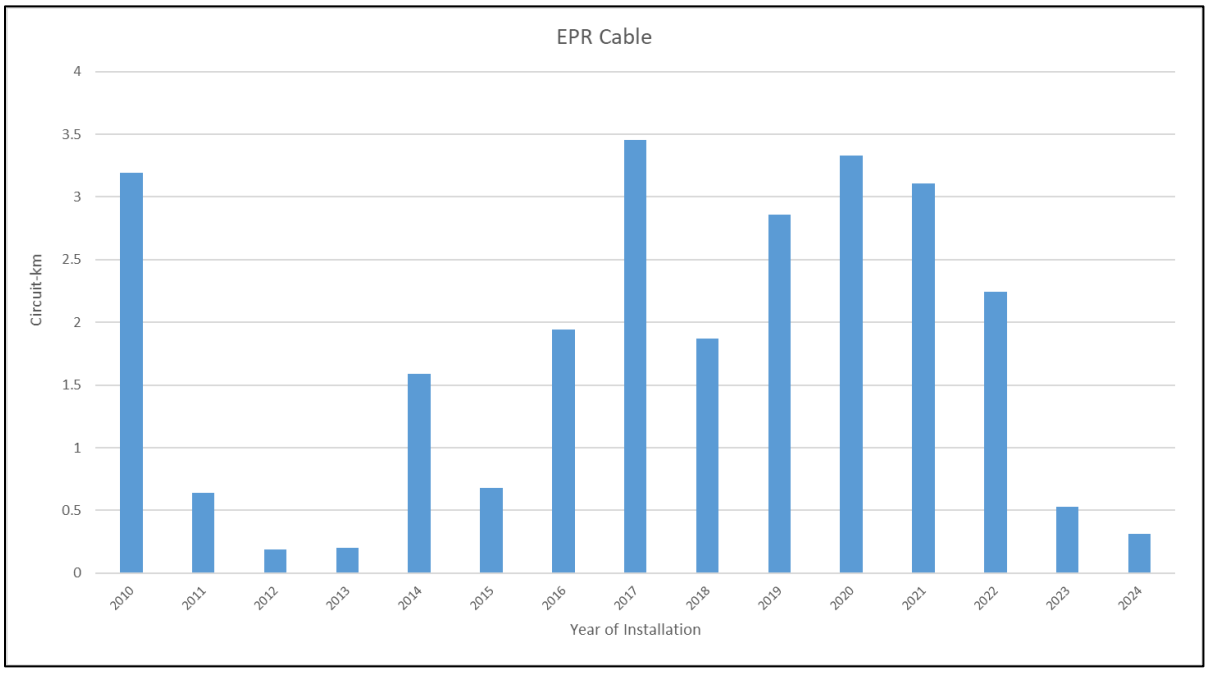


Figure 6-2. Age Distribution of EPR Cable

Figure 6-3 shows the demographics of the large polymeric cable installed. The average age is 15 years old.

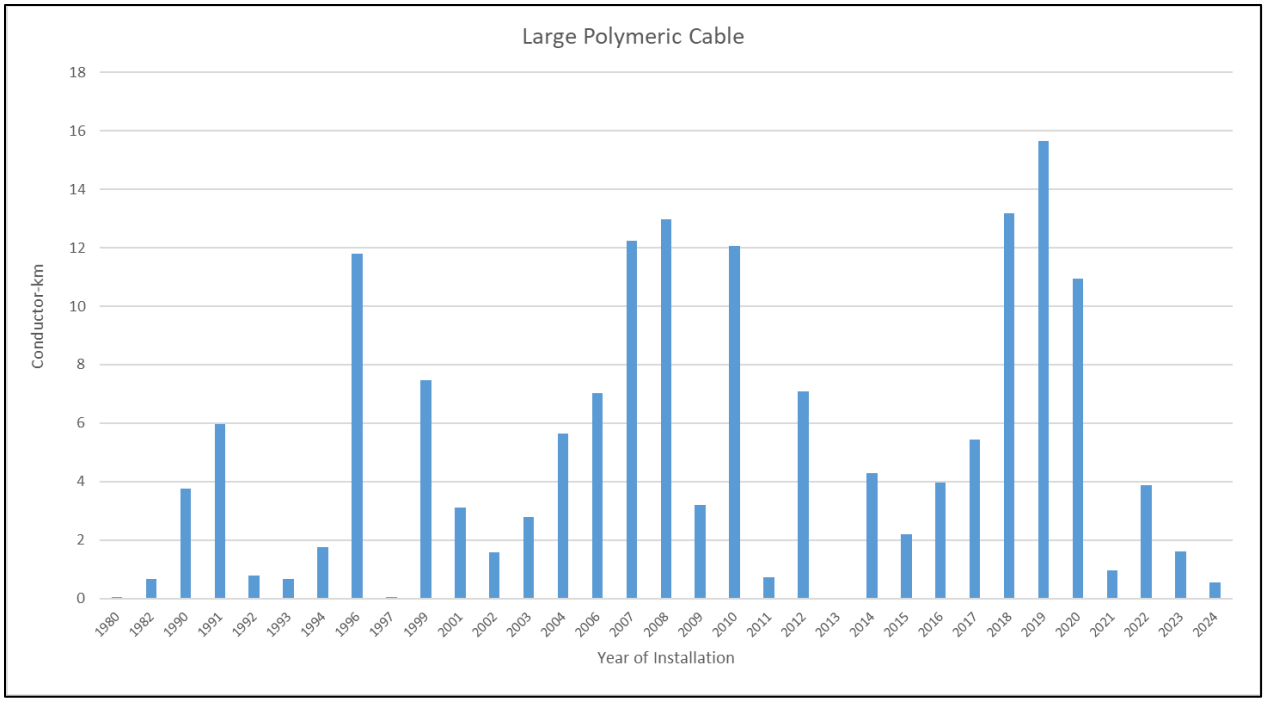


Figure 6-3. Age Distribution of Large Polymeric Cable

Figure 6-4 illustrates the length of polymeric cable used in residential and commercial distribution by year of installation. The average age of this cable is 21 years old.

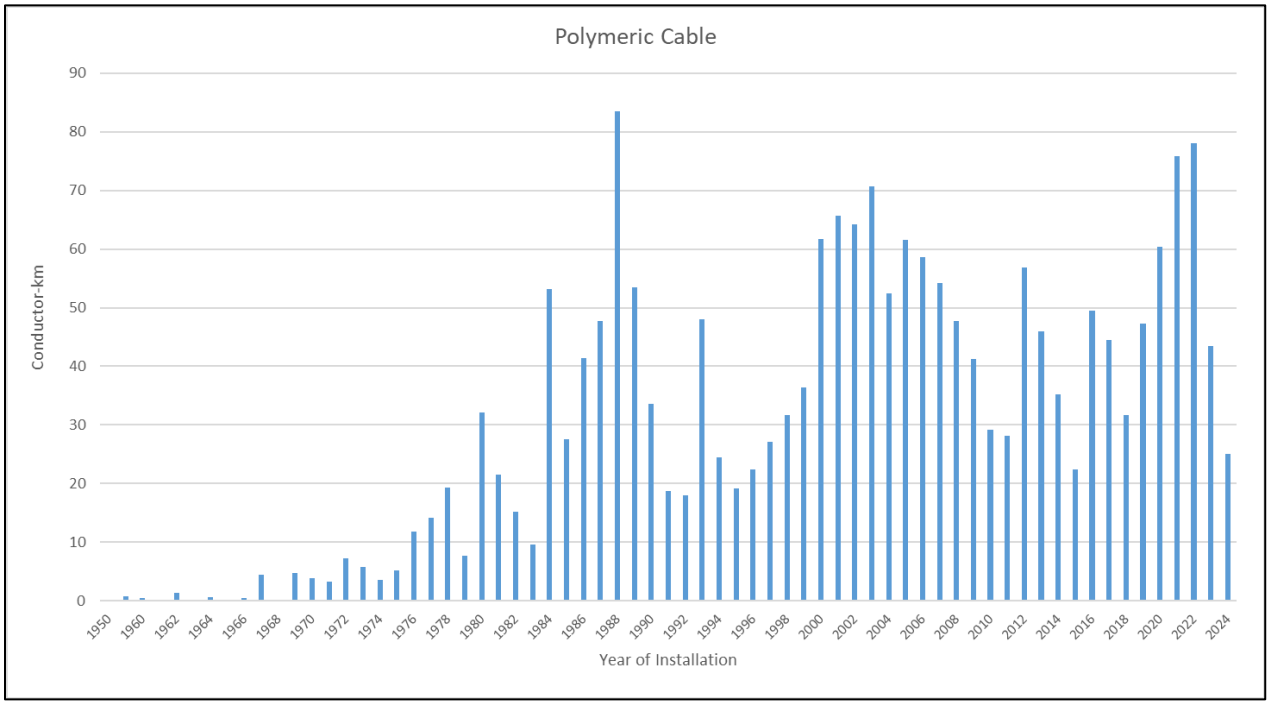


Figure 6-4. Age Distribution of Polymeric Cable

Compared to the previous 2020 ASP, the quality of the asset data for cable in general has improved substantially based on the digitization of very numerous UD drawings[19] that aligned the actual cable routes in GIS to the physical world, and also allowed for the installation year to be available in GIS for all the underground primary cables. Collectively, of all the cable in the system, 8% are past life expectancy and almost 16% will be past the respective threshold in the next 10 years. Long-term cable replacement plans aim to address cable already past life expectancy, as well as address some aging cable approaching end of life, if located in the same geographical neighborhood. Further consideration is also given to neighborhoods that are experiencing a higher rate of cable failure.

6.2 Inspection and Condition

The PILC and EPR cable is located inside duct and maintenance hole systems and cannot be visually inspected (except inside structures or at the equipment interface). The visible portion of the cable is examined for any signs of physical deterioration at the time network transformers and switchgears are inspected. Currently London Hydro does not have a formal testing program for evaluating the condition of these types of cable.

The majority of the large polymeric cable used for egress is also located inside duct systems and cannot be visually inspected (except inside structures or at the equipment interface). Portions of each cable segment are accessible for visual inspection at risers however, and any problems with the condition of cable terminations are normally found during the regular audit of the overhead system.

Polymeric cable in residential and commercial areas, direct buried or in duct, cannot be checked visually along the cable, except for the separable insulated connectors at transformers. Hence, once every three years with transformer inspections, the terminations are examined for signs of tracking, discolouration or neutral corrosion. In addition, any obvious problems with cable risers noticed during overhead system audits (such as a missing cable guard or a damaged terminator) are addressed. Weaknesses or failures of these components could also affect the performance of the cable.

In 2020, London Hydro acquired condition cable testing equipment for insulation diagnostics using the VLF (very-low-frequency) Tan Delta technique. This equipment can perform Tan-Delta (TD) and Partial

[19] UD – Underground Distribution drawings

Discharge (PD) testing to detect dielectric loss and the development of water trees in cable insulation. The VLF testing assembly, as shown in Figure 6-5, is used to test one cable segment between two adjacent transformers at a time. These methods help in evaluating cable condition by identifying and quantifying deteriorated insulation. Cable condition testing enhances the asset condition assessments and helps prioritize cable replacements, targeting areas at most risk of failure.



Figure 6-5. Cable Testing Setup in Residential Subdivisions

At this time, London Hydro conducts cable condition testing in residential subdivisions, testing up to 10 km of polymeric cable per year. So far, approximately 60 km of polymeric cable has been tested since purchasing the equipment in 2020. A plan to resume the testing of large polymeric egress cables based on age and criticality is being developed.

Below is the distribution of the Health Index, based on the 2024 ACA, for each category of cable.

Table 6-2. Condition Assessment of PILC Cable

	Health Index Distribution by Number of Units				
	Very Poor	Poor	Fair	Good	Very Good
Quantities	(<25%)	(25% - <50%)	(50% - <70%)	(70% - < 85%)	(>=85% - 100%)
Circuit-km and Cond-km	0.2	0.9	0.7	1.1	3.2
Percentage	3%	15%	11%	18%	52%

Table 6-3. Condition Assessment of EPR Cable

Quantities	Health Index Distribution by Number of Units				
	Very Poor	Poor	Fair	Good	Very Good
	(<25%)	(25% - <50%)	(50% - <70%)	(70% - < 85%)	(>=85% - 100%)
Circuit-km and Cond-km	0	0	0	0	26
Percentage	0%	0%	0%	0%	100%

Table 6-4. Condition Assessment of Large Polymeric Cable

Quantities	Health Index Distribution by Number of Units				
	Very Poor	Poor	Fair	Good	Very Good
	(<25%)	(25% - <50%)	(50% - <70%)	(70% - < 85%)	(>=85% - 100%)
Cond-km	0	0.6	2.5	0.6	160
Percentage	<1%	<1%	2%	<1%	98%

Table 6-5. Condition Assessment of Polymeric Cable

Quantities	Health Index Distribution by Number of Units				
	Very Poor	Poor	Fair	Good	Very Good
	(<25%)	(25% - <50%)	(50% - <70%)	(70% - < 85%)	(>=85% - 100%)
Cond-km	112	162	199	9	1529
Percentage	6%	8%	10%	<1%	76%

The average Health Index of the PILC cable is the lowest among all cable types at 83%, however, the 18% of cable segment in very poor and poor health condition represents only 1.1 km of PILC cable. For EPR, the Health Index is 100%. The large polymeric cable has an average Health Index of 98% and the polymeric cable used in residential / commercial distribution has an average Health Index of 85%. Globally, the Health Index averages 87% across all cable types since the polymeric cable dominates in terms of quantity.

Figure 6-6 presents the underground cable length according to the year of installation and the associated Health Index.

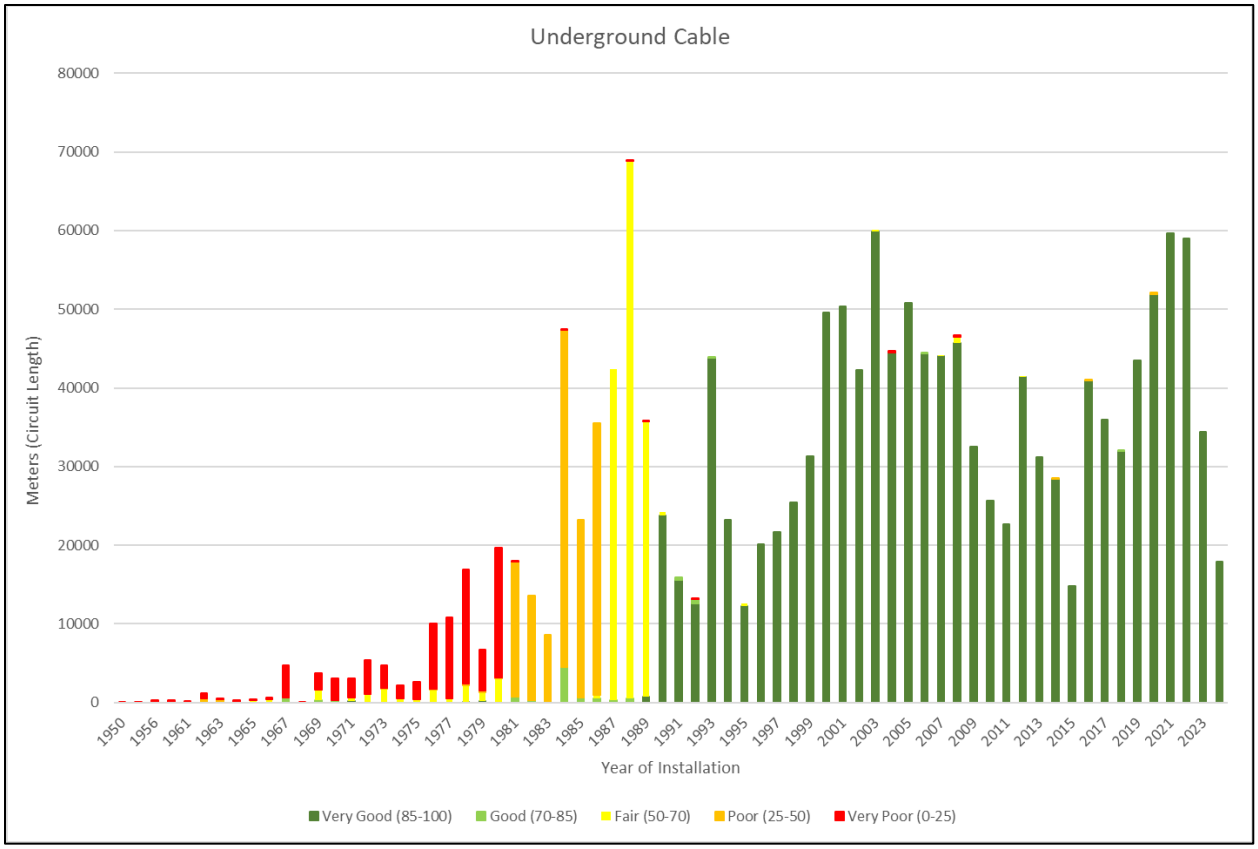


Figure 6-6. Health Categories of Underground Cables

The map in Appendix E illustrates the geographical distribution of the underground cable by Health Index, according to the data tabulated above.

6.3 Risk Assessment

In the past London Hydro has been experiencing a significant number of faults on PILC cable but since the drastic reduction in the use of this cable on the system, very few faults creating a power outage have been reported (only three outages due to PILC cable in the last five years). Also, no failures have been experienced on EPR cable and this cable is considered in very good condition. In addition, the design of the downtown network secondary system offers a contingency supply so that a PILC or EPR cable fault on one or even two 13.8 kV feeders does not always result in an interruption of supply to network customers.

A safety risk associated with downtown cable faults are potential explosive failures in the maintenance holes. The pressure from the high energy released during a fault can cause the maintenance hole lid to be blown into the air, posing a danger to pedestrians and vehicles. In response, London Hydro has implemented a safety measure, using explosion-mitigating circular cast iron maintenance hole covers

(Burrloc) for installation under sidewalks and roadways. Over 600 such maintenance hole lids have been installed throughout the city, out of which 328 are in the downtown area, covering 95% of the maintenance holes in this core area of the city. The budget has been re-introduced to install more covers outside of downtown, which measure also limits access to the structure by the public to prevent theft.



Figure 6-7. Explosion Proof Cover

Large polymeric cable, with nearly 98% of the population currently in very good condition, has only experienced two faults in the last ten years. The amount of this cable used in the system is limited and the cable is considered much younger on average compared to the polymeric cable used in subdivisions. However, given the criticality of this cable as it can serve thousands of customers, and with 2% of the population already in fair condition, routine monitoring and enhanced condition assessments should be in place to effectively assess the cable as it continues to age.

As mentioned in the previous section, a number of techniques are available for testing the insulation dielectric integrity of medium voltage cables. London Hydro initiated a program a few years ago to test large size polymeric cable, based on age and criticality, and this will resume on a more routine basis as a second set of VLF condition cable testing equipment has been acquired this year. Ultimately, any section of egress cable that would score poorly during condition cable testing would be addressed as necessary to alleviate any risks from large scale outages that affect entire feeders.

On the other hand, failures of polymeric cable in residential and commercial subdivisions are the most numerous and accounting for the majority of the reliability impact demonstrated below. A sample of a typical cable failure on polymeric (subdivision) cable is depicted in Figure 6-8.



Figure 6-8. Cable Failure (XLPE)

The failure impact from all cable faults is presented in Figure 6-9. In the past ten years, the count of faults is slightly up (approximately 20%), based on a three-year moving average of the number of cable faults (the red dash line on the graph). Year 2023 particularly represents an outlier due to multiple faults occurring at the same location, after which the fault count has returned to historical levels. This trend may continue to be experienced as the current replacement rates hardly keep up with cable aging every year. At an average number of 16 interruptions due to cable faults per year, approximately 6,500 customer hours of interruption (or over 390,000 customer minutes of interruption) occur every year due to this cause. This represents nearly 7% on average of overall yearly SAIDI (excluding Loss of Supply and Major Event Days), and 25% of the equipment failure related SAIDI on average. The reliability trend is carefully monitored. The risk of customer dissatisfaction also increases if cables remain in service long past their expected average life span, and sudden and frequent failures occur in a short timeframe before the aged cable is addressed.

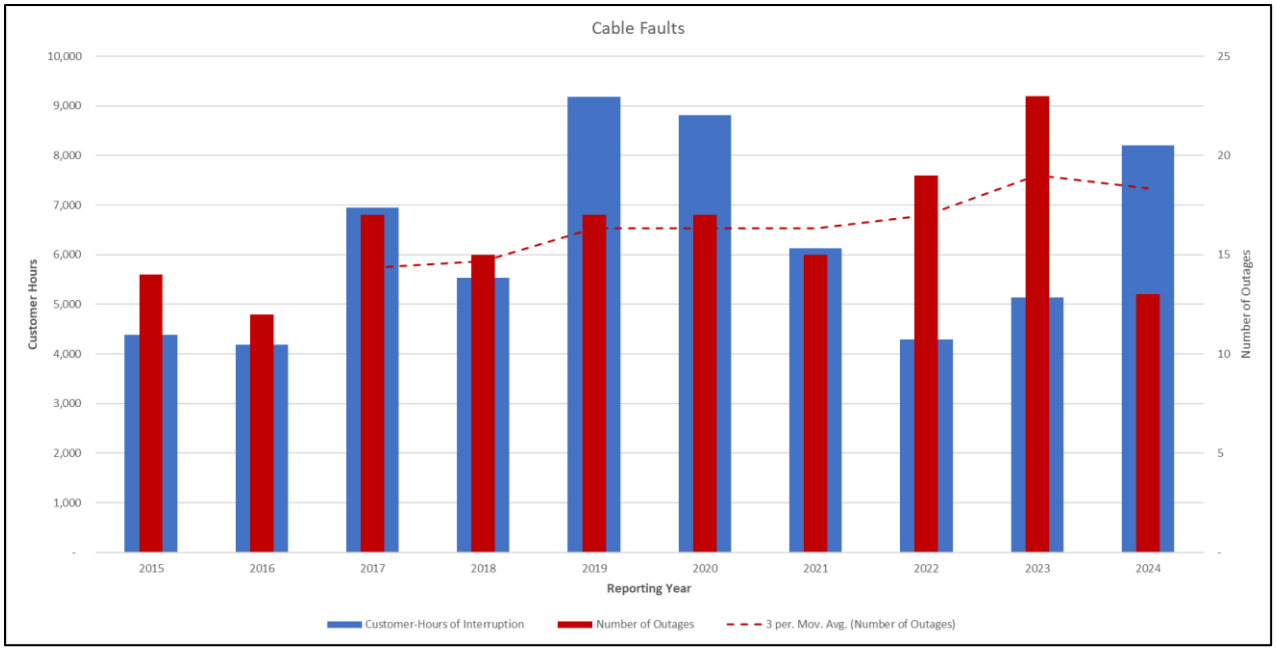


Figure 6-9. Failure Impact from Cable Faults

Figure 6-10 depicts the cumulative number of cable failures experienced historically (the blue line), according to the time to failure (age of cable when it experienced a fault), and the associated total number of customers affected from all cable failures of that age (the orange bar chart). The number of cable faults increases significantly once the cable reaches 30 years in service (based on the three-year moving average – the blue dotted line), which is 75% through its life expectancy.

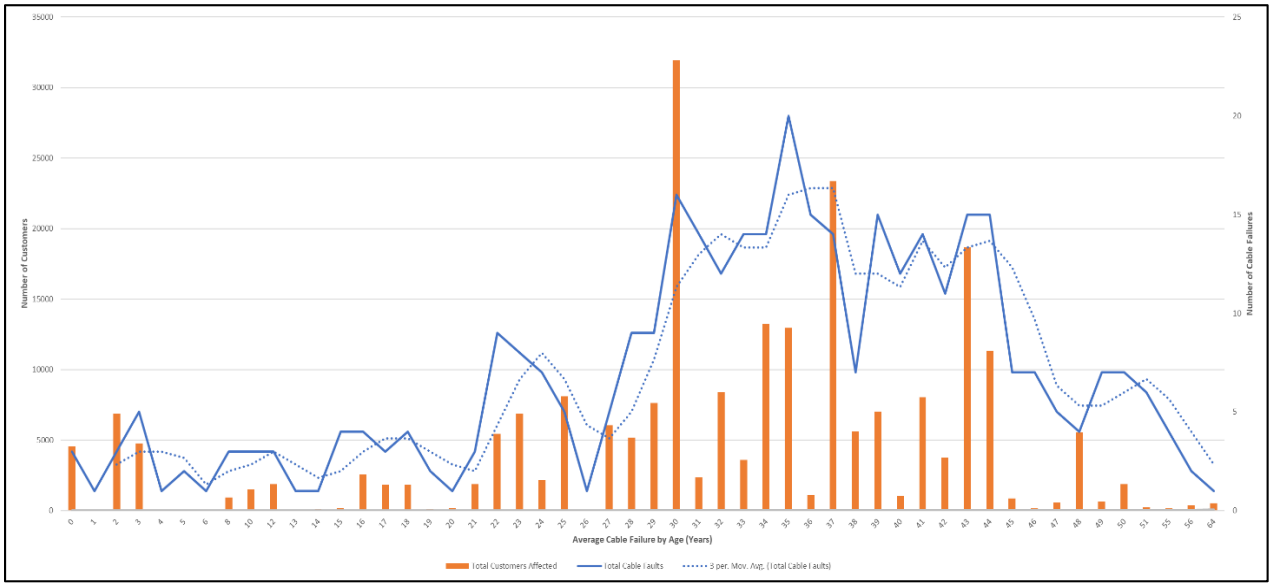


Figure 6-10. Failure Impact from Cable Faults by Cable Vintage

While there is a noticeable decline in the number of cable failures for cable aged at 50+ years old, this is due to the fact that there is significantly less of this cable vintage left in the system compared to cable 30-50 years of age. However, the performance of cable over 50 years of age has been determined to have a failure rate of 60% higher than that of cable between 30-50 years of age. Based on failure data from the last decade, there were 0.37 cable faults per 10 km of cable over 50 years of age, compared to 0.23 cable faults per 10 km of cable between 30-50 years old. The oldest cable in the system is operating with a much higher risk of failure, and therefore this population should be addressed promptly to avoid further reliability decline for customers.

Table 6-6. Failure Rate of Polymeric Cable by Vintage

Failure Rate of Cables (number of cable faults) per 10 km		
<=30 years old	>30 years old and <= 50 years old	50+ years old
0.02	0.23	0.37

Of the polymeric cable used in residential and commercial supply (2011 conductor-km), approximately 275 km (close to 15%) are in very poor or poor condition according to the 2024 ACA. This is represented by cable that is in the upwards of 40 years or older, and this end-of-life demographic should not remain in the system for too long, as additional cable will join these health categories in the following years as cables continue to age. London Hydro should avoid a growth in the backlog of aged and/or deteriorate cable that needs to be replaced at once. An important risk to be mindful of is that an additional 200 km of cable are in fair condition (approximately 35+ years old) and they will move to very poor or poor in the next 5-year planning horizon for a total of 475 km. Almost all of this cable is XLPE.

Starting with year 1990, London Hydro's standard changed from XLPE to TR-XLPE insulation and the life expectancy increased significantly (estimated at 50 years). Therefore, if most of the XLPE cable were to be replaced over a 15-year period, this would coincide with the first cohort of TR-XLPE cable just reaching end of life expectancy (approx. year 2040). A 15-year proposed plan to replace all 475 km of XLPE cable, that is presently in very poor, poor or fair condition, equates to a replacement rate of a minimum of 32 km of cable per year (475/15). Given the existing, significant quantity of aged cable in London Hydro's distribution system, replacing any less than 32 km (i.e. 28 km) of very poor / poor cable per year can increase the overall system SAIDI and SAIFI by 2.5% compared to present day. At the proposed rate of a minimum of 32 km of very poor / poor cable per year (which will eliminate almost all XLPE in a 15-year timeframe), yearly SAIDI and SAIFI is still projected to increase slightly by 2% compared to present day in the near term before seeing a reduction. In order to maintain the current rate of cable faults on underground polymeric cable per year,

up to 46 km of cable needs to be replaced per year, which is corresponding to the FFA amount (next subsection). London Hydro can continue to target the replacement of a minimum of 32 km of very poor and poor cable per year, and continue to test annually in order to prioritize the most deteriorated subdivisions for replacements. This is recognizing that maintaining a levelized and balanced rate of annual cable replacements may result in slightly more cable faults in the near term before getting better.

London Hydro is very committed to continue to address subdivision polymeric cable past end of life with adequate capital budgets. Cable continues to be replaced in priority sequence based on a combination of wider elements that include cable age, condition, and number of cable faults normalized by subdivision total cable length. This approach prioritizes subdivisions at greatest risk and improves reliability and power quality for customers.

In the case of three-phase radial customer supply however, there is an additional risk of outages being significantly prolonged due to having the whole cable out for repairs, and not being able to restore power until the repairs are complete. Also, any repeat outages on a cable already weakened by faults could mean multiple interruptions lasting very long hours for the same customers, unless these cables are proactively addressed. In recent years, London Hydro allocated a separate capital budget for the replacement of three-phase supplies, which power commercial customers throughout the city, as well as residential apartment buildings. The commercial customer segment is of great importance to the economics of the City of London, and London Hydro will continue to budget capital resources where appropriate to address aged or underperforming assets supplying these customers.

This risk of prolonged interruption duration for radial customers, and increased frequency of power quality voltage sag events to all customers, also extends to the very small single-phase residential supplies spread throughout the city that fall outside of designated subdivision areas. As London Hydro works towards the elimination of all XLPE cable throughout the next 15 years, these scattered feeds will also need to be addressed.

6.4 Asset Sustainment Strategy

Currently, London Hydro follows a ‘run to failure’ approach for all PILC cable, unless there are coordination opportunities with new civil infrastructure such as maintenance holes, at which time the PILC cable is stripped back to the adjacent maintenance holes, and new EPR cable is installed in place of the PILC. This

cable is still in use at 4.16 kV municipal substations and it is removed when the 4.16 kV conversion is completed (ex. SUB-17 and SUB-22 were decommissioned in 2024 and the PILC egress was removed). The EPR cable used as substitute for PILC has worked well and continues to remain the primary choice for emergency replacement of PILC cable when it fails. Based on the Flag-for-Action plans published in the 2024 ACA, no PILC or EPR replacements are forecasted over the planning horizon.

Large polymeric cable may require a very small quantity to be addressed in the future horizon based on its condition. Given the criticality of the egress feeders, a levelized 0.5 km of cable replacement annually is included in this report. Station egress cables are in general fairly short in length, so in the future, if condition cable testing would indicate a cable's dielectric strength is compromised, the cable would simply be replaced.

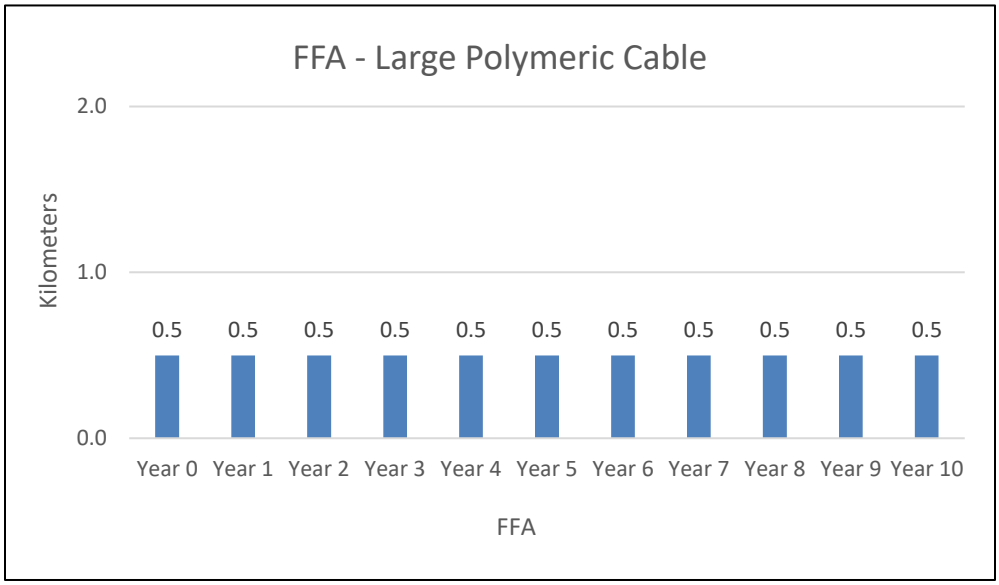


Figure 6-11. FFA Rate for Large Polymeric Cable

Many years ago, London Hydro's approach to polymeric cable rehabilitation in subdivisions changed to a full replacement instead of silicone injection, due to the mixed results of the previous process and increased costs. The full rebuild of subdivisions not only introduces brand new TR-XLPE cable replacing the old XLPE which has a shorter life expectancy, but also eliminates traditional backyard supply changing it to modern, front-yard, in-duct construction that will make future replacements and repairs much easier. It also reduces patrolling effort by not needing to go into backyards, hence outage time during the failure of a cable or transformer is reduced. The new standards associated with a full rebuild better position a subdivision to be ready for anticipated load increases due to electrification and decarbonization.

With respect to medium voltage cables that supply commercial customers, rehabilitation plans were previously driven based on cable failures, with full rebuilds proposed after a cable exhibited multiple failures. While most commercial cable feeds serve only one customer, and therefore the impact to London Hydro's overall reliability would be minimal, the impact of power loss can be significant depending on the type of customer. Increasing numbers of businesses are facing losses directly due to power interruptions, or indirectly due to the related voltage sags that may result in customer facility interruptions. For this reason, a few years ago London Hydro initiated a small program to replace three-phase underground supply to some of the commercial customers where the transformer was also at the end of life. The financial efficiencies are drastically reduced when mobilizing directional drill equipment for short sections of duct and cable systems. As such, very few customers benefit from such upgrades compared to similar investments done in the larger residential subdivision areas. Nevertheless, London Hydro recognizes that commercial and industrial customers have expectations for high levels of reliability, and aged assets at risk of failure cannot remain in the system indefinitely. As well, there are efficiencies to mobilizing once to replace both primary cable and transformers servicing commercial customers and reducing the number of planned interruptions to their operations. Therefore, the quantity of three phase cable replacement will be increased in the following years to address deteriorated or underperforming three-phase supplied areas, aligning with the level of service that customer's value/expect.

The reduced financial efficiencies that occur with shorter cable section replacements also applies to the rehabilitation of the small single-phase radials that are scattered throughout the city, feeding residential homes, and that are not part of larger underground supplied subdivisions areas. While these feeds could supply more than one customer, in contrast to commercial feeds, the customer interruptions from these cable failures may not adversely affect London Hydro's overall reliability. Prolonged interruption durations and high interruption frequencies for these households can become detrimental with post-COVID work-from-home practices for small business owners operating from their own home, for example. Furthermore, the impact of cable failures can affect other commercial and industrial customers on the same feeder or those fed by the same Bus at the Transformer Station due to the momentary interruption and power quality event (ex. voltage sag) that occurs following a cable fault. London Hydro will introduce a new program targeting deteriorated or underperforming single-phase radial underground systems that would not be targeted under any existing capital replacement programs.

Based on the recent 2024 cable condition assessment, London Hydro should plan to address, on average, 46 conductor km of polymeric cable each year over the next ten years, combined single and three-phase. This represents a balanced annual replacement level averaged over the 10-year period in order to efficiently meet the annual FFA quantities as indicated in Figure 6-12. With the findings from condition cable testing sampled in various subdivisions, replacements can be prioritized to areas with highest risk of failure. London Hydro should continue to replace the minimum very poor and poor cable quantities while being mindful that deferrals of cable replacement now will result in a significant accumulation of end-of-life cables in future years. This will correspondingly drive up the number of failures due to having an even higher population of cables at the highest risk of failure rate, leading to decreased overall system reliability. Furthermore, future investments will be less manageable as large swings in expenditure will be required in future years to deal with the backlog, and overall costlier as planned replacements are less expensive and easier to coordinate compared to unplanned replacements required after repeated failures. It is necessary to re-iterate that addressing 46 km of polymeric cable per year does not imply replacement of the whole length, as some condition cable testing will count towards the target quantity addressed.

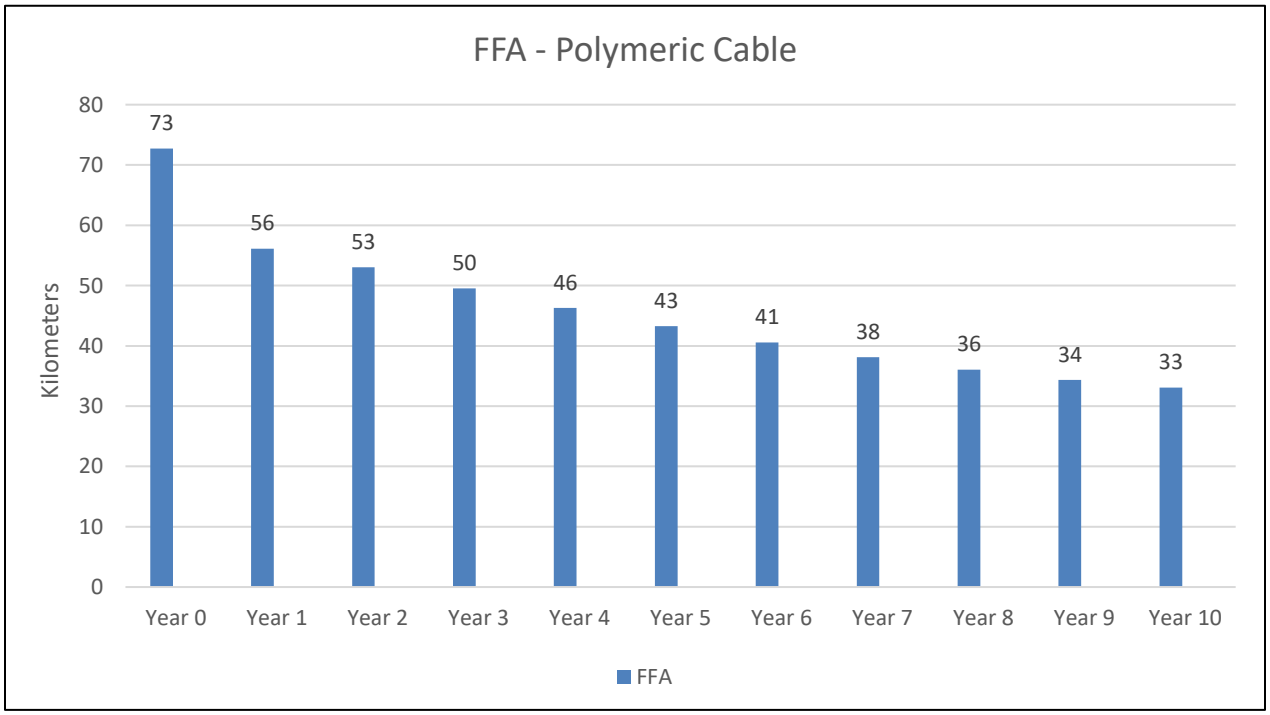


Figure 6-12. FFA Rate for Polymeric Cable

7 Maintenance Hole

There are 1028 maintenance holes in-service on London Hydro's system. Maintenance holes are one of two civil structure types, the other ones are vaults and they are discussed separately in Section 8. Maintenance holes are some of the oldest assets still in service, a few having lasted 90+ years since their original year of installation. Most of these structures are concentrated in the downtown area but there are some scattered in many parts of the city.

7.1 Life Expectancy and Age Distribution

Maintenance holes are assigned 80 years as anticipated service life based on best industry practice and empirical data. Approximately 3% (or 31 units) are past this threshold already, with another 4% (or 43 units) reaching it in the next 10 years. To determine an FFA plan, it was considered based on the methodology of the original 2019 ACA, that the likelihood of asset removal at 75 years is 20% and that at 95 years the likelihood of removal is 95%.

As a result of historical replacement deferrals based primarily on visual inspection results, London Hydro has a number of underground civil assets long exceeding 80 years, with some approaching 100 years old. To address increasing uncertainty regarding long-term performance, London Hydro retained an independent structural engineering firm (AECOM) in 2025 to assess the maximum safe service life of 61 concrete and masonry maintenance holes over 75 years of age.

The purpose of this assessment was to evaluate the extent to which replacement of these assets could continue to be prudently deferred, taking into account potential latent material degradation not readily observable through routine inspections. Based on field condition assessments, AECOM determined a maximum service life of 100 years for concrete structures[20] and 75 years for masonry structures. Notwithstanding these findings, AECOM noted that the practical service life of individual structures may vary materially depending on site-specific factors, including exposure to corrosive de-icing salts, traffic-induced loading, and local environmental conditions.

[20] Including concrete vaults

Roof slabs and associated chimneys do not last as long as the actual structure itself, and correspondingly many roof slabs have been replaced in the last 10-15 years for safety reasons.

The distribution of the year of installation for the maintenance holes is plotted in Figure 7-1. The average age is 35 years old and the oldest maintenance hole in the system is currently 97 years old.

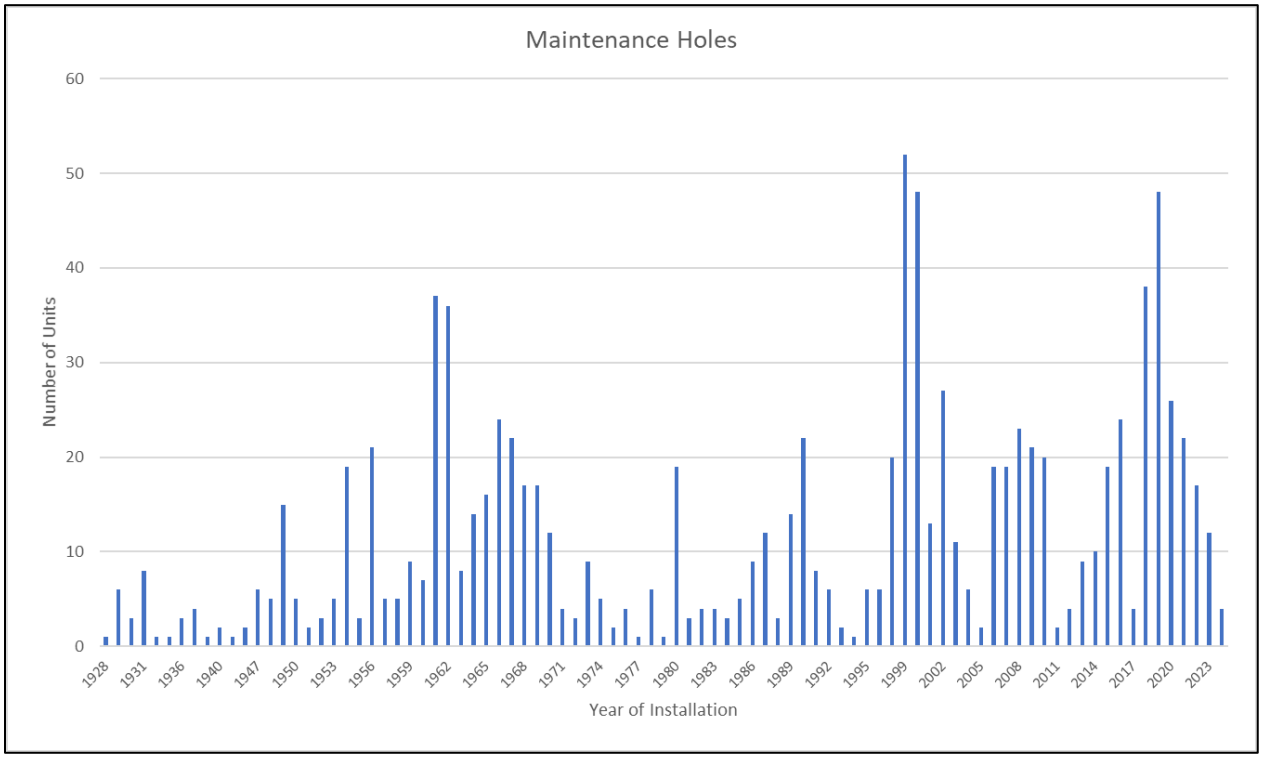


Figure 7-1. Age Distribution of Maintenance Holes

7.2 Inspection and Condition

London Hydro has implemented an internal inspection program to assess each maintenance hole at least once every five years. The inspection checklist covers various aspects, including the condition of the walls, floor, roof slab, as well as the operability of the fault limiters. London Hydro creates panoramic videos of the interior of each maintenance hole (Figure 7-2), capturing new images during inspections or when cable arrangements are modified. These images are linked to the GIS system, helping to confirm existing feeder routes, plan new ones, or provide a general view of the structure.

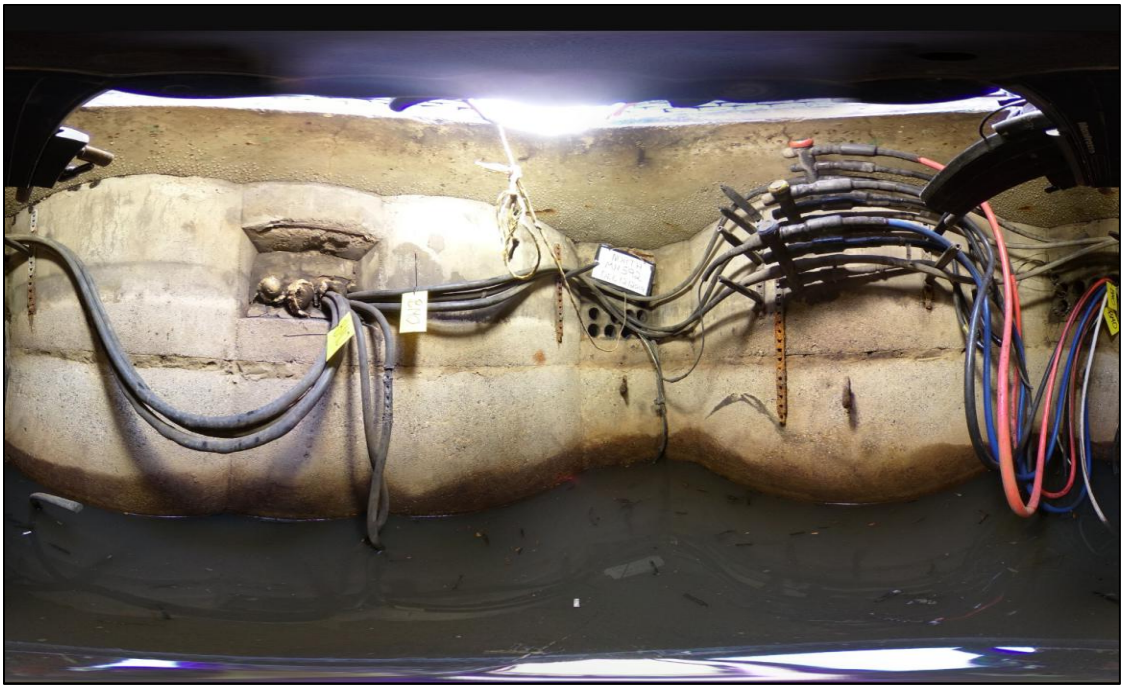
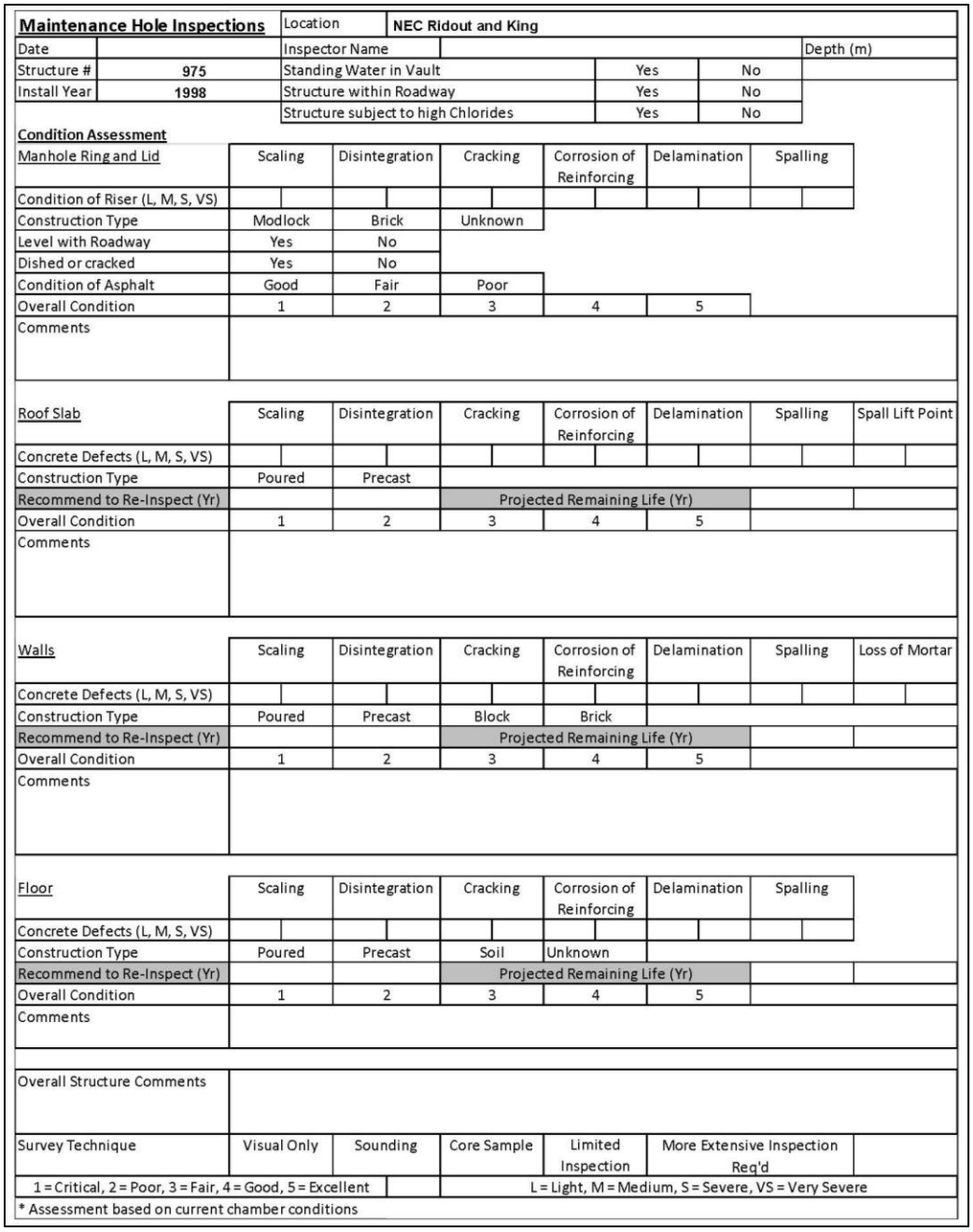


Figure 7-2. Interior View of a Maintenance Hole

For more than one decade now London Hydro has been hiring civil engineering consultants to inspect a certain number of structures annually. Initially, a five-year inspection cycle had been recommended for all civil structures, but a new schedule was recently being developed based on updated recommendations. The inspection cycle now incorporates a risk category (high risk for road structures, low risk for boulevard structures), alongside a condition ranking system (1 to 5, with 1 being the worst). Over the past five years, an average of 150 maintenance holes were inspected annually. The condition data gathered by the civil engineers is analyzed internally to determine which units need replacement, refurbishment or re-inspection.

The inspection checklist used by the consulting engineers is depicted in Figure 7-3.



Maintenance Hole Inspections

Location	NEC Ridout and King				
Date		Inspector Name			Depth (m)
Structure #	975	Standing Water in Vault	Yes	No	
Install Year	1998	Structure within Roadway	Yes	No	
		Structure subject to high Chlorides	Yes	No	

Condition Assessment

Manhole Ring and Lid	Scaling	Disintegration	Cracking	Corrosion of Reinforcing	Delamination	Spalling
Condition of Riser (L, M, S, VS)						
Construction Type	Modlock	Brick	Unknown			
Level with Roadway	Yes	No				
Dished or cracked	Yes	No				
Condition of Asphalt	Good	Fair	Poor			
Overall Condition	1	2	3	4	5	
Comments						

Roof Slab	Scaling	Disintegration	Cracking	Corrosion of Reinforcing	Delamination	Spalling	Spall Lift Point
Concrete Defects (L, M, S, VS)							
Construction Type	Poured	Precast					
Recommend to Re-Inspect (Yr)			Projected Remaining Life (Yr)				
Overall Condition	1	2	3	4	5		
Comments							

Walls	Scaling	Disintegration	Cracking	Corrosion of Reinforcing	Delamination	Spalling	Loss of Mortar
Concrete Defects (L, M, S, VS)							
Construction Type	Poured	Precast	Block	Brick			
Recommend to Re-Inspect (Yr)			Projected Remaining Life (Yr)				
Overall Condition	1	2	3	4	5		
Comments							

Floor	Scaling	Disintegration	Cracking	Corrosion of Reinforcing	Delamination	Spalling
Concrete Defects (L, M, S, VS)						
Construction Type	Poured	Precast	Soil	Unknown		
Recommend to Re-Inspect (Yr)			Projected Remaining Life (Yr)			
Overall Condition	1	2	3	4	5	
Comments						

Overall Structure Comments						
Survey Technique	Visual Only	Sounding	Core Sample	Limited Inspection	More Extensive Inspection Req'd	
1 = Critical, 2 = Poor, 3 = Fair, 4 = Good, 5 = Excellent		L = Light, M = Medium, S = Severe, VS = Very Severe				

* Assessment based on current chamber conditions

Figure 7-3. Contractor Inspection Checklist – Maintenance Holes

The asset condition assessment performed in 2024, which incorporates the year of installation and contractor inspection results, places the condition of the maintenance holes as indicated below (Table 7-1). The average Health Index is 90%. A map illustrating the geographical distribution of the maintenance holes according to their Health Index can be found in Appendix F.

Table 7-1. Condition Assessment of Maintenance Holes

	Health Index Distribution by Number of Units				
	Very Poor	Poor	Fair	Good	Very Good
Quantities	(<25%)	(25% - <50%)	(50% - <70%)	(70% - < 85%)	(>=85% - 100%)
Units	0	21	40	253	714
Percentage	0%	2%	4%	25%	69%

7.3 Risk Assessment

As maintenance holes age and deteriorate, the risk to public and employee safety increases due to the potential for collapse. While maintenance hole problems usually don't affect system performance, London Hydro has previously experienced outages caused by nearby water main damage compromising a structure. A well-maintained structure is less likely to collapse during a water main break than one in poor condition. To mitigate this risk, London Hydro sometimes "condemns" a deteriorated structure, preventing its use until it can be restored or improved for safety.

Historically, maintenance holes have been rebuilt based on civil assessments, typically rebuilt in place but occasionally relocated. They are primarily used for primary and secondary cables in downtown areas, with communication wires and hardware often sharing the same duct system.

Ever since the original assessment done by civil engineers in 2012[21], London Hydro has mainly followed a process of refurbishment, either replacing a roof slab or prolonging the life of a maintenance hole through partial reconstruction (ex. shoring). This process has effectively extended the life of many structures, but at the same time allowing them to reach a very old physical age with currently 20 units in excess of 90 years old. London Hydro is assessing the risk of on-going refurbishments and will develop a plan to tackle the full replacement of a subset of the maintenance holes that are significantly past life expectancy and approaching the maximum service life. This aims to effectively remove these structures from the system before the risk of failure suddenly increases, and levelize spending over the coming years to avoid increasing the backlog of deteriorated assets.

[21] Summary Report of Structures Inventory – Maintenance Holes and Network Transformer Vaults (Phase 1 – 2012) - AECOM

7.4 Asset Sustainment Strategy

London Hydro conducts regular inspections to assess condition and identify maintenance holes that need reinforcement or rebuilding. Based on the civil engineer's annual recommendations, part of the capital budget is set aside for repairs such as replacing roof slabs, fixing walls, or fully rebuilding a structure as necessary.

Rebuilding a maintenance hole at the same location can be far more expensive than new construction. However, in some cases, London Hydro can relocate the structure and the associated ducts, replacing the deteriorated structure at a lower cost. Cost efficiencies arise when the City of London replaces deep services under the roadway, which was seen with the maintenance hole rebuilds along Dundas St. a few years ago. In most cases though, maintenance holes are rebuilt one at a time, with construction occurring around existing cables while the old structure is removed. This report does not address the need to eventually replace entire aged duct systems between old or new maintenance holes.

Figure 7-4 illustrates the number of maintenance holes to be addressed over the next ten years, due to a combination of condition and age, as per the 2024 ACA report. AECOM's final report[22] recommended a 10-Year work plan in which, of the 61 maintenance holes currently over 75 years of age and assessed as being in fair or poor condition, 18 are proposed for minor rehabilitation or enhanced monitoring, and 43 are proposed for replacement. All assets will continue to be monitored to ensure they remain safe for continued service.

Excerpt from AECOM's report:

"In general, it is highly recommended that structures be replaced before their end of service life regardless of the condition rating. The visual inspection review and assigned condition rating does give a reasonable assessment on the condition of the structure but cannot account for unknowns not assessed in the review. The exterior of the structure cannot be reviewed as well as the internal condition of the structural elements including the embedded reinforcing steel. As age of structure increases, the risks of unknowns and hidden deterioration increases. These risks could lead to catastrophic failure of the structure over a short period of time."

[22] Condition Assessment Report 2025 Maintenance Holes and Vault Chambers – November 2025 (AECOM)

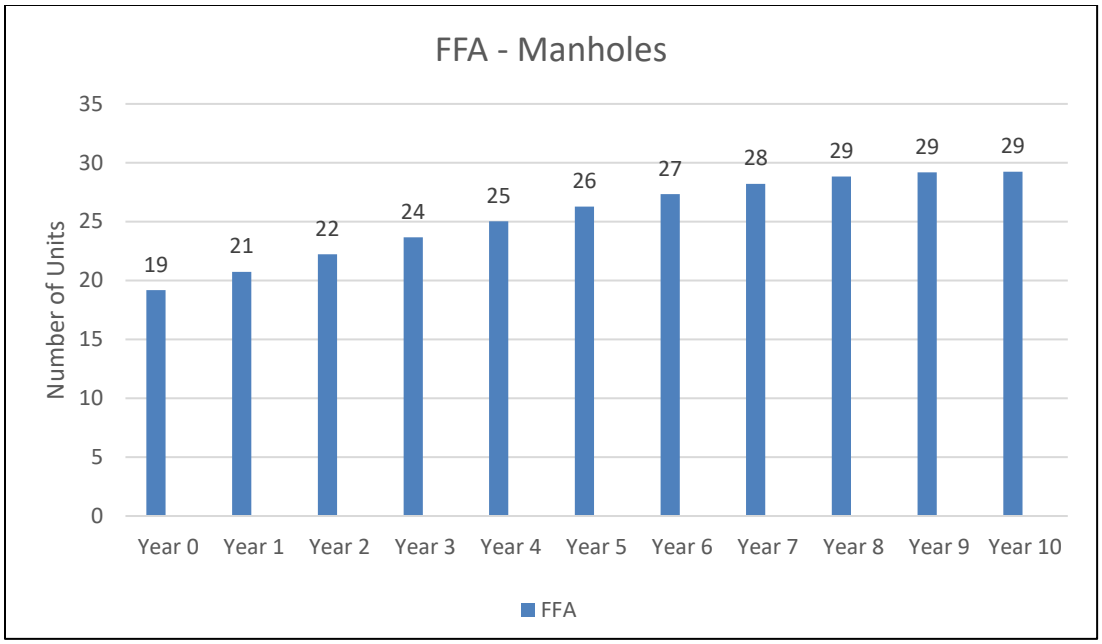


Figure 7-4. FFA Rate for Maintenance Holes

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8 Vault

There are 67 vaults in-service on London Hydro's system. These vaults are housing network transformers and are the other type of civil structure beside maintenance holes, but mostly found in the downtown area.

8.1 Life Expectancy and Age Distribution

Vaults are assigned 80 years as anticipated service life, based on best industry practice and empirical data. Approximately 4% (or three units) are past this threshold already, with another 4% reaching it in the next 10 years. A similar approach to an updated anticipated maximum service life of 100 years extends to concrete vaults as mentioned in Section 7.1. There are additional vault components beside the structure itself, like access and ventilation grates, ladders, lighting and sump pumps; these do not make the subject of this report because of their relatively minor financial value.

Figure 8-1 below illustrates the distribution of the year of installation for the 67 vaults London Hydro has on its system. While there are few vaults in service installed as early as the 1930's and 1940's, it is noticeable that a higher number were installed in the 1950's. The on-going condition of these structures, together with the maintenance holes, is monitored carefully. The average age of London Hydro's vaults is 47 years.

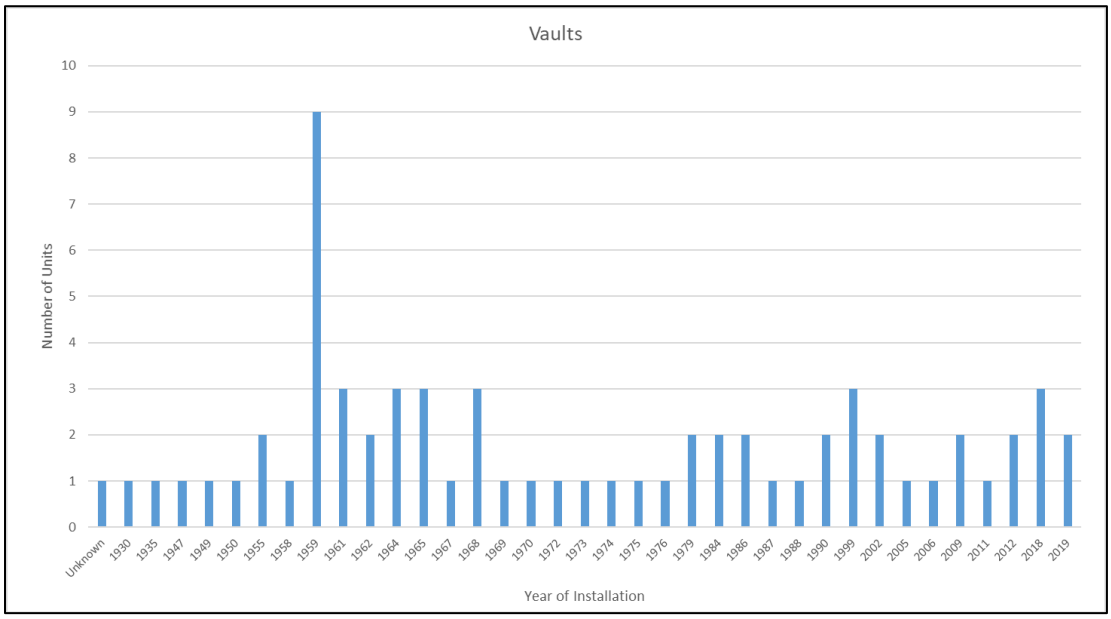
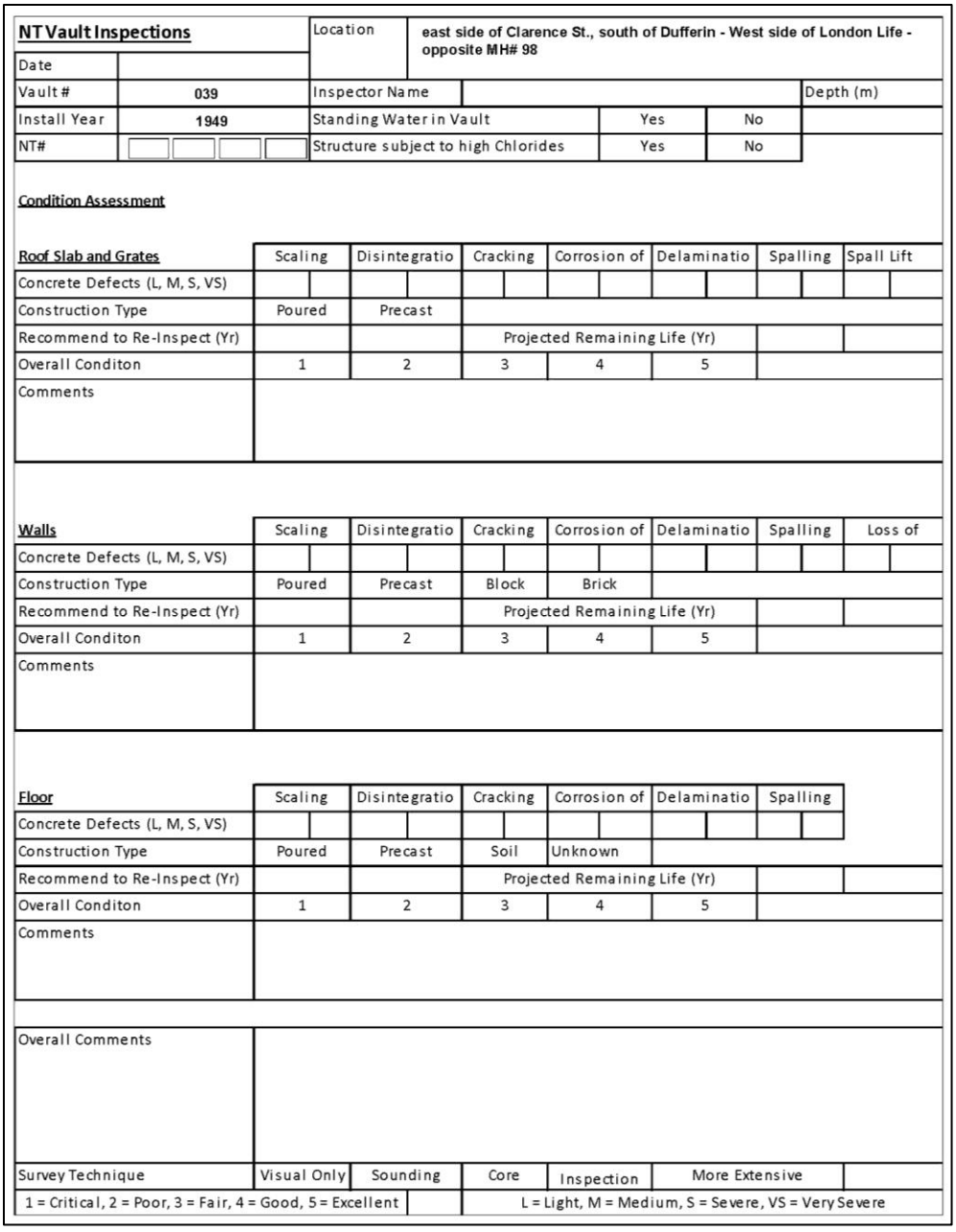


Figure 8-1. Age Distribution of Vaults

8.2 Inspection and Condition

London Hydro has created an internal vault inspection checklist that Operations staff must complete when auditing network transformers approximately every six months. The checklist covers the condition of various components such as walls, roof slabs, access grates, ladders, pumps, and lighting. In some cases, after decommissioning the network transformer and removing the electrical components, the vault may be abandoned; this still poses a potential safety risk if left to deteriorate, so they continue to be inspected until they are fully removed. Depending on the type of concrete used, some vaults are more susceptible to spalling and deterioration.

More than ten years ago, safety concerns within older vaults escalated to a system-wide inspection by a civil engineering firm; the general recommendation provided by AECOM was that London Hydro does not need to replace all the vaults when they reach life expectancy. A five-year inspection cycle was originally recommended. The current inspection schedule is being revised as described in Section 7. Figure 8-2 shows the inspection checklist for vaults used by civil engineers, with '1' being the ranking for the worst condition and '5' being the best condition. In the last five years, the average number of vaults inspected per year was 17. The information about the condition of each vault is recorded internally, and an analysis is done every year to determine the units that need replacement or refurbishment, and the units that need to be re-inspected in the following year.



NT Vault Inspections

Location	east side of Clarence St., south of Dufferin - West side of London Life - opposite MH# 98		
Date			
Vault #	039	Inspector Name	Depth (m)
Install Year	1949	Standing Water in Vault: Yes / No	
NT#		Structure subject to high Chlorides: Yes / No	

Condition Assessment

Roof Slab and Grates	Scaling	Disintegratio	Cracking	Corrosion of	Delaminatio	Spalling	Spall Lift
Concrete Defects (L, M, S, VS)							
Construction Type	Poured	Precast					
Recommend to Re-Inspect (Yr)			Projected Remaining Life (Yr)				
Overall Conditon	1	2	3	4	5		
Comments							

Walls	Scaling	Disintegratio	Cracking	Corrosion of	Delaminatio	Spalling	Loss of
Concrete Defects (L, M, S, VS)							
Construction Type	Poured	Precast	Block	Brick			
Recommend to Re-Inspect (Yr)			Projected Remaining Life (Yr)				
Overall Conditon	1	2	3	4	5		
Comments							

Floor	Scaling	Disintegratio	Cracking	Corrosion of	Delaminatio	Spalling
Concrete Defects (L, M, S, VS)						
Construction Type	Poured	Precast	Soil	Unknown		
Recommend to Re-Inspect (Yr)			Projected Remaining Life (Yr)			
Overall Conditon	1	2	3	4	5	
Comments						

Overall Comments						
Survey Technique	Visual Only	Sounding	Core	Inspection	More Extensive	
1 = Critical, 2 = Poor, 3 = Fair, 4 = Good, 5 = Excellent		L = Light, M = Medium, S = Severe, VS = Very Severe				

Figure 8-2. Contractor Inspection Checklist – Vaults

According to the 2024 ACA, only one vault is in poor condition and seven are in fair condition (Table 8-1). The average Health Index of the vaults is 86%. A map illustrating the geographical distribution of the vaults according to their Health Index can be found in Appendix G.

Table 8-1. Condition Assessment of Vaults

	Health Index Distribution by Number of Units				
	Very Poor	Poor	Fair	Good	Very Good
Quantities	(<25%)	(25% - <50%)	(50% - <70%)	(70% - < 85%)	(>=85% - 100%)
Units	0	1	7	20	38
Percentage	0%	2%	11%	30%	58%

8.3 Risk Assessment

As vaults age and deteriorate, they can pose safety risks to the public or employees if they collapse, similar to the maintenance holes. However, the vaults are typically not located under roads, so they experience less deterioration from vehicle vibrations and loading, unless they are by a main road with extreme traffic. The roof slabs installed in the sidewalks are exposed to weather and road salt, making them prone to spalling. This can pose a risk to pedestrians. When an internal audit identifies a vault needing attention, it is added to the list for annual civil engineering inspection. If the deterioration threatens staff safety, the vault may be 'condemned' until repairs are made.

8.4 Asset Sustainment Strategy

Rebuilding a vault at an existing site can be more expensive than constructing a new one elsewhere due to design and operational complexities. However, most vaults are rebuilt in their original locations for practical reasons. The rebuild process involves temporarily removing the network transformer, then reinstalling either a refurbished or a new transformer along with the associated cables. While most vaults house a single transformer, some can hold up to four. In some cases, instead of a full rebuild, a vault can be refurbished at a lower cost if its condition allows for improvement.

However, like the maintenance holes, refurbishment pushes out a full rebuild of extremely aged structures and currently London Hydro has two vaults that are over 90 years old. These two structures were re-visited by AECOM along with another three vaults, all past 75 years of age. As mentioned in the past, if the vault condition is relatively good, even though its age may be advanced, the structure might not be replaced for a number of years past its life expectancy. Although some of these vaults may not need replacement, increased monitoring may be advisable beyond the internal inspections, which could drive O&M costs higher.

As per the recent AECOM report[23], the asset management strategy for vaults includes two vault replacements in this planning horizon and monitoring an additional three vaults.

As roof slabs have a life expectancy much shorter than the vault itself, a separate schedule for roof slabs may be required in the planning interval.

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[23] Condition Assessment Report 2025 Maintenance Holes and Vault Chambers – November 2025 (AECOM)

9 Pole Mounted Transformer (Single-Phase and Three-Phase)

London Hydro's overhead distribution system has 7532 pole mounted distribution transformers, about half of which are single-phase units and the rest are in three-phase installations, as follows:

- 3796 single-phase units and
- 3736 in three-phase applications[24]

Single-phase pole mounted transformers are used mainly in residential applications while three-phase installations are common for commercial customers. Approximately 80% of the pole mounted transformers are used on the 27.6 kV system, with the remaining 20% on the 4.16 kV and 8.32 kV systems.

9.1 Life Expectancy and Age Distribution

Pole mounted transformers are assigned 55 years as anticipated service life based on best industry practice and empirical data. Approximately 4% of all units are past this threshold and another 7% will reach it in the next 10 years. To determine an FFA plan, it was considered based on the methodology of the original 2019 ACA, that the likelihood of asset removal at 45 years is 20% and that at 65 years the likelihood of removal is 95%. Transformers are expected to operate without major maintenance or refurbishment before they reach life expectancy.

The distribution of pole mounted transformer by year of installation and according to their system voltage is shown in Figure 9-1 for single-phase units[25] and in Figure 9-2 for three-phase installations. The average age of pole mounted transformers in single-phase installations is 26 years old and for the pole mounted transformers in three-phase installations it is 22 years old.

[24] There are a few banks of 2 units in service.

[25] The spike in the single-phase transformers from 1961 represents a population of units annexed from old Ontario Hydro during the annexation of additional land to the City of London in 1961. At that time, the age of these transformers was unknown so it was adopted as 1961 but they are certainly older.

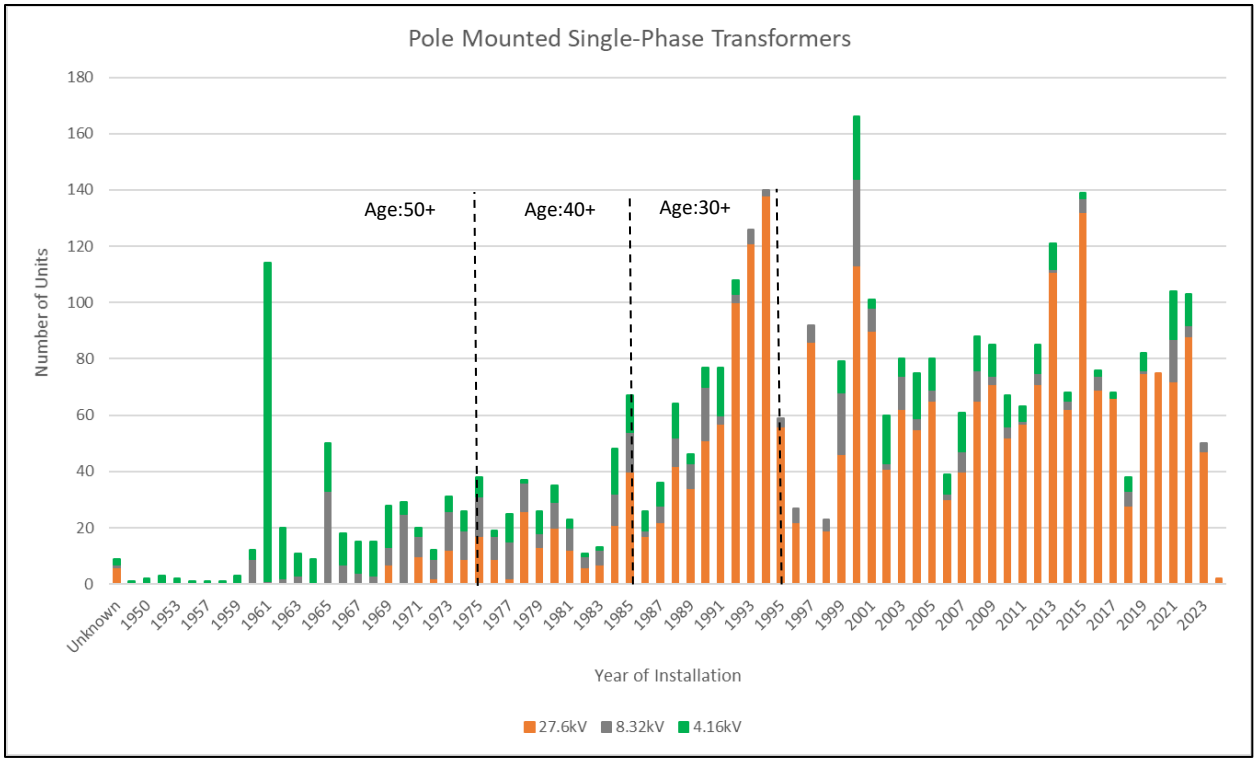


Figure 9-1. Age Distribution of Pole Mounted Single-Phase Transformers

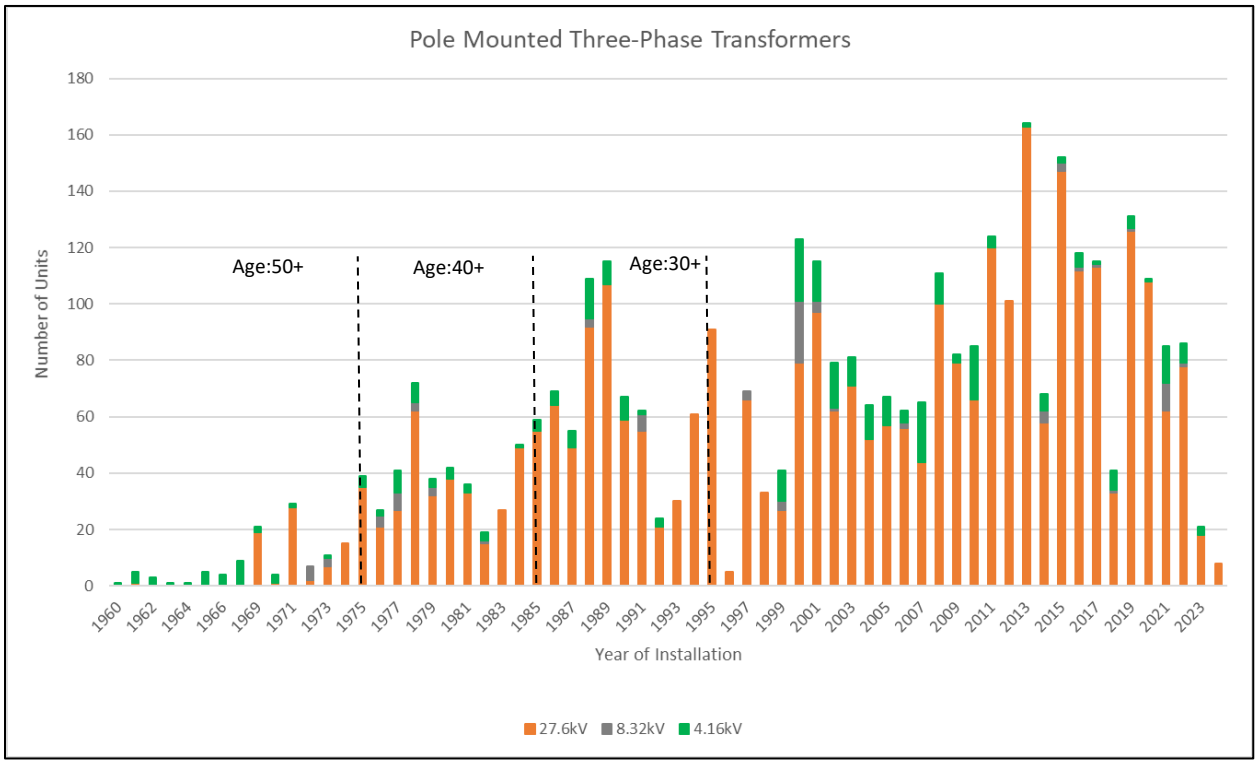


Figure 9-2. Age Distribution of Pole Mounted Three-Phase Transformers

9.2 Inspection and Condition

London Hydro inspects all of its pole mounted transformers once every three years. A number of problems are usually found over the course of the three years, related sometimes to damaged arresters or broken neutral wires, as well as ground connections. Any obvious deficiencies (oil leaks, etc.) found are recorded and the equipment found to require urgent attention is slated for immediate replacement / repair. An example of a screen for inspecting a pole mounted transformer in Mobile Workforce is found in Figure 9-3.

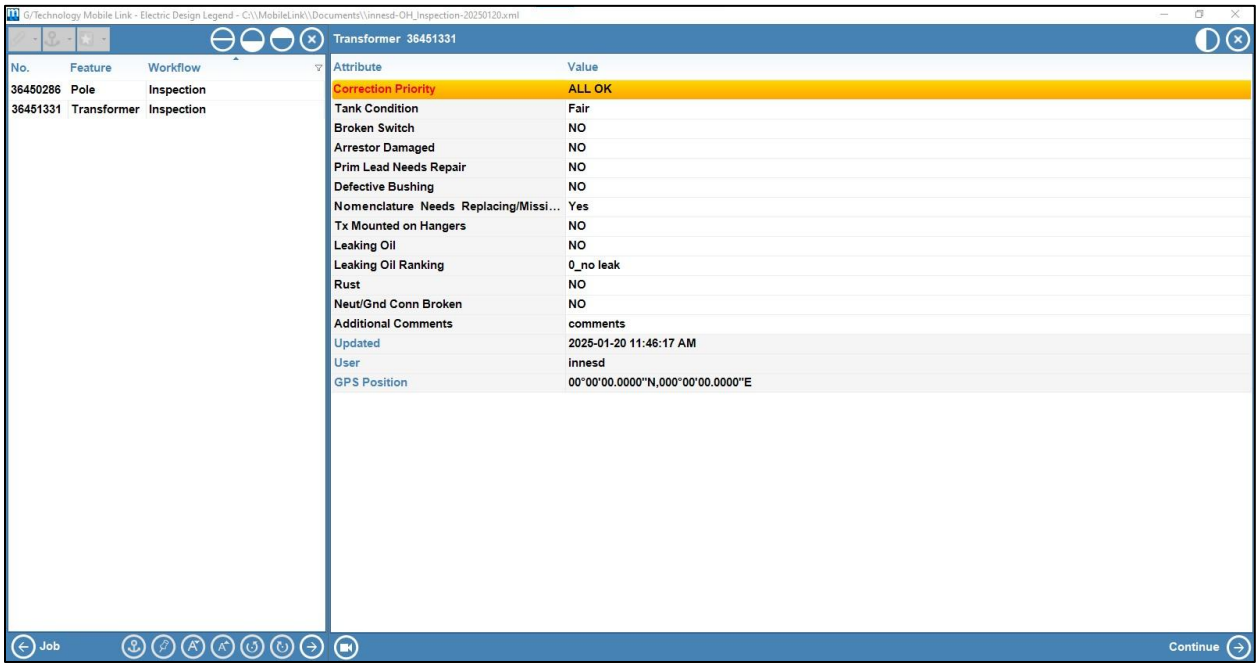


Figure 9-3. Inspection Checklist – Pole Mounted Transformers

As per the 2024 ACA the average Health Index of single-phase pole mounted transformers is 93% and that of three-phase transformers is 97%.

When considering the calculated Health Index of each unit, the following distribution is observed for the single-phase transformers (Table 9-1):

Table 9-1. Condition Assessment of Pole Mounted Single-Phase Transformers

	Health Index Distribution by Number of Units				
	Very Poor	Poor	Fair	Good	Very Good
Quantities	(<25%)	(25% - <50%)	(50% - <70%)	(70% - < 85%)	(>=85% - 100%)
Units	43	165	167	163	3251
Percentage	<1%	4%	4%	4%	86%

The three-phase installations have the following distribution for the Health Index (Table 9-2):

Table 9-2. Condition Assessment of Pole Mounted Three-Phase Transformers

	Health Index Distribution by Number of Units				
	Very Poor	Poor	Fair	Good	Very Good
Quantities	(<25%)	(25% - <50%)	(50% - <70%)	(70% - < 85%)	(>=85% - 100%)
Units	1	12	97	148	3478
Percentage	<1%	<1%	3%	4%	93%

Figure 9-4 presents the pole mounted transformer distribution according to the year of installation and associated Health Index.

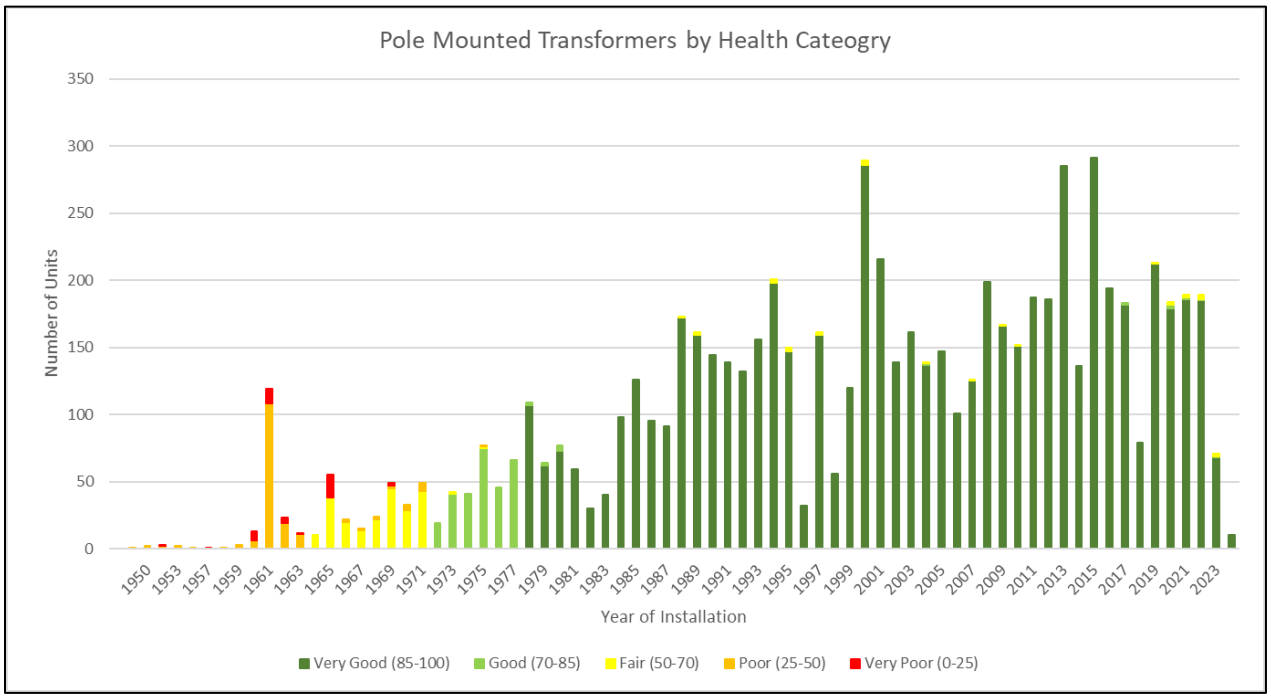


Figure 9-4. Health Categories of Pole Mounted Transformers

The map in Appendix H illustrates the geographical distribution of the pole mounted transformer installations by Health Index, according to the data tabulated above.

9.3 Risk Assessment

If the correct protection device is applied, pole mounted transformers usually have a small impact on reliability when they fail, since each unit supplies only a limited number of customers. If they fail catastrophically, however, a risk to public safety exists. Fuses protecting pole mounted transformers are designed to prevent catastrophic failures, especially at voltage levels where a high level of energy is available. In general, no safety issues have been associated with failures, as most of the units energized at 27.6 kV are equipped with a current limiting fuse that is capable of interrupting faults in less than a quarter cycle (1 cycle being 0.016 sec). In rare instances transformers can be severely overloaded resulting in overheating and potential hot oil spills.

In the past five years London Hydro experienced an average of 22 pole mounted transformer failures per year (Figure 9-5), representing a 0.3% failure rate to the whole population, and contributing an average of 83,000 customer minutes of interruption per year, much lower than in the case of pad mounted transformers. Based on these statistics, it can be concluded that London Hydro's pole mounted transformers in general deliver a reliable performance.

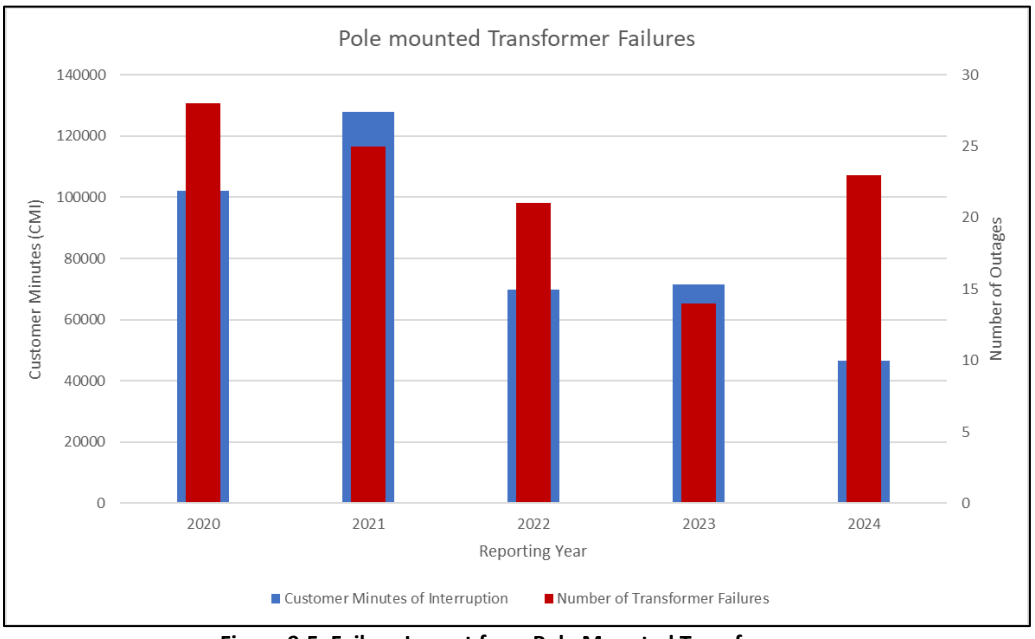


Figure 9-5. Failure Impact from Pole Mounted Transformers

A pole mount transformer failure, however, usually results in additional financial expenses compared to a proactive replacement due to costs associated with remedying the transformer failure and / or potential resulting oil spill. The pole mounted transformers qualified as very poor or poor in the 2024 ACA are mostly found on the 4.16 kV and 8.32 kV systems. According to the map in Appendix H, two larger clusters of these transformers are located in the conversion Zones D and G, which will proactively be eliminated when the load is converted to 27.6 kV.

Transformer loading depends on the size of the load relative to the installed kVA and is also affected by changes in ambient temperatures over the year. In case of transformer failures, like-for-like replacements usually are sized in KVA similarly to the unit that failed. However, in rebuilds or conversion projects, if loading is exceeding 70-80% of the installed kVA, the transformer is upsized to allow for some potential long-term load growth. In general, in the case of pole mounted transformers the wear of the units is moderate from a loading perspective, since when the load increases, it is very practical and easy to upgrade to a larger size overhead transformer, so the risk to overloading is minimal.

9.4 Asset Sustainment Strategy

London Hydro typically does not replace pole mounted transformers proactively due to aging, instead allowing most units to run until they fail. Some transformers are replaced each year due to unplanned outages or issues found during inspections. They are also replaced during pole line rebuilds or conversions, but these rebuilds are generally driven by the condition of the poles or the need for additional system capacity, rather than the condition of the transformers themselves.

The Flag For Action plan shows the expected number of assets to be addressed each year in the planning horizon based on historical replacement rates (Figure 9-6). It proposes an average number of 95 replacements per year over the course of the next ten years.

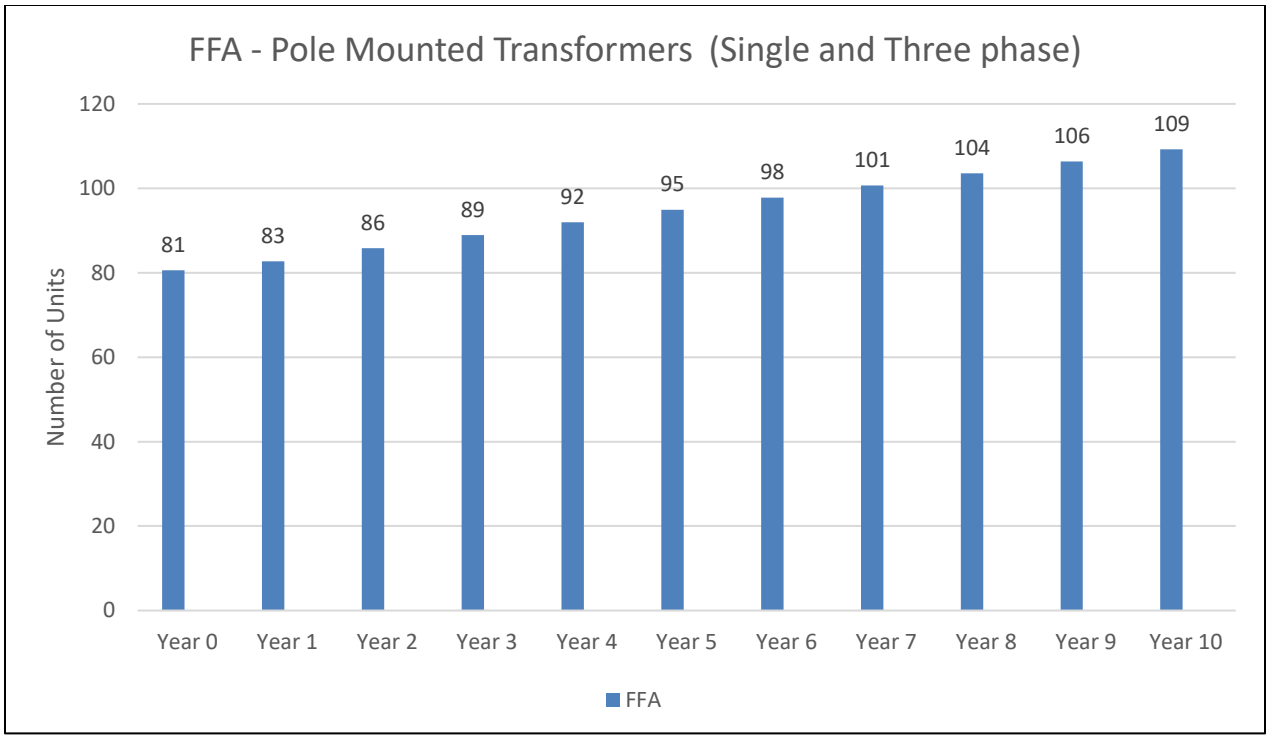


Figure 9-6. FFA Rate for Pole Mounted Transformers

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10 Step-down Transformer

London Hydro owns and maintains a number of pole mounted step-down transformers that provide supply to subset systems at 4.16 kV and 8.32 kV, stepping the voltage down from 27.6 kV. These installations (single or three-phase) are kept in place in areas where limited conversion was completed and some stretches of conductor and loads remained energized at a different voltage than 27.6 kV.

There are 57 units in total across the system, more than 60% are installed on the 8.32 kV system which has been reduced.

10.1 Life Expectancy and Age Distribution

Step-down transformers are assigned 55 years as anticipated service life based on best industry practice and empirical data. These units are relatively young with only one transformer reaching life expectancy in the next ten years.

The distribution of step-down transformers by year of installation is shown in Figure 10-1. The average age of step-down transformers is 20 years old.

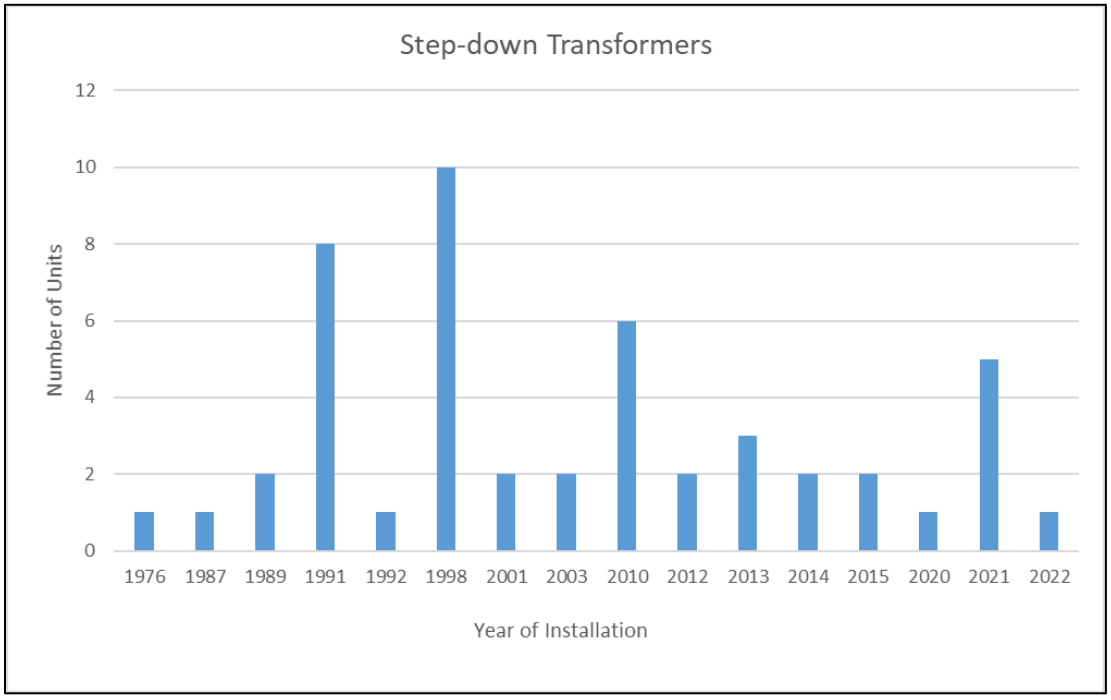


Figure 10-1. Age Distribution of Step-down Transformers

10.2 Inspection and Condition

The inspection cycle for step-down transformers is the same as for all pole mounted transformers in the system and was described in Section 9.

As per the 2024 ACA the average Health Index of all step-down transformers is 99%.

When considering the calculated Health Index of each unit, the following distribution is observed for the step-down transformers (Table 10-1):

Table 10-1. Condition Assessment of Step-down Transformers

	Health Index Distribution by Number of Units				
	Very Poor	Poor	Fair	Good	Very Good
Quantities	(<25%)	(25% - <50%)	(50% - <70%)	(70% - < 85%)	(>=85% - 100%)
Units	0	0	0	1	56
Percentage	0%	0%	0%	2%	98%

The map in Appendix I illustrates the geographical distribution of the step-down transformer installations.

10.3 Risk Assessment

Adequate over-current protection is installed at every step-down transformer or transformer bank but the fuse sizes are being reviewed when outages occur. There are not too many risks associated with this type of equipment and failure of step-down transformers given their limited number, are rather rare. If any occurred in the last five years, it would be included in the 5-year history of pole mounted transformer failures.

10.4 Asset Sustainment Strategy

No replacements are proposed for step-down pole-mounted transformers in this planning horizon.

11 Overhead Switch

London Hydro has 1223 switches installed on the overhead system, operating at various distribution voltages, but the majority of the units are installed on the 27.6 kV system. The various types and quantities are provided below in Table 11-1. The map from Appendix J illustrates the geographical distribution of all overhead switch devices by type.

Table 11-1. Overhead Switch Count by Type and Voltage System

	27.6 kV	8.32 kV	4.16 kV
Motorized Load-break Switches	50	--	--
Manual Load-break Switches (Gang-operated)	276	--	--
Manual Non Load-break Switches (Disconnects)	595	53	249

The switches are used to create normally open or normally closed points on the distribution feeders. The motorized load-break switches are SCADA connected and can be operated remotely from the System Operating Centre.

11.1 Life Expectancy and Age Distribution

Overhead switches are assigned 40 years as anticipated service life based on best industry practice and empirical data.

Motorized switches, using modern vacuum interrupting technology for 'breaking' load, are just half way through their life expectancy, originally installed in the late 1990s – early 2000s. The average age for these devices is 22 years old.

Manual load-break switches and disconnects have been in use for decades and some have likely been in service for longer than 40 years, but the exact year of installation remains unknown for many of the units (500+). Although more than 40% of the non-motorized overhead switches have the age unknown, for the remaining population the average age is only 14 years old.

The age distribution cumulative for all switch types with a known age is provided in Figure 11-1.

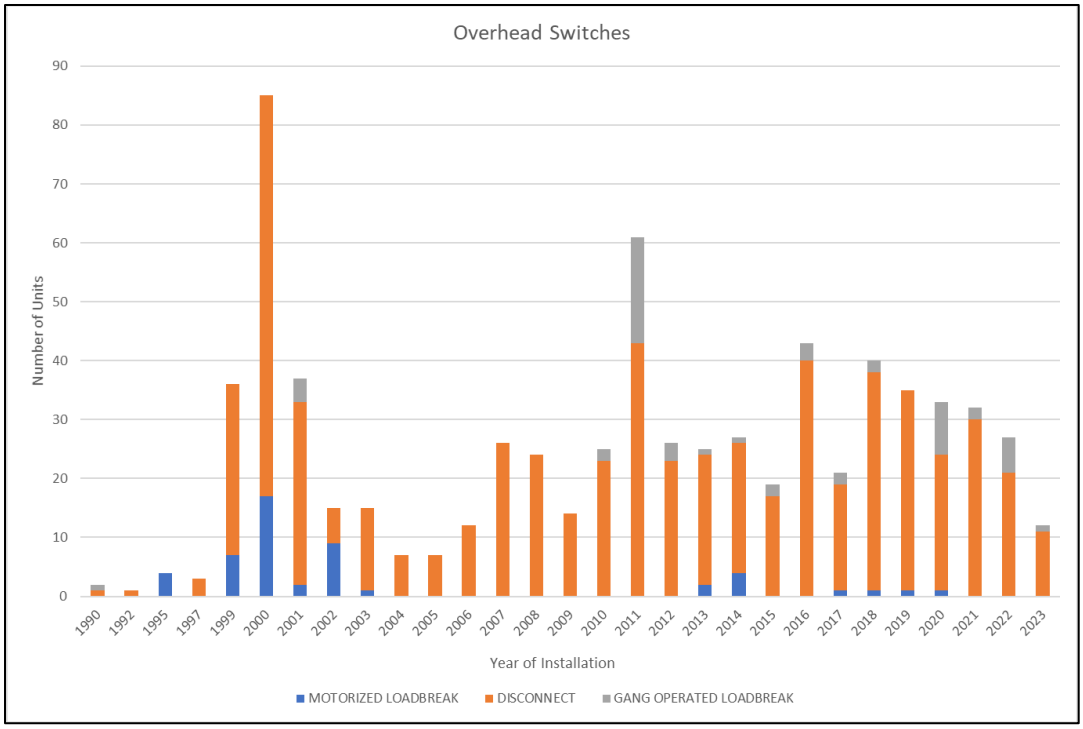


Figure 11-1. Age Distribution of Overhead Switches

11.2 Inspection and Condition

All overhead switches are included in the inspection of overhead circuits that occurs once every three years, which also includes hot spot scans taken at each switch. Apart from finding minor problems, such as missing padlocks on the control cabinet or ground connections, the condition of these overhead devices cannot be fully determined just by a visual inspection. Infrared inspections can provide indication to current hot spot locations, but this snapshot in time does not necessarily represent the switch's overall aged condition. In most cases, hot spot connections can be repaired in the field, with the switch being put back into service thereafter. Further inspections into the cabinetry and control cables of the motorized load-break switches are also completed during P&C's (Protection and Controls) department annual audits, and any issues with control cables are found at that time. These P&C audits were a recent addition after an increased number of control cable failures were experienced.

In 2024 London Hydro implemented a new inspection form for the motorized and manual load-break switches in Mobile Workforce. The inspection template is found below.

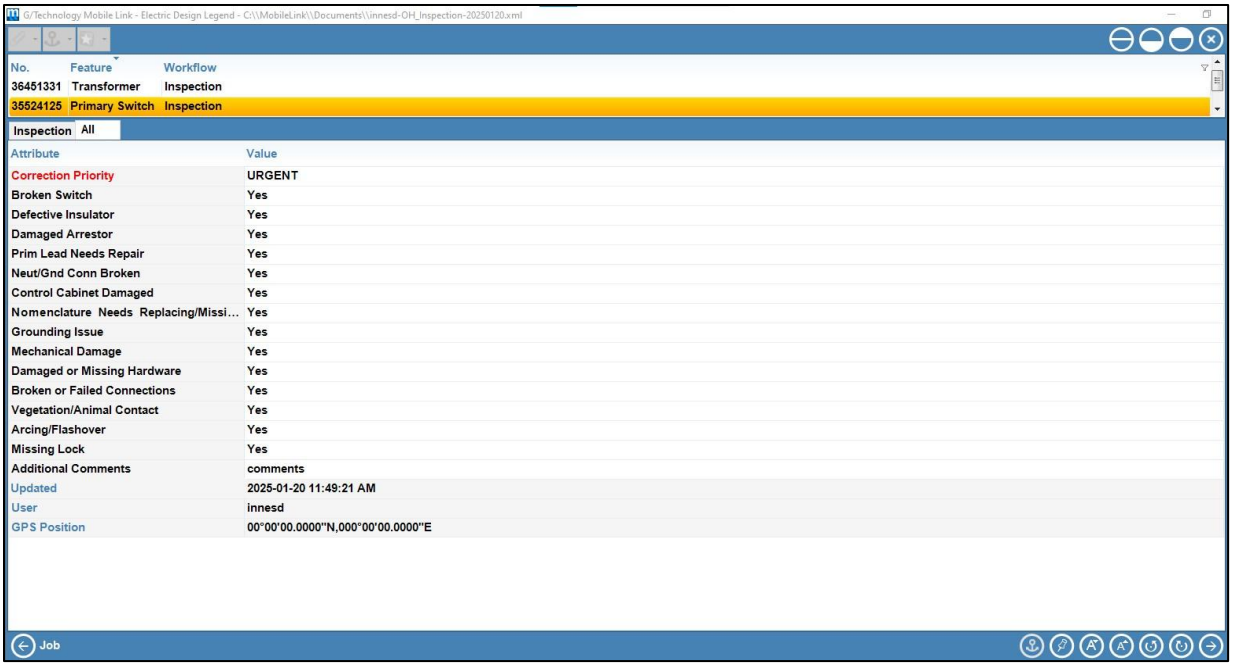


Figure 11-2. Inspection Checklist - Overhead Switches

As a result of the reduced performance in recent years (i.e., switches failing upon attempting to operate), in addition to the inspection of these devices, a five-year maintenance program has re-started several years ago for the manual load-break switches. Fifty percent of the devices (133 of the total 276) had their maintenance completed between 2020 and 2024, and their records are brought up to date. The plan is that over the next 3-5 years, all the manual load-break switches would have had maintenance and the units that are malfunctioning during maintenance will be repaired or replaced. The inspection screen for the digital maintenance form in Mobile Workforce is found below. Where possible, the year of installation will be collected from the nameplate for the units without a known age, to improve the asset data quality.

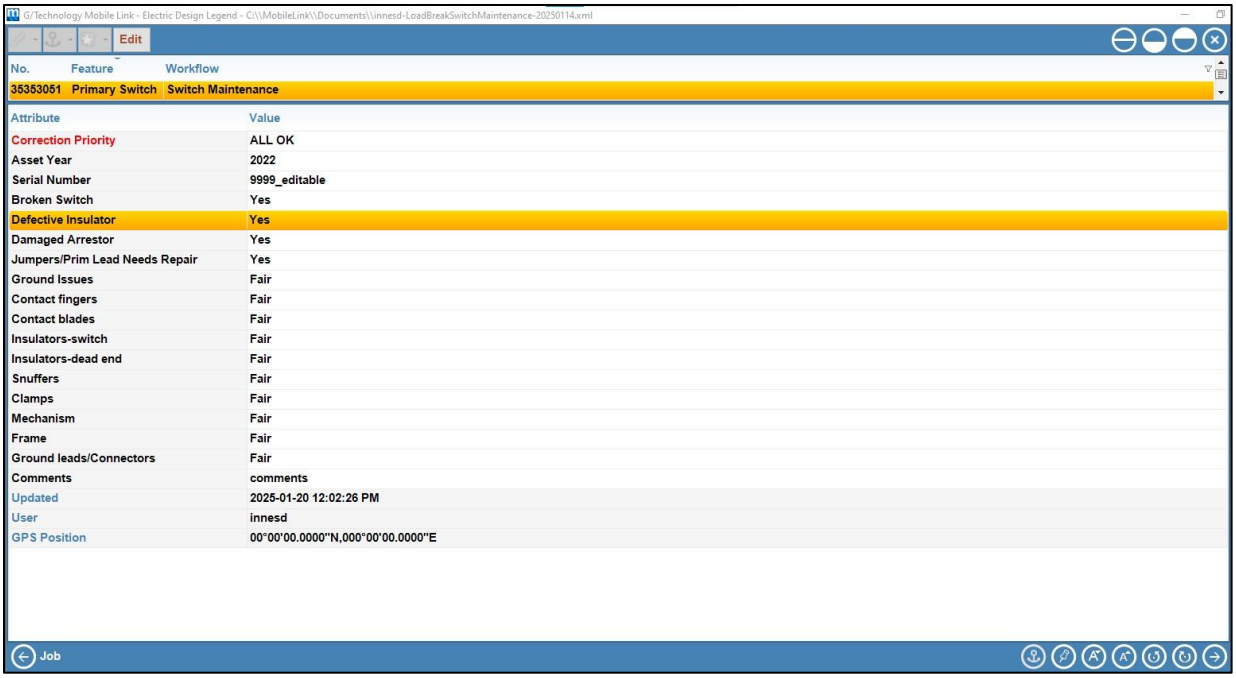


Figure 11-3. Maintenance Checklist - Overhead Switches

The Health Index for overhead switches was calculated based on age only at this 2024 ACA cycle, so for the ones that had the year of installation known, the following distribution applies (Table 11-2). Many of the devices that have the year of installation unknown could actually fall in the very poor and poor categories, especially if condition data will be available at the next round of Asset Condition Assessment.

Table 11-2. Condition Assessment of Overhead Switches

	Health Index Distribution by Number of Units				
	Very Poor	Poor	Fair	Good	Very Good
Quantities	(<25%)	(25% - <50%)	(50% - <70%)	(70% - < 85%)	(>=85% - 100%)
Units	0	0	0	3	712
Percentage	0%	0%	0%	0%	100%

11.3 Risk Assessment

As it was mentioned, it is not feasible to accurately determine the condition of load-break switches through visual inspection while in service. These switches may fail during operation, particularly if the arc snuffers fail, leading to flashovers and insulator damage. Age and corrosion can also cause deterioration of linkages and alignment, resulting in failures. Since some of these devices may have been in service for decades and not maintained, it is noted in recent years that some stop operating and failures have been experienced making the device unavailable when switching is planned on the system.

Since all the load-break switches are used on 27.6 kV main feeders, their low-probability, high-impact failure can lead to loss of power for a significant number of customers. A number of failures have been recorded since the last ASP, some not resulting in an outage necessarily but nevertheless rendering the device inoperable, affecting planned jobs or extending restoration attempts during an outage. The failure impact of the six failures combined that caused outages in the last five years is depicted in Figure 11-4 for manual load-break switches and in Figure 11-5 for motorized load-break switches. Together, these multiple events averaging at 1+ per year, when resulting in an outage, affect thousands of customers supplied by the feeder they are installed on.

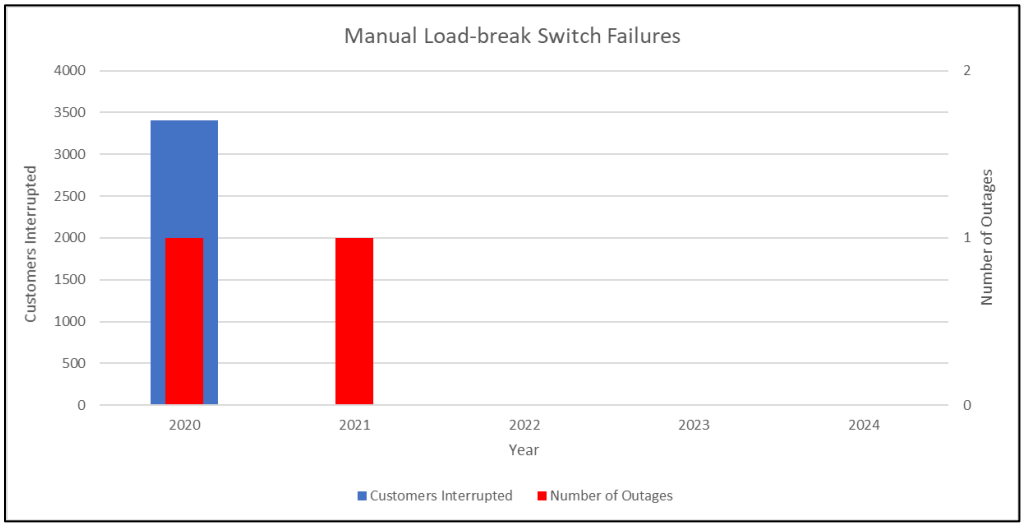


Figure 11-4. Failure Impact from Manual Load-break Switches

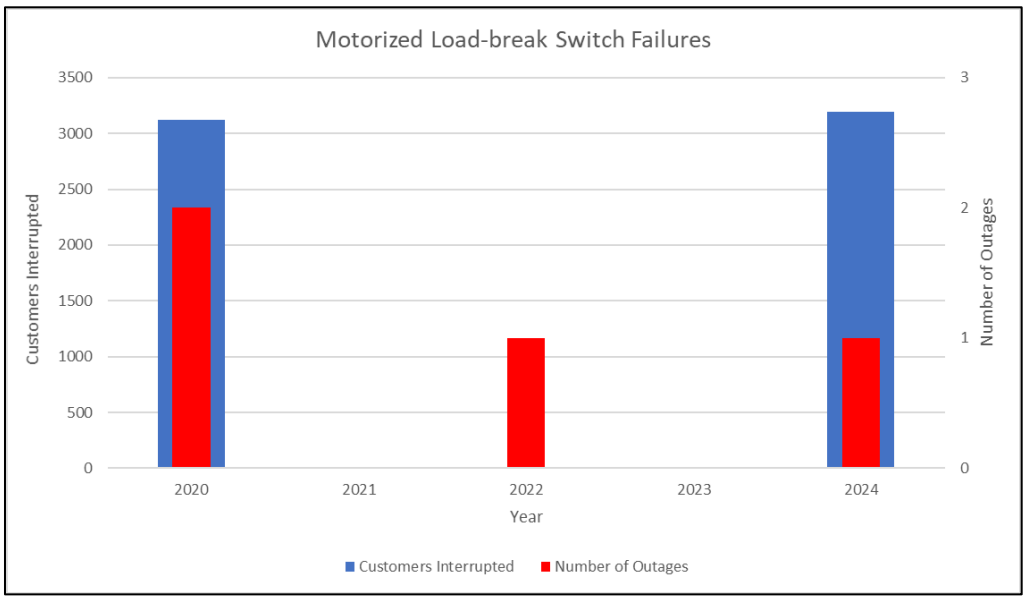


Figure 11-5. Failure Impact from Motorized Load-break Switches

Of even more significance to the asset management of these devices is that an additional 11 failures of one or other switch type occurred over the past five years that did not cause a power outage (Table 11-3).

Table 11-3. Failures of Switches without Outages

Year		2020	2021	2022	2023	2024
No. of non-outage failures	Manual Switch	1	0	0	1	0
	Motorized Switch	4	0	0	1	4

There is not a common mode of failure identified for these devices; failure of motorized units cannot be prevented for multiple reasons, i.e. unavailability of spare parts, limited maintenance or capability of the device, obsolescence.

A picture of a failed SCADAMATE motorized switch is presented in Figure 11-6.

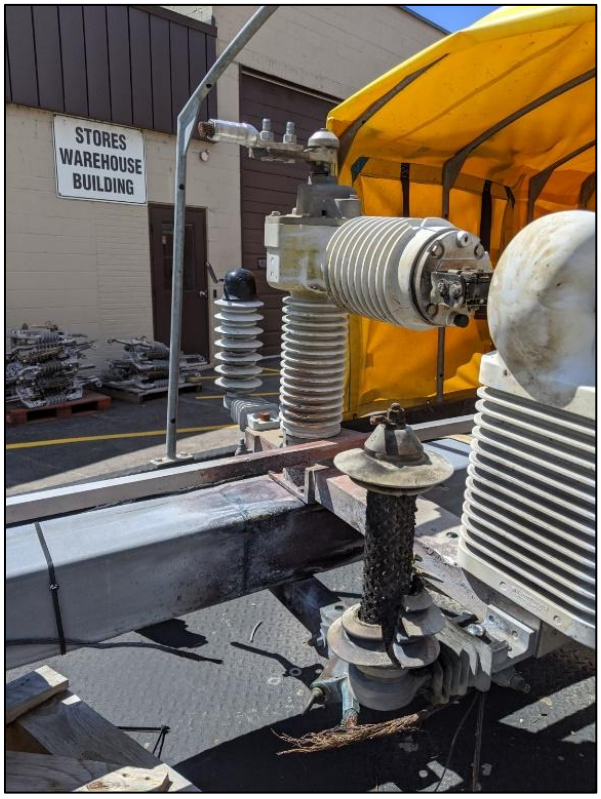


Figure 11-6. Failed Automated Switch

In the past London Hydro has experienced serious incidents due to a design flaw in disconnects (manual non load-break switches) from a specific manufacturer. These devices would break apart, causing conductors to fall or wrap around other circuits. The faulty switches were replaced, and the product was discontinued. As a preventative measure, the defective so-called 'Clamshell' connectors were also replaced in all switches of that type to avoid future failures. This is further detailed in Section 13.2.

11.4 Asset Sustainment Strategy

A five-year maintenance schedule was re-introduced for the manual load-break switches several years ago. The previous strategy to run the switches to failure or replace them as part of a pole line rebuild may change to refurbishment / repair / replacement of the 'suspect' switches found, so their reliability increases. Based on the historic rate of failure in the last five years and the mode of failure described for the motorized load-break switches (Joslyn and SCADA-MATE), it would be prudent to plan for up to three units per year as average replacement rate in this planning horizon.

Non load-break disconnect switches are not costly enough to warrant a proactive replacement plan; as such, no replacements are proposed in this planning interval.

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12 Overhead Recloser

London Hydro has 141 reclosers installed on the system, almost entirely vacuum interrupting technology employing automatic circuit interrupters with electronic relays; there are only two oil hydraulic reclosers[26] with mechanical protection that are considered obsolete[27]. The map in Appendix K illustrates the locations of all the reclosers across the system.

Like overhead switches, reclosers are installed on the main feeder backbone, in an open or closed state. They have the same functionality of creating normally open or closed points, but are also used for protection of the equipment in the event of a downstream fault on the circuit. Almost all of London Hydro's reclosers are installed on the 27.6 kV system and they use vacuum interrupting bottles for 'breaking' load and for interrupting fault current.

Table 12-1. Recloser Count by Type and Voltage System

	27.6 kV	8.32 kV
Vacuum Recloser	139	--
Oil Recloser	--	2

12.1 Life Expectancy and Age Distribution

Overhead reclosers are assigned 40 years as anticipated service life based on best industry practice and empirical data.

Modern vacuum interrupting reclosers are relatively new on the distribution systems; the oldest devices were installed in the early 2000. Although a number of failures in the last five years from a variety of causes have been recorded, there is not enough operating history to be able to predict future failure trends and a more accurate life expectancy because they have been in service for a limited period of time.

The age distribution for reclosers is provided in Figure 12-1. Their average age is 9 years old.

[26] Since the beginning of this year (2025), one oil recloser has been removed leaving only one on the 8.32 kV system on a Hydro One shared feeder.

[27] No new oil reclosers are being introduced on the system.

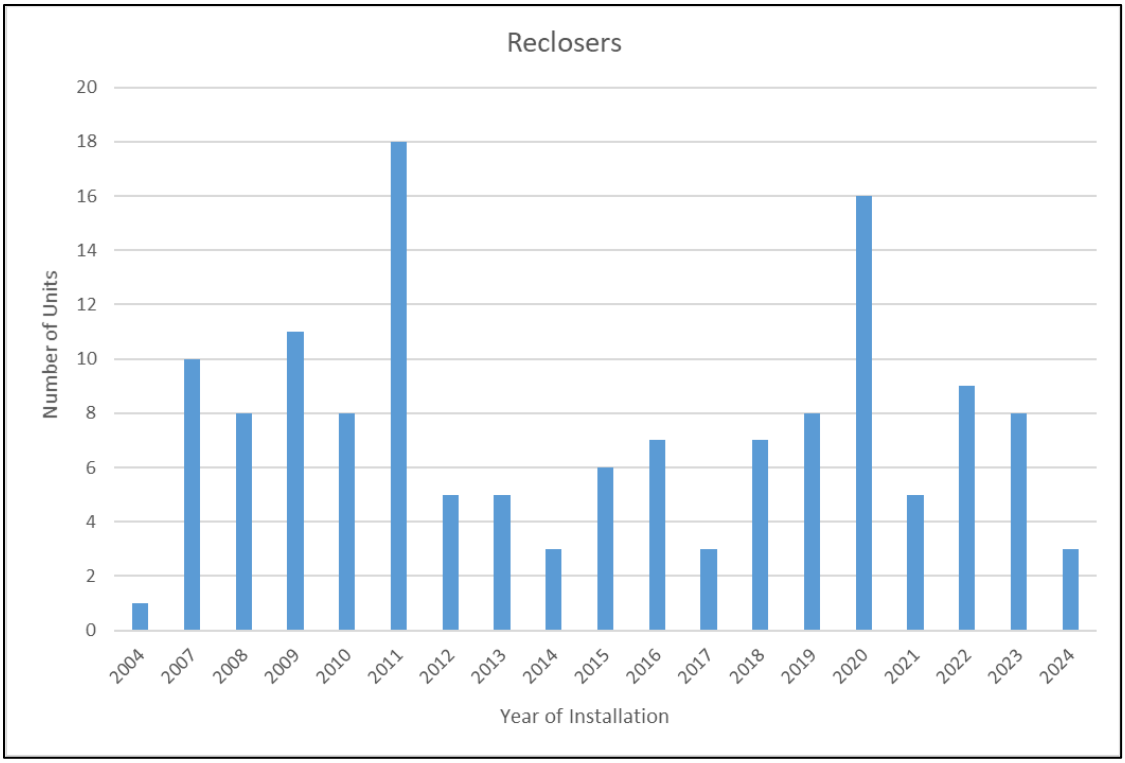


Figure 12-1. Age Distribution of Reclosers

12.2 Inspection and Condition

All reclosers are inspected during the routine overhead circuit inspection conducted every three years, which also includes hot spot scans taken at each device. While minor issues, like missing padlocks or ground connection problems, may be identified, their overall condition cannot be fully assessed through visual inspection alone. Infrared inspections can provide indication of current hot spot locations, but this snapshot in time does not necessarily represent the recloser's overall health condition. In most cases, hot spot connections can be repaired in the field, with the recloser being put back into service thereafter. Further inspections into the cabinetry and control cables are completed during annual P&C (Protection and Controls) Department audits, and any issues with control cables are found at that time. These P&C audits were a recent addition after an increased number of control cable failures were experienced.

Recently, a digital form was created in Mobile Workforce to record some general condition data for the reclosers during overhead inspections. The sample form is presented below in Figure 12-2.

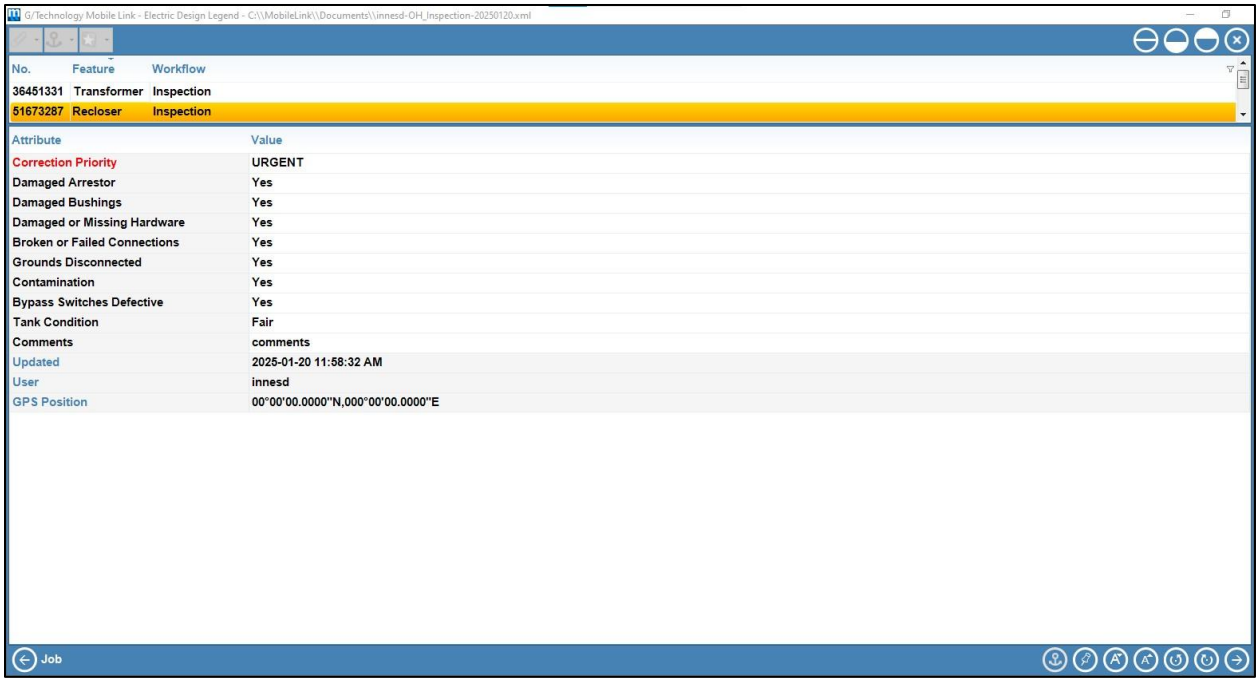


Figure 12-2. Inspection Checklist – Reclosers

The Health Index for the reclosers is 100%, as the distribution below indicates all units being in very good condition (Table 12-2).

Table 12-2. Condition Assessment of Reclosers

	Health Index Distribution by Number of Units				
	Very Poor	Poor	Fair	Good	Very Good
Quantities	(<25%)	(25% - <50%)	(50% - <70%)	(70% - < 85%)	(>=85% - 100%)
Units	0	0	0	0	141
Percentage	0%	0%	0%	0%	100%

12.3 Risk Assessment

Since most of the reclosers are used on 27.6 kV main feeders, their low-probability, high-impact failure can lead to loss of power for a significant number of customers. Their failure rate is now noticeable compared to the previous ASP, with an average of two outages per year. In addition to this, at least 70% more recloser failures (an additional seven over the course of the past five years) were experienced that did not cause an outage, but required hardware replacement. This group of assets is thus beginning to impact the overall system performance. On average, approximately 3500 customers experience a power interruption with every recloser failure.

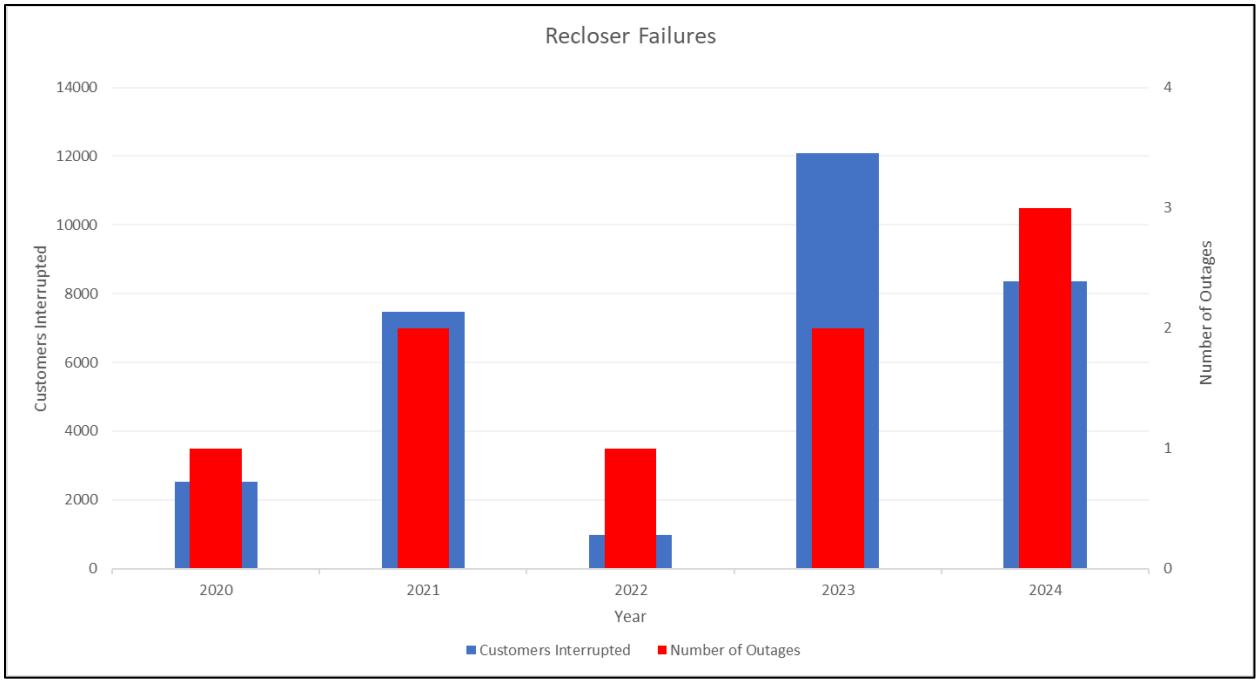


Figure 12-3. Failure Impact from Reclosers

A variety of failure modes have been observed, such as control cables degradation from moisture, pod flashovers and other. A picture of a failed older style vertical recloser is presented in Figure 12-4 with visualizing burnt marks on the recloser pod. London Hydro is engaging with manufacturers to provide longer lasting solutions based on the specific cause of failure.

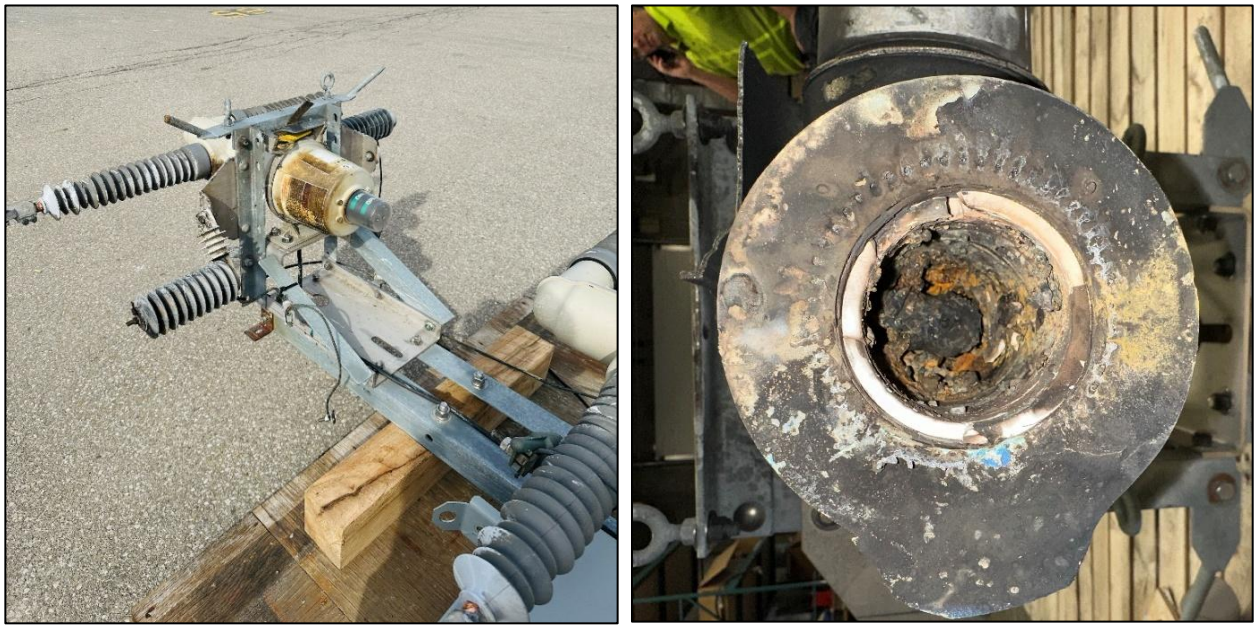


Figure 12-4. Failed Recloser and Damaged Pod

12.4 Asset Sustainment Strategy

Given the relatively young age of London Hydro's reclosers on the 27.6 kV system, there is no need to consider their proactive replacement based on age within this planning horizon. However, after the failure rate recorded in the past five years, and considering the replacement of these units are more costly, one reactive replacement per year is planned in this horizon.

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13 Pole and Pole Attachments

London Hydro's overhead system is comprised of poles, pole attachments, and overhead lines (primary and secondary circuitry). This section deals with poles and pole attachments. The primary and secondary overhead circuits are not analyzed in much detail in this report because there is no proactive asset sustainment strategy for those asset types. Evaluating the practical condition of the overhead system focuses on the condition of poles and the various pole attachments: cross-arms, insulators, cutouts, automatic conductor splices, mid-span taps, and switch installation components.

13.1 Pole

The 2024 Asset Condition Assessment study reported 29640 poles in service in London Hydro's territory[28], which support approximately 1386 circuit km of overhead primary wire.

London Hydro primarily uses its own poles for overhead infrastructure, but also owns infrastructure on Bell Canada poles, mainly in rear yards, making their condition just as important. London Hydro also uses Hydro One poles through joint use agreements and some customer-owned poles for private equipment or transformers on rural private property[29]. Of the total of 29640 poles, the numbers by material type and owner are provided in Table 13-1:

Table 13-1. Poles Count by Owner and Type

Owner	Wood	Steel & Alum.	Concrete	Composite	Total
London Hydro	27153	58	135	8	27354
Bell	2286	--	--	--	2286

13.1.1 Life Expectancy and Age Distribution

Poles are generally assigned 55 years as anticipated service life based on industry practice and empirical data. To determine an FFA plan, it was considered based on the methodology of the original 2019 ACA, that the likelihood of asset removal at 55 years is 20% and that at 75 years the likelihood of removal is 95%.

[28] Owned by London Hydro and Bell Canada
[29] Hydro One and customer-owned poles are not included in the analysis in this report.

However, pole testing data over the last decade has provided evidence that the longevity of some wood poles at London Hydro, based on the years in service, approaches 60-70 years. On the other hand, some wood poles reach their end of life after only 30-35 years. Pole replacements are not solely correlated with age; the condition of the pole itself also plays a significant role, which is influenced by factors such as environmental conditions or loading on the pole, for example.

London Hydro owns 27354 poles of which a very large majority (over 99%) are made of wood as indicated earlier; these poles are discussed in detail in this report, including an additional 2286 Bell wood poles.

It has been a standard for many years at London Hydro and across Ontario to purchase fully treated cedar poles due to their natural resistance to decay. Several factors affect the structural integrity of a wood pole and hence its average life expectancy:

- dynamics, such as the species of wood and the type of wood preservative used
- the surrounding environment (ground moisture, insects etc.)
- loading on the pole, such as a transformer mounted on the pole, number of conductors installed, joint use attachments, etc.
- external mechanical damage

London Hydro has improved its pole records substantially, with only 1% of poles lacking installation year data (approximately 300 poles: 100 London Hydro owned and 200 owned by Bell). For these poles, it may not be possible to estimate the age due to the lack of an installation tag installed on the pole, or in case of poles owned by Bell. Figure 13-1 indicates the approximate year of installation for all the poles in the system. The average age of the poles is 31 years old.

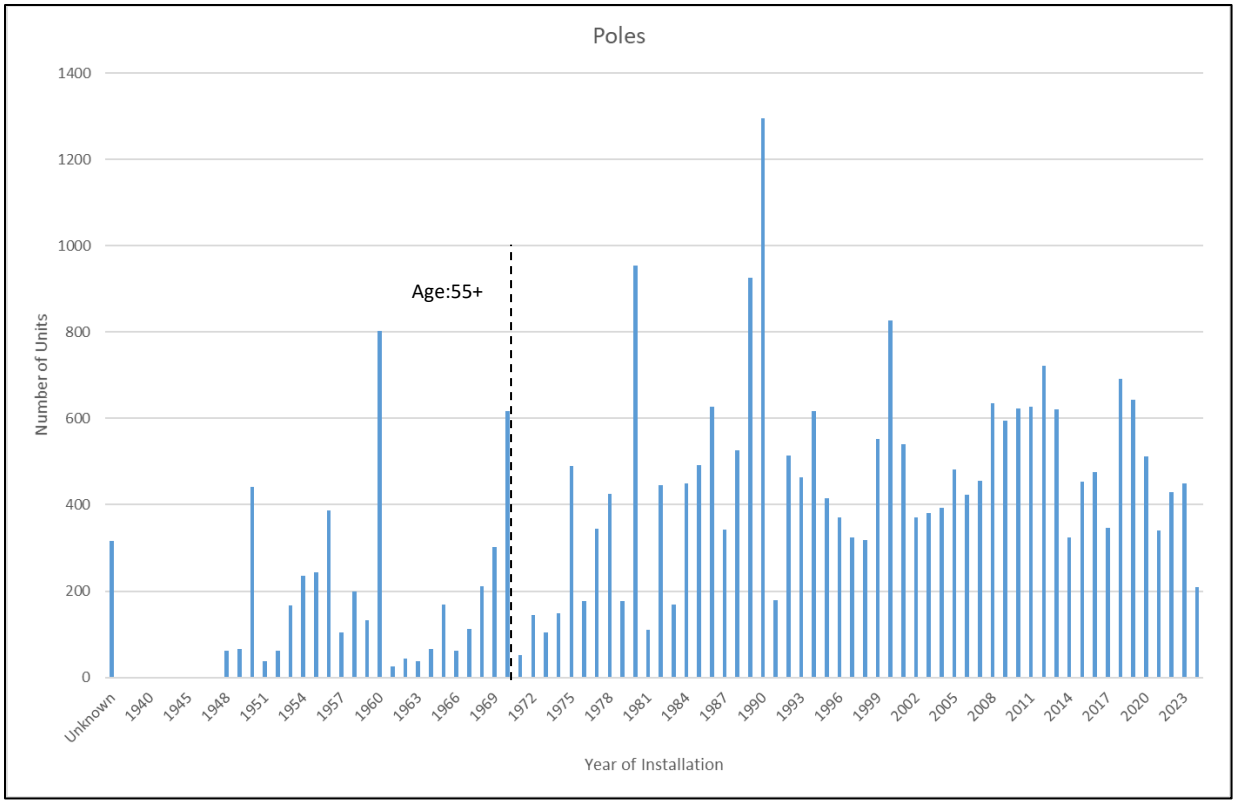


Figure 13-1. Age Distribution of Poles (Wood and Other)

London Hydro does not rely solely on the age of poles to decide replacements. However, age helps identify a large group of poles that may need to be addressed over the next 10 years due to aging. Notably, 15% of the poles – those installed in or before 1970 – have already reached their typical 55-year useful lifespan.

The duration that a pole is in service may not only be dependant on the condition of the pole itself, but is sometimes determined by multiple factors including City of London's road widenings and developer driven works. Historically, London Hydro's GIS system has been used to record the year when a pole was removed from service, regardless of the reason. Figure 13-2 provides that information, for a large sample of retired poles, indicating the real "field age" at which every single pole was taken out of service. It appears that a larger quantity of poles is being removed after they turn 20 years old and until they turn 55-60 years old, a cohort where there is also a large population. The weighted average age at which poles have been removed until now is 37 years old, which is younger than the typical life expectancy.

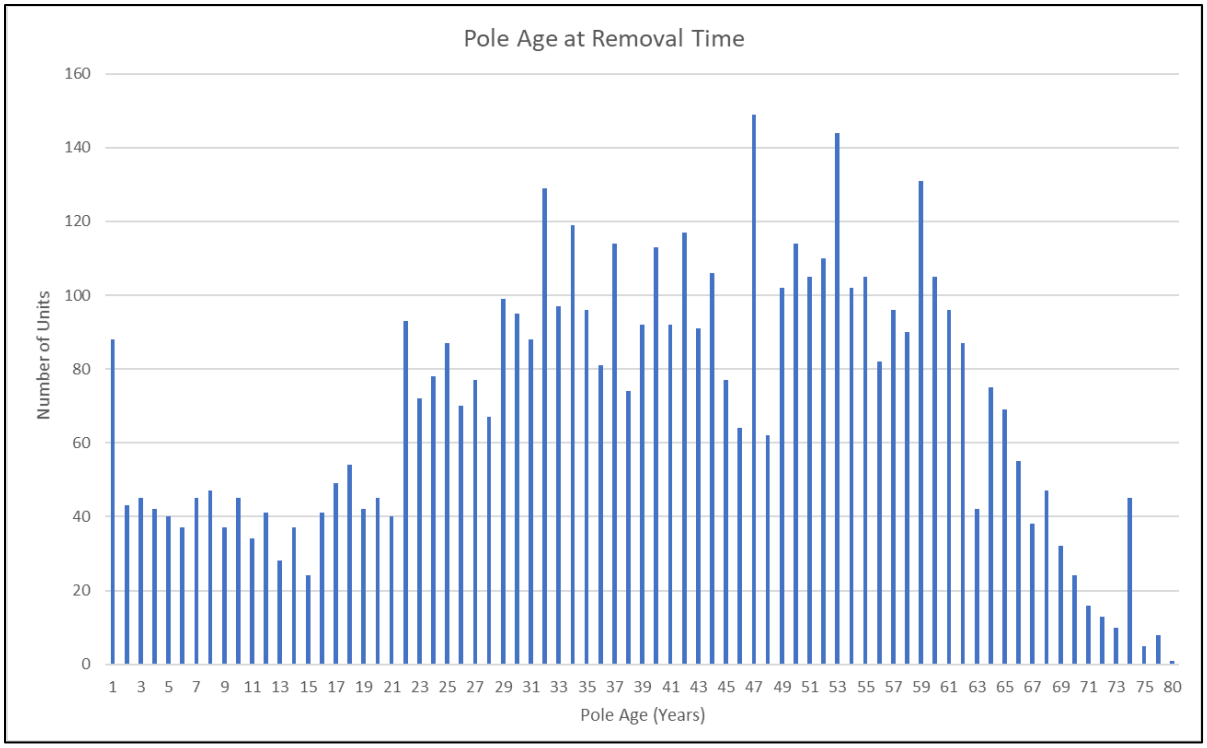


Figure 13-2. Pole Removal Age Data Historically (2007-2025)

The in-service duration of London Hydro's poles will continue to be recorded and monitored, to permit assessing when removals occur compared to the pole's expected service life.

Given the varying reasons for pole replacements (primarily driven by a condition-based approach but also external work), Table 13-2 demonstrates the replacements rates accomplished in the last five years by age demographic. Although a large quantity of pole replacements is happening prior to age 55, the rate of replacement itself is the highest for the oldest population segment (26% for poles aged greater than age 55, which is twice and four times the rate compared to the younger demographic cohorts). This indicates that the condition-based replacement approach still demonstrates that the oldest population has a higher removal risk than the younger population; however real-world installation circumstances can greatly impact the life span of younger poles.

Table 13-2. Pole Replacement Rate (2020-2024)

Age Range	Replacement Rate
0-20	6%
21-55	13%
56-99	26%

13.1.2 Inspection and Condition

Each year London Hydro engages a contractor to test an average of 3000-3500 London Hydro owned wood poles; those identified as needing immediate replacement are scheduled to be replaced within the following 12 months maximum. London Hydro changed the method of pole testing in 2023 to the *resistograph* method. An executive summary on pole replacement strategy was published this year[30], which evaluated the effectiveness of the resistograph test method. After implementing the new testing methodology, approximately 245 poles were replaced based on testing results from 2023 and 2024. It has been found that of the poles tested in 2023 and 2024 with the new resistograph method (over 7800 poles), 3.2% needed to be replaced as opposed to less than 1% that needed to be replaced using the old testing methodology prior to 2023. The poles that fail the test (measuring 60% strength or less) are being found with increased accuracy and relevance due to the new method of testing.

Pole testing is conducted on wood poles as follows:

- Poles that have been in service less than 20 years are not tested
- Poles that have been in service for 20 years are tested in that year
- Poles that have been tested at least once are re-tested according to the result of the prior test[31]

London Hydro conducts annual pole testing, with a focus on regularly inspecting older poles. Experienced contractors perform the pole testing using the new method: they estimate installation dates when needed, document pole species, and perform visual checks of attached hardware, which if deficient is reported right away. This condition-based testing helps to identify weak or rotting poles and supports decisions on necessary replacements.

An example of high severity of pole decay in a wood pole is illustrated in Figure 13-3, and similarly, severe deterioration found in a concrete pole for example is depicted in Figure 13-4.

[30] Pole Replacement Strategy Executive Summary – March 2025

[31] London Hydro's practice is to re-test poles every five years unless a shorter re-testing interval is recommended by the contractor.



Figure 13-3. Severe Decay in Wood Pole



Figure 13-4. Severe Deterioration in Concrete Pole

Alongside its pole testing program, London Hydro conducts system-wide field inspections every three years by the Operations department. Starting in 2025, London Hydro created separate inspection forms for the wood poles and the concrete poles in the Mobile Workforce. The two inspection checklists are presented below in Figure 13-5 and Figure 13-6.

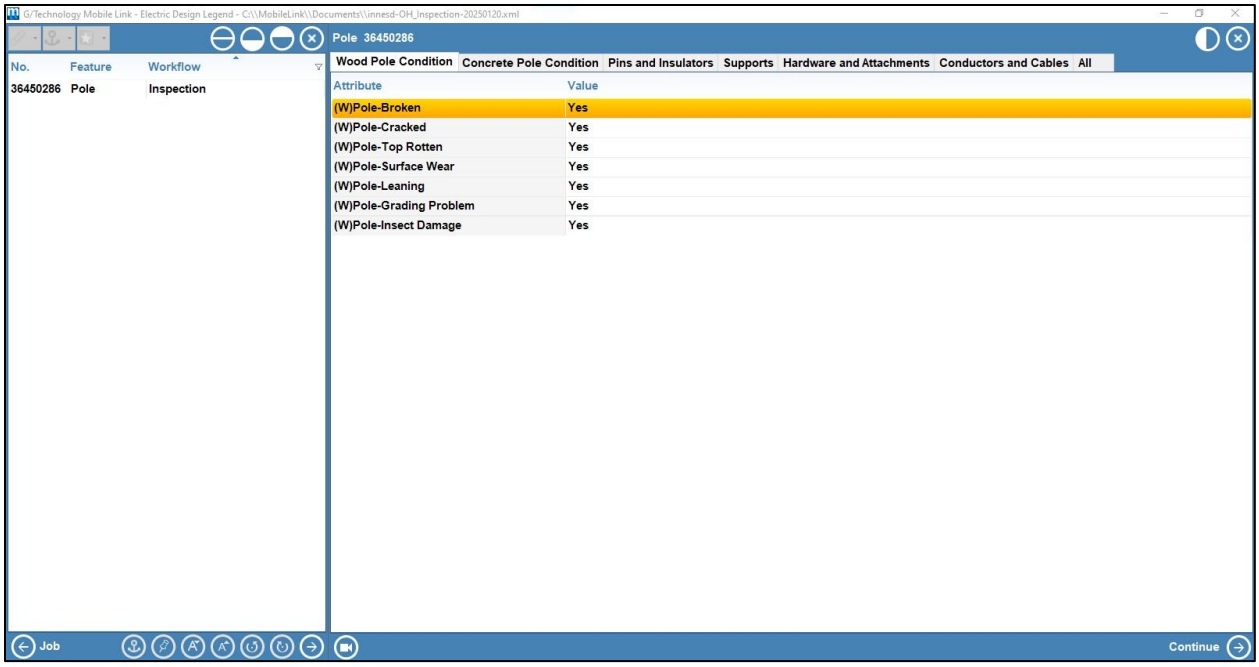


Figure 13-5. Inspection Checklist – Wood Pole

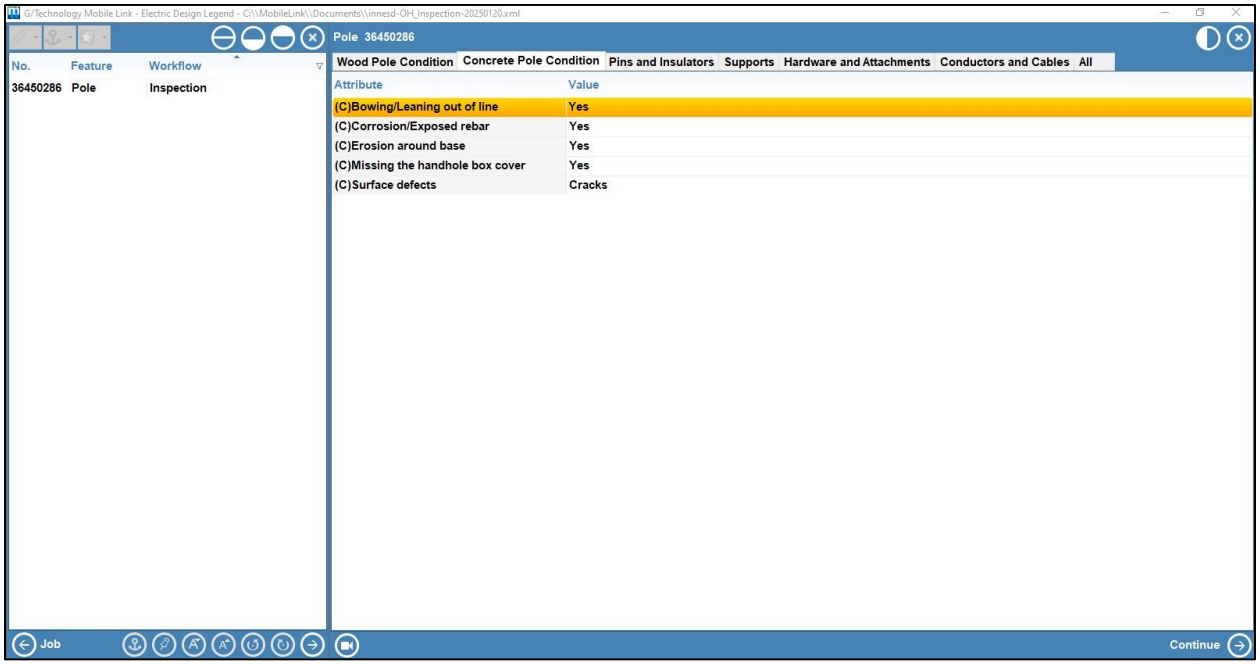


Figure 13-6. Inspection Checklist – Concrete Pole

A Correction Priority condition is available for the overall overhead inspection and reviewed by Line Department to act if the issue is urgent.

Based on the 2024 ACA, the average Health Index of the poles is 88%. The distribution of the various health categories is presented below for wood poles and for concrete poles, separately. Table 13-3 and Table 13-4

summarize the condition assessment of the poles with the respective numbers and percentages in each health category.

Table 13-3. Condition Assessment of Wood Poles

	Health Index Distribution by Number of Units				
	Very Poor	Poor	Fair	Good	Very Good
Quantities	(<25%)	(25% - <50%)	(50% - <70%)	(70% - < 85%)	(>=85% - 100%)
Units	73	916	2988	4120	21178
Percentage	<1%	3%	10%	14%	72%

Table 13-4. Condition Assessment of Concrete Poles

	Health Index Distribution by Number of Units				
	Very Poor	Poor	Fair	Good	Very Good
Quantities	(<25%)	(25% - <50%)	(50% - <70%)	(70% - < 85%)	(>=85% - 100%)
Units	0	0	8	18	109
Percentage	0%	0%	6%	13%	81%

While the concrete poles appear to be in good condition generally, wood poles of poor or fair condition are very numerous. However, fewer poles are in very poor or poor condition now than there were five years ago at the time of the ACA, respectively less than 4% now compared to 8% in 2019. Consistent pole testing has allowed for a timely approach in addressing these severely deteriorated poles. Considering the increased impact of storm weather seen and expected to be seen in the future, addressing the at-risk population in a timely manner will be imperative to ensure that degraded poles are replaced before there is a risk of impending failure.

Figure 13-7 presents the poles by year of installation, color coded by their associated Health Index. As would be expected, the condition gradient follows the demographics, the older the poles the worst their health condition.

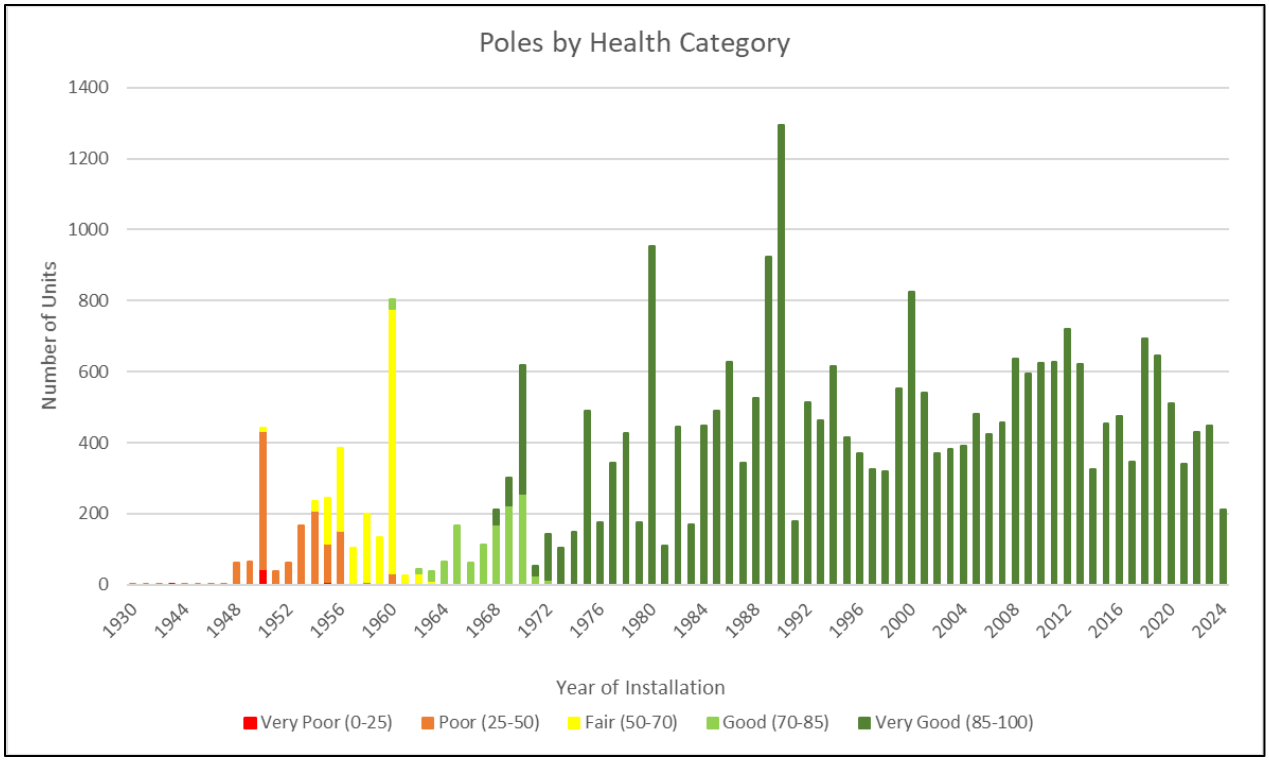


Figure 13-7. Health Categories of Poles

The map in Appendix L illustrates the geographical distribution of all the poles based on their Health Index presented above.

13.1.3 Risk Assessment

Decaying wood poles are a safety risk for workers and can endanger Operations staff and the public if they fail, especially during storms, leading to reduced system reliability. To improve performance, priority should be given to inspecting and replacing aged, high-impact poles – such as multi-circuit or corner poles – since their failure affects very many customers. London Hydro should focus on these during testing and annual replacement planning to prevent severe outages.

There are two ways to plan for the renewal of this asset type with focusing on the elimination of the very deteriorated poles prior to their actual failure. One approach is to maintain a limited number of aging poles (e.g., over 55 years old) in service each year. However, due to current pole age distribution, this would lead to large and uneven annual replacement numbers and scattered locations, making the process less efficient. The preferred approach is risk-based optimization, which balances system performance with

asset replacement. London Hydro uses this method for overhead assets including pole replacements, focusing each year on deteriorated assets that could impact reliability.

13.1.4 Asset Sustainment Strategy

When planning the replacement of deteriorated poles, two approaches can be combined together:

1) Deteriorated poles that do not meet the minimum strength criteria (above 60% strength) are replaced on a one-for-one basis, as per the results of the pole testing program, with existing hardware and associated equipment transferred to the new pole, or updated to current standards where necessary;

2) A full pole line with mostly deteriorated poles can be reconstructed, including the replacement of hardware such as brackets, insulators, conductors, and transformers. London Hydro incorporates both these methods in the pole sustainment strategy, while optimizing overhead asset renewal on a risk-based approach.

Previous ACA replacement rates of poles have been achieved by London Hydro through a combination of London Hydro driven infrastructure replacements, and third party driven work. C

Deteriorated based replacements according to the strength threshold are necessary; however, annual pole testing does not provide an indication on forward looking pace of deterioration, such as how much of the older population will actually test poorly once significantly passing life expectancy. Therefore, an updated FFA plan based on health index for the wood poles in this ASP is presented in Figure 13-8 that aims to mitigate the significant accumulation of deteriorated poles. Poles will continue to be replaced based on poor testing results, as well as targeted deteriorated pole line rebuild programs, which considers overhead risk (i.e., continuation of the 4.16 kV voltage conversion, rebuilds of the 27.6 kV overhead system that are most deteriorated), in addition to City and developer-driven projects that London Hydro must respond to.

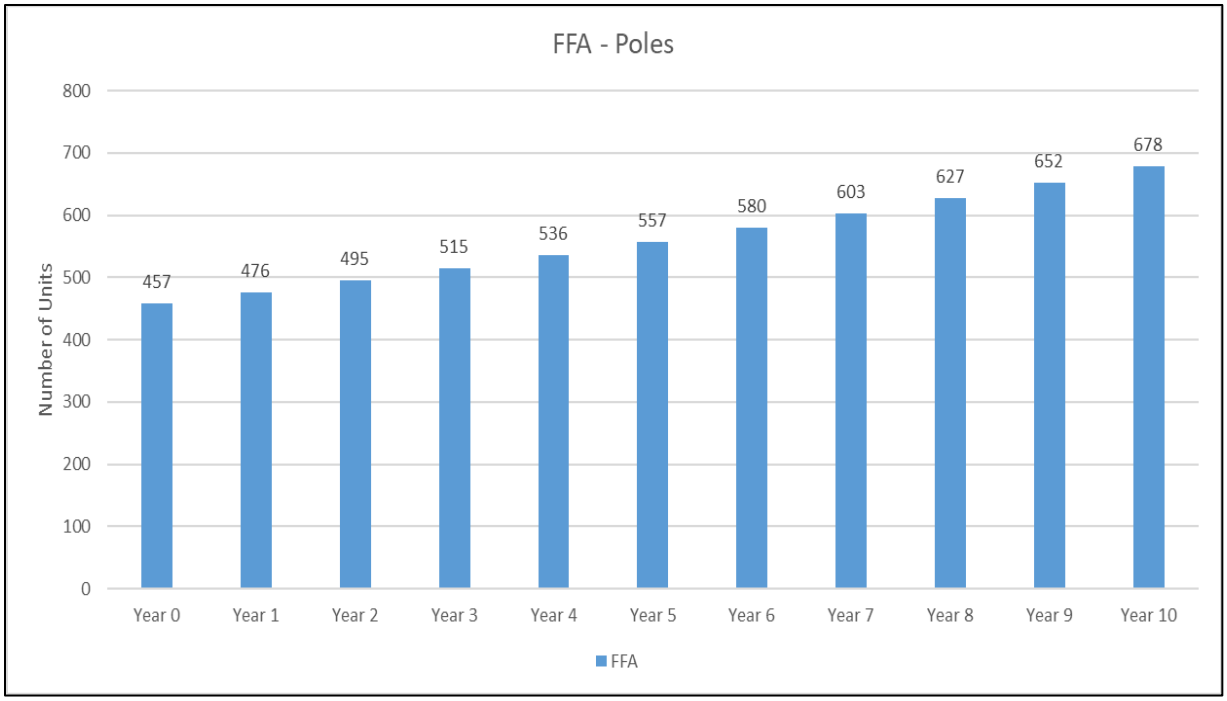


Figure 13-8. FFA Rate for London Hydro Wood Poles

For the London Hydro concrete poles, a field condition assessment was conducted by a third-party contractor several years ago and a number of concrete poles were replaced by wood poles due to their existing deterioration. Concrete poles are included in the annual pole inspection program and replaced based on a risk-approach.

13.2 Pole Attachments

Although London Hydro maintains records in GIS for pole installations as discussed previously, pole attachments (e.g. insulators, switch installation components such as clamshell connectors, etc.) are not tracked separately within GIS due to their wide variety of types / applications / alternatives, as standards and purchasing options have evolved over time. In many cases, a certain subset of attachments can be replaced without affecting the main equipment it is installed on (for example, the replacement of a faulty line insulator installed on a pole is done without affecting the installation year or health of the pole itself). Generic demographics (vintage) and condition information about pole attachments are discussed in the following sections together with plans aimed at the sustainment strategy of these overhead asset components that form the pole attachments class.

13.2.1 Life Expectancy and Age Distribution

Pole attachments generally survive the life of the pole or pole line; however, those that degrade faster and develop a repeating pattern of failure modes are more likely to fail / be replaced prior to the pole reaching end of life, or prior to the pole line being rebuilt. As mentioned, pole attachments are not tracked within GIS directly, and therefore an accurate age distribution is not available. Instead, the known failure modes drive the life expectancy for this asset group, with replacement rates planned based on factors such as safety, criticality, and risk of failure associated with the various attachments. Generic vintage data for certain pole attachments can be inferred from dates of construction standard modifications, typically correlated with alterative hardware selection to replace those known to fail.

The following degraded and at-risk pole attachments have been identified within the system as requiring corrective action:

Cross Arms

For many decades, London Hydro's standard overhead design has utilized armless construction. In cases where cross arms are required for new installations – such as dead-ends or taps – highly durable steel cross arms are now used, although no specific lifespan has been formally established for them. It is expected that only a small number of wooden cross arms remain in service, and it is reasonable to assume that any still in place are over 40 years old.



Figure 13-9. Pole Construction with Wooden Cross Arms

Porcelain Insulators

Porcelain insulators have served utilities for over 50 years, however recurring outages from a consistently identified failure mode has led to intervention into the uses of these types of insulators. Industry investigations on the various failures modes associated with porcelain material have exposed the fact that

the climate / environment conditions where these insulators are installed can cause the material to develop microscopic cracks. These can develop, for example, due to the mechanical stress from wind or conductor tension, which may cause cracking and fractures, making them susceptible to failure. Moisture ingress that freezes and heats over time can cause these cracks to expand. This material degradation reduces the dielectric strength increasing the possibility for electrical flashovers. Below are a few types of porcelain insulators that are present in the system:

		
Porcelain Stand-off and Line-post porcelain	Porcelain Pin type	Porcelain Single Bell Suspension and Dead-End Insulators

Figure 13-10. Porcelain Insulators – Various Types

Other Deficient Insulators

PERMALI dead-end insulators are known to fail due to material degradation that leads to surface tracking, increasing the risk of failure. Also, the original so-called EPAC post type insulators are identifiable by their alternating large and small skirts. Due to the inconsistency in the level of current leakage, these pose a safety and reliability concern.

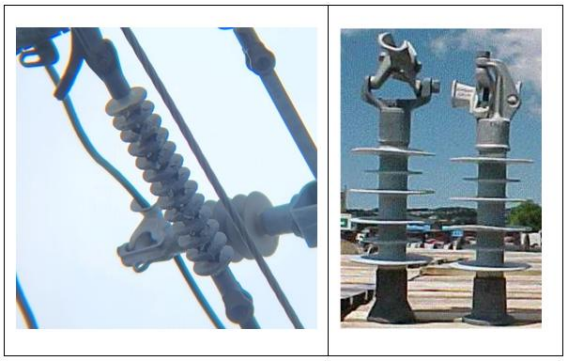


Figure 13-11. Permali (Left) and EPAC (Right) Insulators

Porcelain Cutouts

The same failure mode identified for porcelain insulators also applies to porcelain cutouts, where a porcelain insulator is present. These are known to fail due to cracking and fractures caused by mechanical stress.



Figure 13-12. Broken Porcelain Cutout

Automatic Splices (Quick Sleeves)

Automatic splices (quick sleeves) are obsolete due to their failure risk factors. Failure to maintain the proper tension that the splice relies on, or the degradation of internal components, such as the spring and jaw assembly responsible for griping the conductor, may cause the splice to loosen overtime leading to failure.



Figure 13-13. Automatic Splices

Mid-Span Taps (Flying Taps)

Mid-span taps on medium-voltage overhead lines in a "Z" configuration are at risk of failure due to mechanical stress, which introduces additional strain on the conductors, leading to fatigue and eventual failure.



Figure 13-14. Mid-Span Taps

Switch Installation Components

Clamshell connectors installed at various manual gang-operated switch locations, as well as the connections at the compression lug and switch assembly installed at station risers were identified to be replaced due to increased frequency and impact from historical failures.



4-bolt cane clamps (Clamshell connectors)



Station riser connection

Figure 13-15. Switch Components

Based on the known locations identified so far as part of an ongoing system wide inventory audit, the following total number of locations is estimated for each targeted deficiency (Table 13-5):

Table 13-5. Pole Attachments – Deficiency Locations

Pole Attachments	Number of Locations
Suspect Insulators	650
Porcelain Cutouts	1900
Automatic Splices	250
Mid-Span Taps	50
Switch Installation Components	180

13.2.2 Inspection and Condition

London Hydro performs visual inspections of its entire overhead system on a three-year cycle, inspecting one third of the system each year as part of an internal inspection program. While assessing the structural integrity of overhead conductors from the ground is challenging, these inspections have occasionally identified issues such as arc flash damage or fraying. Additionally, an infrared survey is conducted during the inspection to detect hot spots, which may indicate overheating caused by component overloading or, more commonly, increased resistance from a weak connection. Any identified issues are addressed based on their severity and associated risk.

London Hydro has encountered significant failures with many vintages and types of various pole attachments outlined earlier (deteriorated insulators, porcelain cutouts, etc.). To address these degraded / prone to failure equipment, an inventory survey has been organized to identify, monitor, and track the locations of these deficiencies until replacement would take place. The implementation strategy of this inventory survey and tracking has been done with a focus on the safety and reliability risks. Priority for inspection has been given to feeders / locations with critical customers, or areas experiencing repeated failures to date. Based on a holistic overhead system risk-based optimization approach, targeted audits are also conducted to coordinate with other geographically associated projects for efficiency. A sample of audit results based on the outlined audit strategy is shown in Figure 13-16.

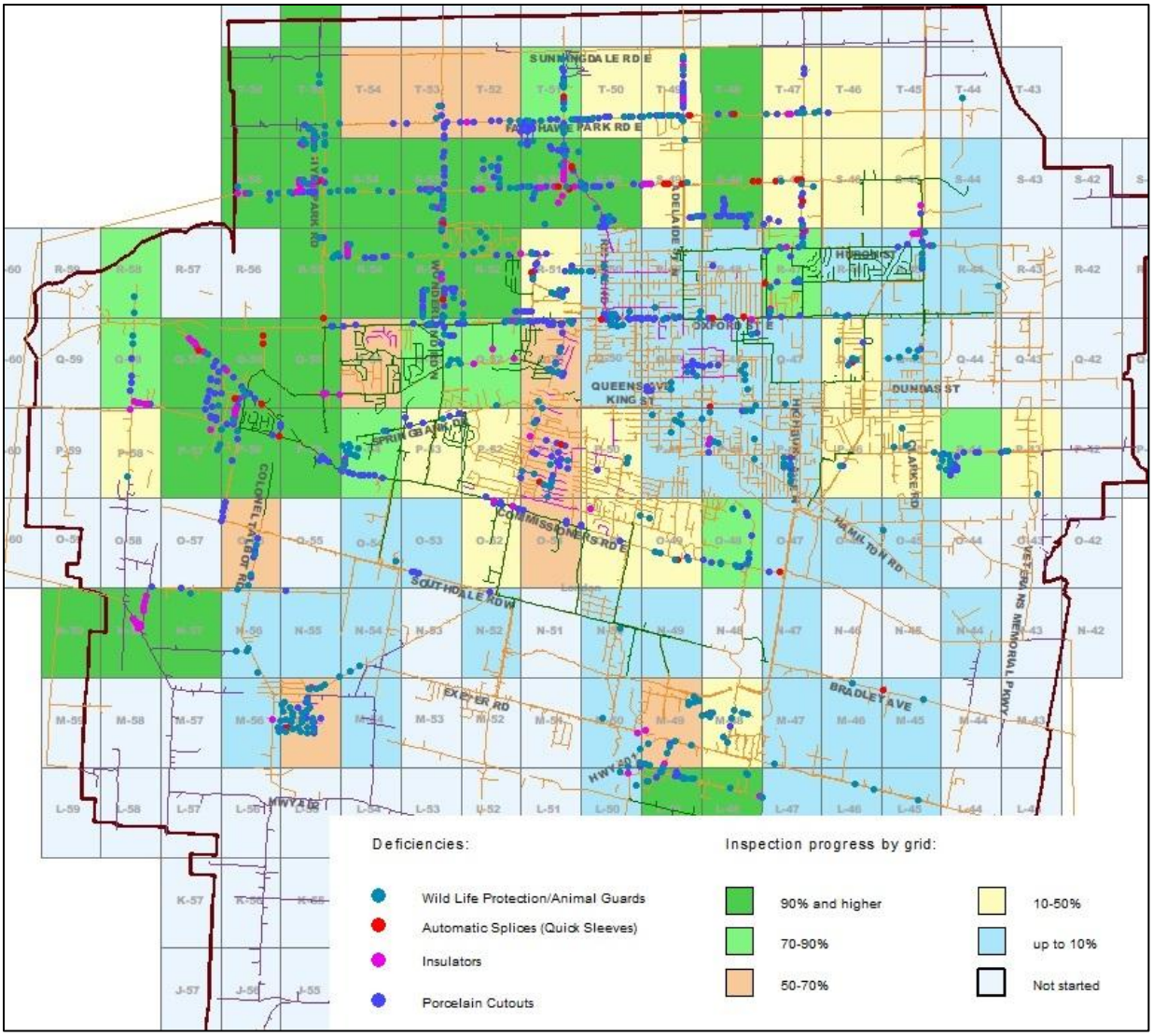


Figure 13-16. Sample Inventory Audit Results

13.2.3 Risk Assessment

Deteriorated pole attachments can pose significant safety hazards and reliability concerns if not addressed before failure. Depending on the location of the failure of the pole attachment, for example on the main line of a feeder, interruptions can impact thousands of customers, and outage duration can be lengthy if patrols are required to determine the exact location of the equipment failure. The high likelihood of failure and consistent reliability impact seen is of concern. Over the last five years, interruptions due to the failure of pole attachments contributed on average 12,800 customer hours of interruption (or over 768,000 customer minutes of interruption) every year, and roughly 22,000 customer interruptions on average each

year. This represents contributions of nearly 11% and 14% respectively to overall yearly SAIDI and SAIFI (excluding Loss of Supply and Major Event Days) on average over the last five years (Figure 13-17).

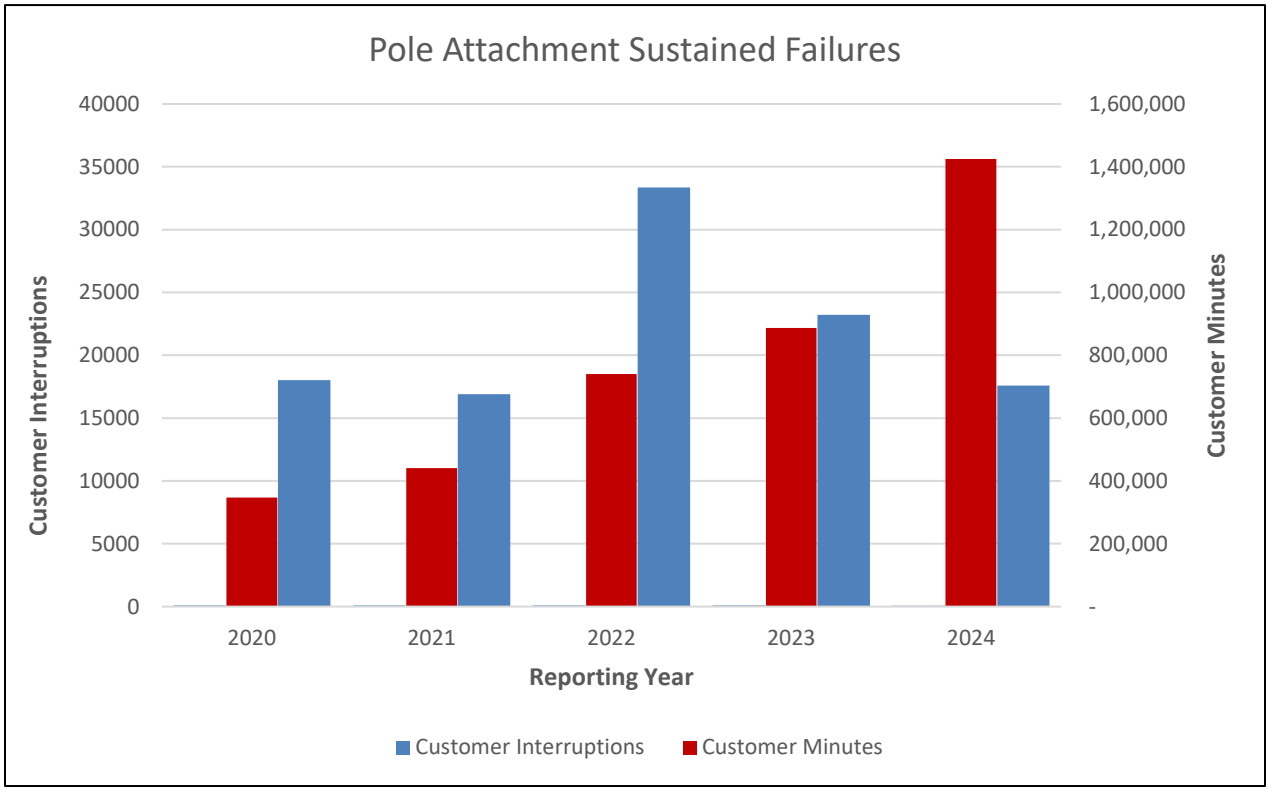


Figure 13-17. Failure Impact from Pole Attachments

Furthermore, certain failure modes of this type of equipment can pose a safety concern to the public. For example, the failure of porcelain cutouts can result in poles fires that are a safety risk for the public, or the failure of a quick sleeve can result in the energized conductor letting go from the splice and falling to the ground.

It is evident that these types of equipment can pose a significant risk to the system reliability and public safety. In addition to the potential for widespread electrical outages affecting large customer segments, the structural integrity of deteriorating conductors presents a hazard, increasing the likelihood of conductor failure and subsequent infrastructure damage. Therefore, comprehensive replacement projects have been developed to align these assets with current overhead construction standards, ensuring compliance with current London Hydro standards and enhancing system resilience.

Conductors typically present minimal risk to system operation, except for #6 solid copper conductors. Although rare, broken conductors can pose serious safety hazards, such as falling to the ground or

unintentionally energizing de-energized lines where crews are working. Bundled primary conductors are especially prone to this risk.

The Christmas tree pole configuration using wood cross arms once posed a significant risk of pole fires in the city but they have been eliminated. Severe pole fires could cause the top of the pole, or the cross arm along with attached conductors, to fall – posing a serious safety threat to both workers and the public. This risk due to Christmas tree configuration has now been largely reduced or virtually eliminated; however, the risk of pole fires exists due to other factors such as failure of porcelain cutouts, etc.

13.2.4 Asset Sustainment Strategy

During pole line rebuilds across the city, London Hydro takes the opportunity to replace conductors and pole attachments where needed. However, even when conductors are simply transferred from old pole lines to new ones, pole attachments could be replaced in coordination with the other work.

Recurring outages from consistently identified modes of failure have led to the following sustainment strategies adopted for pole attachments:

- New cross arm installations, whenever still in use, are standard steel.
- As polymeric insulators are the current North American industry standard, any porcelain insulator, stand alone or part of a cutout, is being replaced with polymeric alternatives.
- Automatic splices have been replaced in the construction standards with a more reliable compression type overhead splice.
- Mid-span taps in “Z” configuration are eventually replaced in a “C” like configuration that reduces strain / stress.
- New switch installation components are following the current standards.

Budgets in the associated capital plans will have to support the necessary work described above in a coordinated approach for practical and financial efficiencies.

14 Substation Transformer

London Hydro supplies a portion of its residential and commercial electricity demand through substation transformers that step-down the voltage from the 27.6 kV system. Within its service area, there are a total of 63 substation transformers: 32 are power transformers located at municipal substations operating at either 4.16 kV or 13.8 kV, while the remaining 31 are installed at customer-dedicated substations. It is important to note that several 4.16 kV substations had their load converted to receive power from the 27.6 kV system, and now only the main 4.16 kV feeders along major roads are still used to connect with adjacent remaining substations. No station remains at 8.32 kV voltage.

Many of London Hydro's original municipal substations were built 50 to 60 years ago during a period of rapid city growth, when 27.6 kV was used as a sub-transmission voltage and 4.16 kV was the standard distribution level. London Hydro has been actively phasing out 4.16 kV substations through conversion projects[32] in priority based on multiple factors such as age, condition, and performance of assets.

Fifteen years ago, London Hydro built three new substations: Sub-10, Sub-11, and Sub-12, to supply the downtown 13.8 kV network from a 27.6 kV source. These substations form a closed looped system called the downtown "ring bus" and are equipped with step-down transformers, switchgear, and digital relays for protection and control.

The map in Appendix M indicates the substations that remain in service and the removed ones, and the boundaries of each conversion zone.

14.1 Life Expectancy and Age Distribution

Substation transformers are assigned 55 years as anticipated service life based on industry practice and empirical data. Seven substation transformers past this threshold were still in-service last year but operating at light load levels.

The distribution of all the substation transformers by year of installation is presented in Figure 14-1. The average age is 28 years old.

[32] 4.16 kV Conversion Progress Report 2025 Update

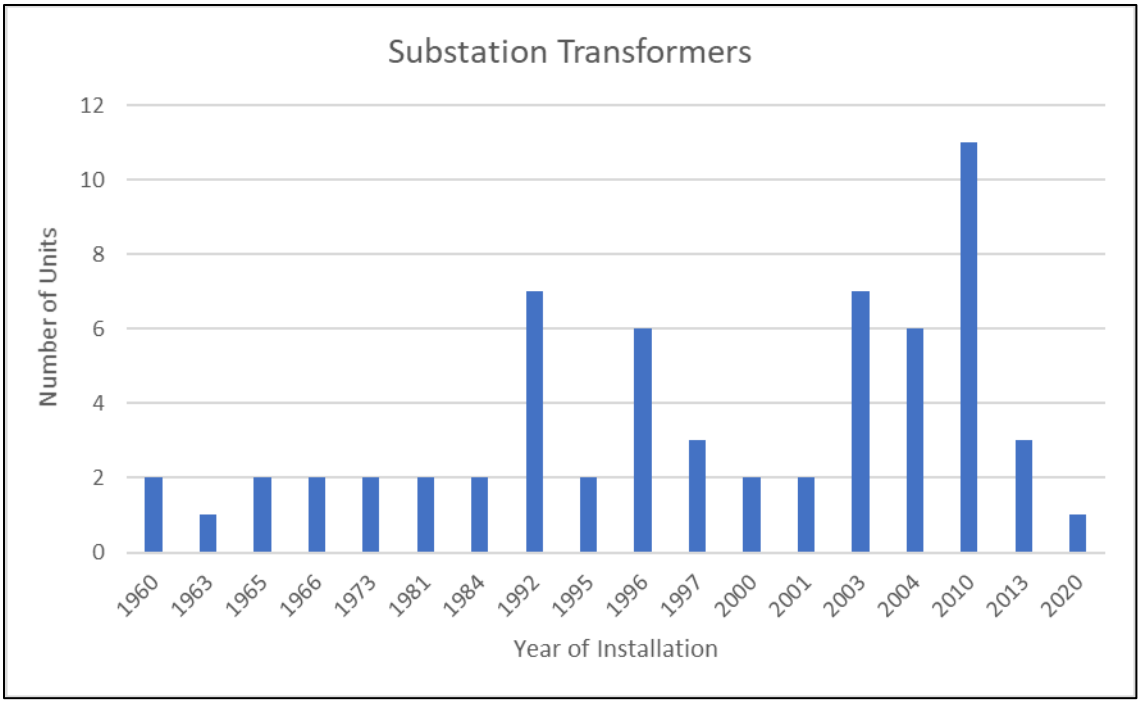


Figure 14-1. Age Distribution of Substation Transformers

14.2 Inspection and Condition

London Hydro's substations are inspected at different intervals depending on their design. Outdoor substations with open buses, exposed cables, and neutrals are inspected monthly, while all other types undergo inspections every quarter. The sample inspection checklist used in Mobile Workforce for substations is presented in Figure 14-2. Collected field data is documented, allowing for the generation of summary reports and the tracking of repair progress. Substation inspections also serve to ensure site security and, during winter months, to check the condition and operation of heaters.

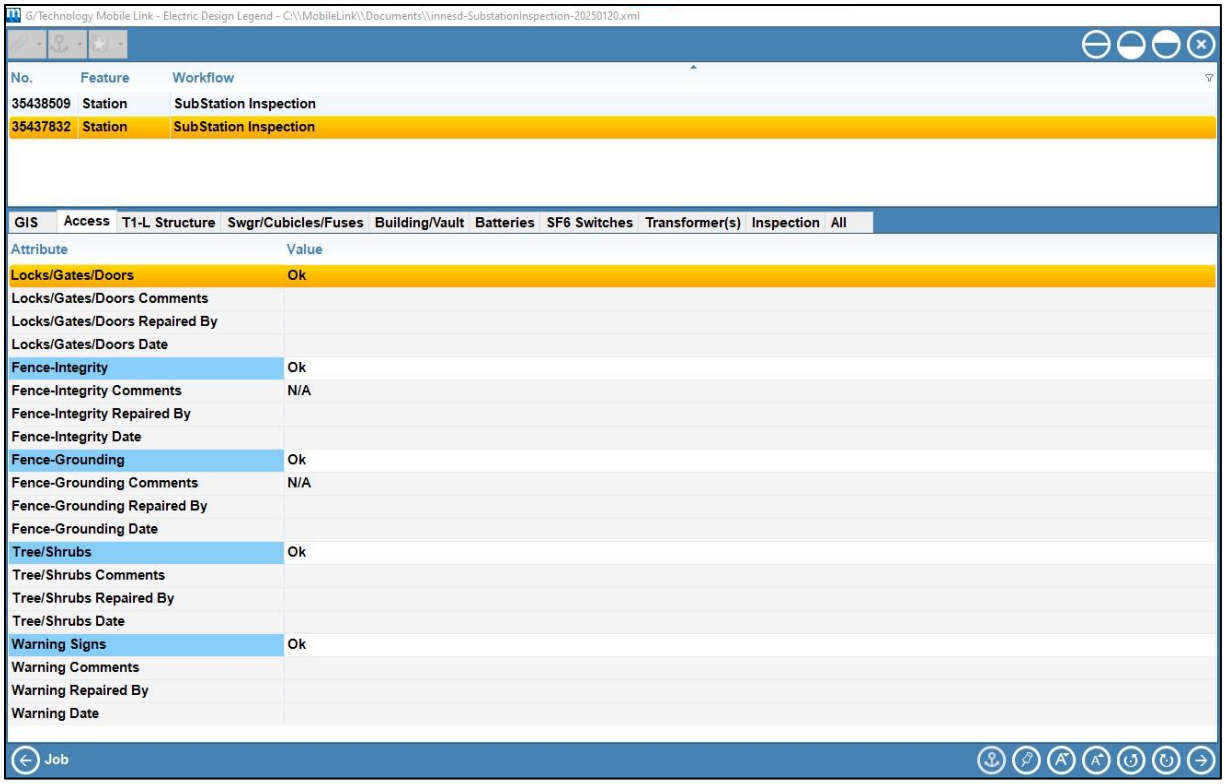


Figure 14-2. Inspection Checklist – Substations

At the same time with substation inspections, substation transformers are also subject to specialized inspections guided by the forms shown in Figure 14-3 and Figure 14-4, typically conducted on a quarterly basis. Comprehensive details on the inspection and maintenance procedures for municipal substation transformers are outlined in the 2023 report titled "*Guideline for the Inspection and Maintenance of the Substation Transformers.*"

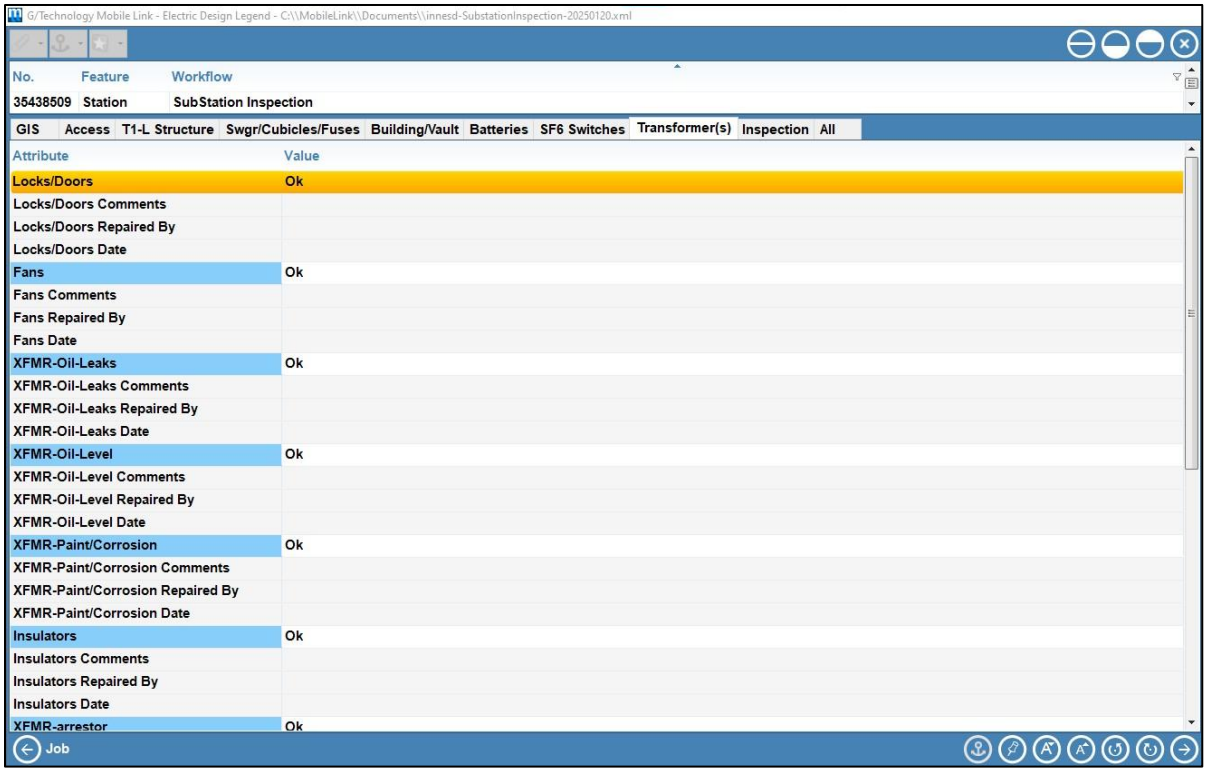


Figure 14-3. Inspection Checklist – Substation Transformers (Screen 1)

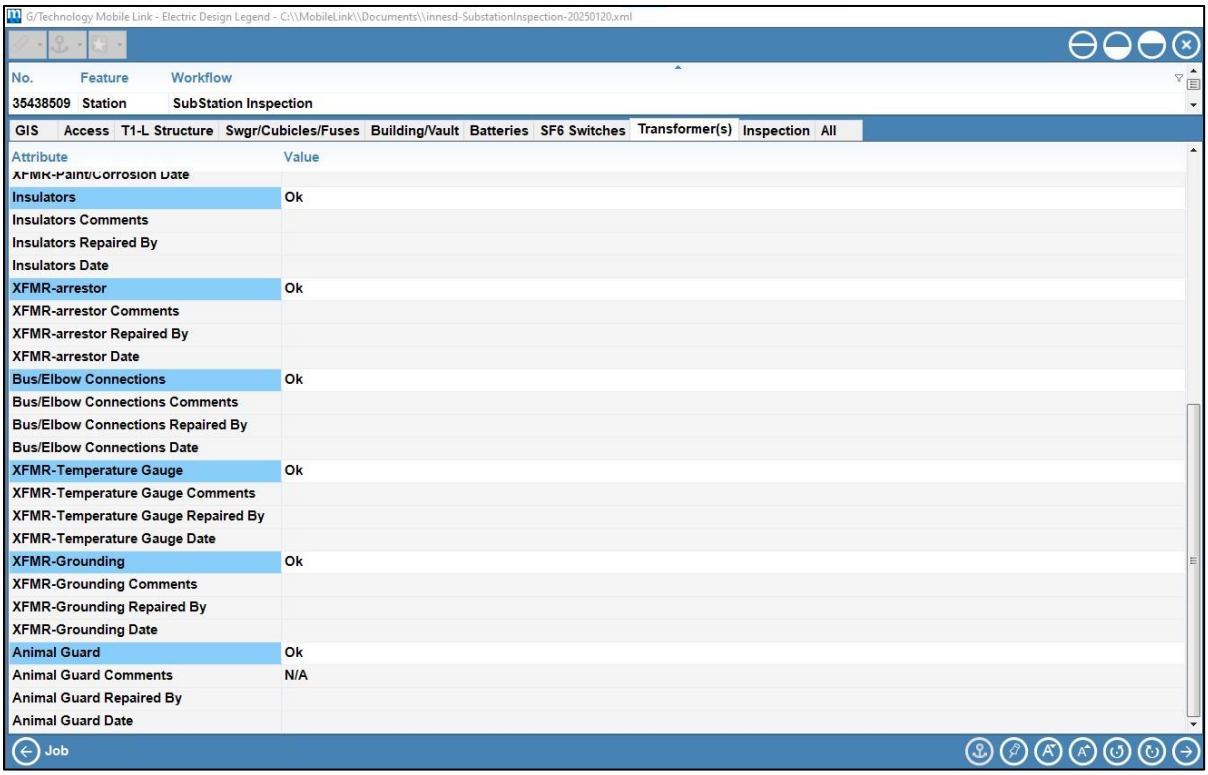


Figure 14-4. Inspection Checklist – Substation Transformers (Screen 2)

As part of the annual transformer inspections, oil samples are collected and sent to a specialized laboratory for testing. These tests usually include Oil Quality (OQ) analysis and Dissolved Gas Analysis (DGA). The results, interpreted according to international industry standards[33], help assess the condition of the transformer insulation and identify early signs of potential internal faults. Historical OQ and DGA results are analyzed to understand each transformer's operational history and to guide maintenance planning. Any irregularities found are evaluated to decide whether a transformer is needed to be taken out of service for a detailed inspection, or if further maintenance work on the transformer is warranted (i.e., oil change). London Hydro also conducts an annual infrared survey at substations to identify overheated components or weak connections. However, maintenance and replacement planning primarily relies on findings from annual oil analyses and routine detailed inspections.

While some of London Hydro's substation transformers are relatively old, voltage conversions over the years have decreased their load, so they are seldom overloaded and typically remain in good working condition. However, ongoing maintenance is necessary to address urgent issues such as oil low dielectric strength or leaks.

The condition assessment of the substation transformers according to the 2024 ACA has the following distribution (Table 14-1), with the average Health Index being 80%.

Table 14-1. Condition Assessment of Substation Transformers

	Health Index Distribution by Number of Units				
	Very Poor	Poor	Fair	Good	Very Good
Quantities	(<25%)	(25% - <50%)	(50% - <70%)	(70% - < 85%)	(>=85% - 100%)
Units	0	17	1	5	40
Percentage	0%	27%	2%	8%	63%

For substation transformers' asset condition, after calculating their Health Index using the defined 2024 ACA methodology, none of the units are in the very poor category but 17 units[34] are in the poor category. Among the municipal substation power transformers, the following Health Index values were obtained (Table 14-2). As of the end of 2024, 17T1 and 22T1 had already been eliminated from service through conversion in their respective zones.

[33] IEEE C57.104-2019: IEEE Guide for the Interpretation of Gases Generated in Mineral Oil-Immersed Transformers
[34] The 17 units include municipal substation power transformers and customer dedicated substation transformers.

Table 14-2. Health Index Power Transformers (4.16 kV and 13.8 kV)

SUB PTX	HI	SUB PTX	HI
17T1	26%	83T2	94%
16T1	29%	96T1	95%
27T1	30%	9T1	95%
29T1	41%	12T3	96%
22T1	42%	24T1	96%
52T1	42%	93T1	96%
49T1	46%	12T1	97%
12T2	48%	51T1	97%
35T1	81%	83T1	97%
41T1	81%	11T1	98%
55T1	82%	11T2	98%
23T1	83%	11T3	98%
39T1	85%	11T4	98%
43T1	91%	12T4	98%
10T1	94%	44T1	98%
38T1	94%	33T1	100%

14.3 Risk Assessment

All of London Hydro's substation sites and transformers are PCB-free. However, oil leaks from substation transformers continue to pose a serious environmental risk. Even when leaks are contained on-site, they can still penetrate soil and gravel, potentially contaminating groundwater or entering the sewer system. Each potential incident however would be addressed promptly, with clean-up conducted in compliance with current environmental standards and regulations. In the year 2020, London Hydro introduced a new oil containment design for substation transformers that so far has been implemented at Sub-39 and Sub-114.

The primary risk associated with aging substation transformers is the potential impact on system reliability in the event of a failure. Although the distribution system is generally designed with backup supply capabilities to manage transformer failures or planned maintenance outages, these contingency events place greater strain on the system during peak demand periods.

Several municipal substations have been decommissioned over the past decade as the deteriorated 4.16 kV infrastructure and associated loads have been upgraded to 27.6 kV. This conversion process sometimes allows for the recovery of spare components, including substation transformers, which can be redeployed at other sites. As London Hydro progresses with voltage conversion in the designated zones, some

substation transformers may remain in operation despite carrying little or no load. In the event of a contingency, these lightly loaded substations may be required to support and backup other substation's load. Therefore, it is crucial to ensure that all 4.16 kV loads have an established backup supply before a substation is fully decommissioned.

14.4 Asset Sustainment Strategy

London Hydro conducts preventive maintenance on substation transformers when oil testing reveals unacceptable degradation or when dissolved gas analysis (DGA) detects the presence of arcing by-products. Preventive maintenance may include procedures such as drying and / or filtering oil that has absorbed excessive moisture, or cleaning and repairing tap changers responsible for internal arcing. Corrective maintenance is often carried out on older transformers, particularly to address oil leaks. If the leaks continue and become difficult to control, the transformer will be given a higher priority for condition improvement or replacement.

The most recent report *"4.16 kV Conversion Progress Report (2025 Update)"* outlines the conversion work completed since 2022 and details the remaining portions of the 4.16 kV distribution system. The report reaffirms the ongoing priority of converting 4.16 kV substations. This effort is aimed at lowering the risk of in-service transformer failures by ensuring that the highest-priority substations are addressed promptly. The objective is to proactively identify and address existing and potential risks through the strategic planning of capital projects in targeted areas.

Voltage conversion will continue within designated zones throughout the planning horizon. The original multi-year voltage conversion strategy already led to several zones completed, as shown in Table 14-3. Current plans focus on decommissioning the remaining substations and associated transformers in Zones D and G. This process is driven not only by the condition of the substation transformers but also by the condition of the overhead and underground infrastructure served by each substation. Consequently, while work in Zone D is underway, capital projects in Zone G may begin if system audits highlight priority assets for removal – such as deteriorated Bell poles in backyards – or identify areas of poor reliability performance. Final capital planning decisions will be guided by broader system planning initiatives.

Table 14-3. Substation Multi-Year Conversion Plan by Zones

Conversion Zone	No. of Substations Removed[35]	No. of Transformers Removed[36]
Zone A (complete)	3	5
Zone B (complete)	4	5
Zone C (complete)	4	4
Zone D (2026-2028)	5	5
Zone E (complete)	3	3
Zone F complete)	2	2
Zone G (2027-2030)	2	3
Total	**23**	**27**

As part of its strategy, London Hydro will consider redeploying younger and healthy substation transformers – removed during voltage conversions – to substations currently operating with older units. This approach could extend the service life of those substations, particularly if they are intended to remain in operation until future conversion plans are implemented. This ASP assumes that no capital investment will be required specifically for proactive replacement of aging substation transformers, but one substation transformer removal per year can be expected in this planning horizon as part of the overall 4.16kV voltage conversion plan and ongoing inspections and maintenance.

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[35] Indicates the number of stations decommissioned within the conversion zone
[36] Indicates the total number of station transformers to be removed upon completion of the conversion zone

15 Substation Switchgear

Over the past five years, London Hydro has decreased its number of municipal substations from 36 to less than 30. As a result, the quantity of switchgears providing secondary protection at these substations has also been reduced. Despite this reduction, London Hydro continues to maintain a diverse inventory of switchgear types and plans to keep them operational until the station's load has been converted and the respective station is decommissioned. In addition to municipal substations switchgears (27), there are protective switchgears at seven customer dedicated substations.

The following types of switchgear continue to be in use at London Hydro:

- Circuit breaker
- Oil recloser
- Pad mounted solid-dielectric
- Pad mounted SF6
- Overhead solid-dielectric recloser
- Pad mounted vacuum recloser

15.1 Life Expectancy and Age Distribution

Substation switchgears are assigned different service life intervals, according to their type, based on industry practice and empirical data.

- 40 years for reclosers
- 40 years for pad mounted solid-dielectric
- 45 years for pad mounted switchgear SF6
- 50 years for circuit breakers

Thirteen units (10 circuit breaker assemblies and three oil reclosers) are currently past their respective life expectancy.

Many of London Hydro’s original municipal substations were installed 40 to 50 years ago during a period of rapid city growth, and the associated switchgears are of a similar age. The three most recent substations (Sub-10, Sub-11, and Sub-12) were built about 15 years ago and are among the newest. In addition to step-

down transformers, these stations are equipped with pad-mounted solid-dielectric switchgear and digital relays for automated protection and control.

Including the switchgears installed at customer dedicated substations, the distribution of the switchgears by year of installation is presented in Figure 15-1. The average age of all the switchgears is 37 years old.

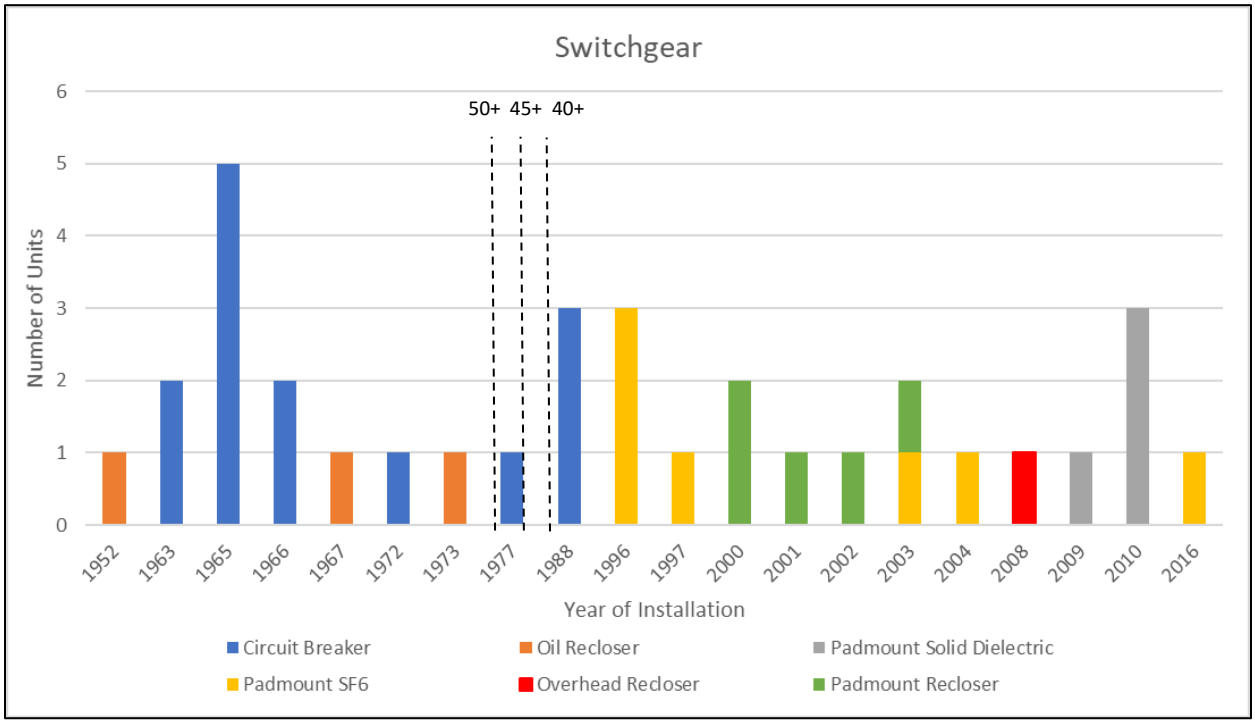


Figure 15-1. Age Distribution of Switchgears

London Hydro operates metalclad switchgear line-ups at several of its municipal substations. These units include various types of breakers that provide secondary protection. The oldest assemblies were installed in the early 1960s. The longevity of these switchgear line-ups is largely due to the availability of replacement parts, which has supported their continued operation over the decades. Other switchgear assemblies are oil-filled hydraulic reclosers, and automatic pad mounted or overhead reclosers. These devices serve as replacements for breakers in smaller substations, which typically supply a single feeder. In addition, six new automated load centers and ten new SCADA controlled fault interrupters act as circuit breakers at Sub-10, Sub-11, and Sub-12.

The protective equipment at the substations utilizes only modern electronic relays. All the old electromechanical relays have been replaced. While London Hydro lacks sufficient data to determine the

average lifespan of electronic relays, it is anticipated that some will require replacement within the next decade, having been in service for 20 years at which age failures could start to occur.

London Hydro also operates a number of primary switches at 4.16 kV substations, conventionally designated as T1-L. These switches serve to isolate the substation transformer from the incoming medium-voltage supply feeder. The overhead switches are generally as old as the original 4.16 kV switchgear, whereas some of the solid-dielectric pad-mounted switches are relatively newer.

15.2 Inspection and Condition

The substations inspection schedule was discussed in Section 14 Substation Transformer.

For switchgears in particular, inspections are scheduled on a monthly or quarterly basis depending on switchgear type. For maintenance, a 5-year cycle is implemented unless a deficiency is caught during inspection that needs immediate attention.

The condition assessment of switchgears according to the 2024 ACA has the following distribution (Table 15-1), with an average Health Index of 64%.

Table 15-1. Condition Assessment of Switchgears

	Health Index Distribution by Number of Units				
	Very Poor	Poor	Fair	Good	Very Good
Quantities	(<25%)	(25% - <50%)	(50% - <70%)	(70% - < 85%)	(>=85% - 100%)
Units	12	0	1	1	20
Percentage	35%	0%	3%	3%	59%

Most of the switchgears that are in very poor condition (for which analysis was based solely on age) are represented by circuit breakers installed in the 1960s. London Hydro conducts regular maintenance and repairs on all substation breakers, which includes lubrication, testing, cleaning, and replacing arc chutes as needed. The oil-filled reclosers at municipal substations are also maintained by the Operations department (e.g. the oil is replaced when and if necessary). Overall, the switchgear equipment is being maintained in working condition.

As part of routine maintenance, all relays undergo a thorough inspection, and Operations staff reassess their performance in the event of any mis-coordination during faults. Newer electronic relays – most of

which are around 15-20 years old – are considered to be in good condition but potentially approaching life expectancy.

The condition of the remaining original T1-L switches is assessed during routine substation inspections. London Hydro also carries out periodic maintenance on T1-L switches mounted on overhead lattice structures (open bus) within substations (two stations).

15.3 Risk Assessment

The primary risk associated with deteriorated or faulty switchgear is reduced system reliability, particularly in the event of an internal bus failure. Because each switchgear line-up typically serves multiple feeders, such a failure can lead to power outages across a broader area. Additionally, inadequately maintained switchgear may fail during operation, posing an arc flash hazard to personnel. When reclosers are used for protection within substations, they function as stand-alone units, each dedicated to protecting a single feeder so the impact to reliability is diminished should one recloser fail in service.

A relay failure can lead to breaker mis-operation, which in turn may cause a power outage across an entire 4.16 kV feeder. Relays are essential for interrupting faults, minimizing equipment damage, and ensuring public safety. As such, proper calibration and maintenance are crucial to maintaining reliable operation.

The primary risk associated with the failure of a T1-L switch is reduced reliability, as it can result in a complete loss of power to the entire substation. If the substation's load lacks backup – particularly during peak demand periods – the outage could persist until the switch can be repaired or replaced. As a result, these substations are prioritized for maintenance.

15.4 Asset Sustainment Strategy

Over the past decade, many municipal substations have been decommissioned following the conversion of 4.16 kV loads to 27.6 kV. This process sometimes creates opportunities to salvage spare parts for reuse in other switchgear installations.

Switchgear assets are maintained in coordination with their associated substation transformers, batteries, and other relevant infrastructure. Switchgears at 4.16 kV substations will be removed as stations are decommissioned following the conversion of their associated loads. Of the circuit breakers with the lowest Health Index – specifically those at Sub-16, Sub-17, Sub-22, and Sub-27 – two switchgear line-ups have

already been decommissioned by the end of 2024. In the planning interval there is no capital budget associated with a new switchgear but removals will occur in coordination with substation decommissioning.

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16 Batteries

London Hydro currently maintains a number of battery banks that are required at municipal step-down substations, to enable the breakers to be opened and closed during power outages. With proper maintenance, batteries can be expected to last a minimum of 15 to 20 years.

There were 18 battery banks in service at municipal substations at the end of 2024. In addition to these, there are batteries in seven SF6 switchgear at some load centres[37] (e.g. two at Sub-4, London Life).

16.1 Life Expectancy and Age Distribution

Battery banks are assigned 20 years as anticipated service life based on industry practice and empirical data.

The distribution of all the batteries by year of installation is presented in Figure 16-1. The average age of all the batteries is 13 years old. Almost all batteries (83%) are below end-of-life.

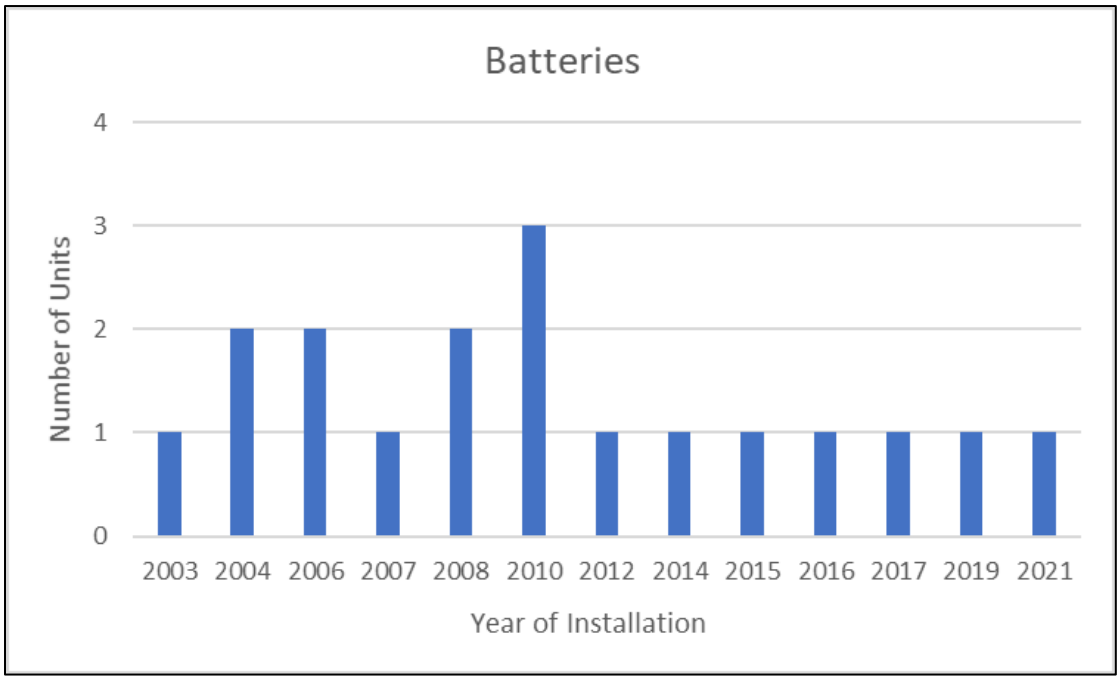


Figure 16-1. Age Distribution of Batteries

[37] Some of these batteries required replacement recently due to poor test results so capital budgets will continue to be allocated for batteries beyond finishing 4.16 kV conversion.

16.2 Inspection and Condition

Capacity tests are performed annually for the substation batteries, with each battery bank having a drawdown test at least every other year. The battery banks get a visual inspection with every substation inspection and measurements (voltage, current) are recorded, checking the voltage of every individual cell. If the water is low, it is topped up by the operators.

The inspection checklist used in Mobile Workforce can be found in Figure 16-2.

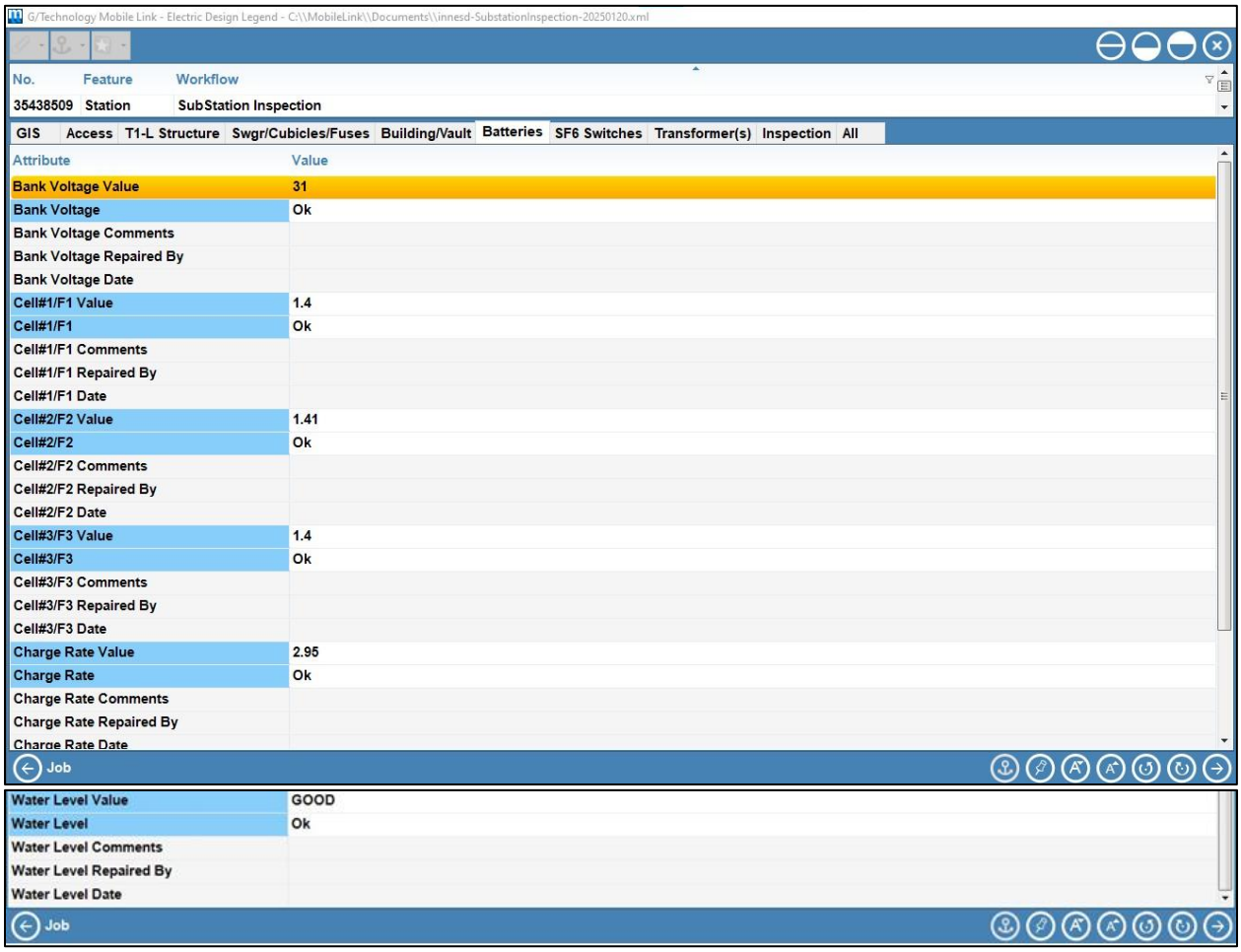


Figure 16-2. Inspection Checklist – Batteries

The condition assessment of the batteries according to the 2024 ACA has the following distribution (Table 16-1), with an average Health Index of 76%.

Table 16-1. Condition Assessment of Batteries

Quantities	Health Index Distribution by Number of Units				
	Very Poor	Poor	Fair	Good	Very Good
	(<25%)	(25% - <50%)	(50% - <70%)	(70% - < 85%)	(>=85% - 100%)
Units	1	1	4	3	9
Percentage	6%	6%	22%	17%	50%

16.3 Risk Assessment

The primary risk associated with deteriorated batteries is the potential failure of relays to function properly, which can lead to incorrect breaker operations during faults and trigger the station's primary protection system causing a broader outage. Batteries are essential to substations, as they must remain in good condition to support remote relay resets and ensure circuit breakers can be operated during power outages.

16.4 Asset Sustainment Strategy

The battery banks are replaced as part of an ongoing annual program; tests determine which substation needs the batteries replaced. It is anticipated that one battery bank will be replaced annually for the next ten years.

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17 Low Voltage Underground Cable

This section covers the low-voltage (LV) underground cables used for residential and commercial secondary service connections. It also includes some information on pedestals, which are components found in older residential secondary distribution systems. The total length of secondary cable installed across the system based on voltage and phase is found in Table 17-1. According to London Hydro's early standard installation practices, it can be assumed that the majority of the secondary residential conductor (240/120 V) is 1/0 Al in size, but there are other conductor sizes, smaller (#2) or larger (4/0 and 350 kcmil in residential supply, and up to 500 kcmil and 750 kcmil on the secondary network downtown), depending on ampacity requirements (e.g. 100 amps, 200 amps, 400 amps).

Table 17-1. Low Voltage Cable Length by Service Classification[38]

Service Type	LV Single-Phase	LV Three-Phase		
Service Voltage	240/120 V	208Y/120 V	600Y/347 V	Non-standard[39]
Length (km)	4038	71	64	<1
Total Length (km)	4174			

The estimated cable length based on a 2024 GIS query shows a much larger quantity of LV cable compared to the previous ACA report. This increase is primarily due to the large number of Underground Distribution (UD) drawings that have been converted from paper to digital format over the past five years. These digitized drawings more accurately reflect the actual field route in GIS, resulting in more precise cable length estimates.

There are many customer-owned LV secondary cables (including City of London and other utilities such as Rogers and Bell), usually serving three-phase customers but also some single-phase load, that are included in the table above which are not analyzed in the remainder of this section. Only London Hydro owned LV underground cable, which is an estimated 4012 km out of the total of 4174 km, is analyzed herein; this length includes approximately 16 km of downtown network secondaries.

[38] Typical ownership for commercial secondary conductor is customer-owned, but there are some services owned by London Hydro.
[39] Non-standard low voltages present on London Hydro system are: 416/240 V, 480Y/277 V and 600 V Delta.

A report entitled “Low Voltage (LV) Underground Conductor Risk Assessment and Asset Management Strategy” was issued in December 2024. For convenience, some of the information is reproduced in this 2025 Asset Sustainment Plan.

17.1 Life Expectancy and Age Distribution

In the absence of any specific industry standards, the average lifespan of LV underground service cable is generally assumed to be a minimum of 60 years – approximately 1.5 times that of underground primary cable installed at the same time. In many subdivisions, the primary cable has been replaced once while the secondary cable is still the original one.

London Hydro started installing underground cable in subdivisions in the early 1960’s, so much of the original conductor could be close to its end of life already. With the advent of UD conversions, both the length and installation year of LV underground cables are now more accurately captured in GIS. As a result, less than 1% of the total cable length currently has an unknown installation year, compared to five years ago when it was 5%. For the LV underground conductor the demographics as per GIS are depicted in Figure 17-1 (unknown installation year is recorded as “0”).

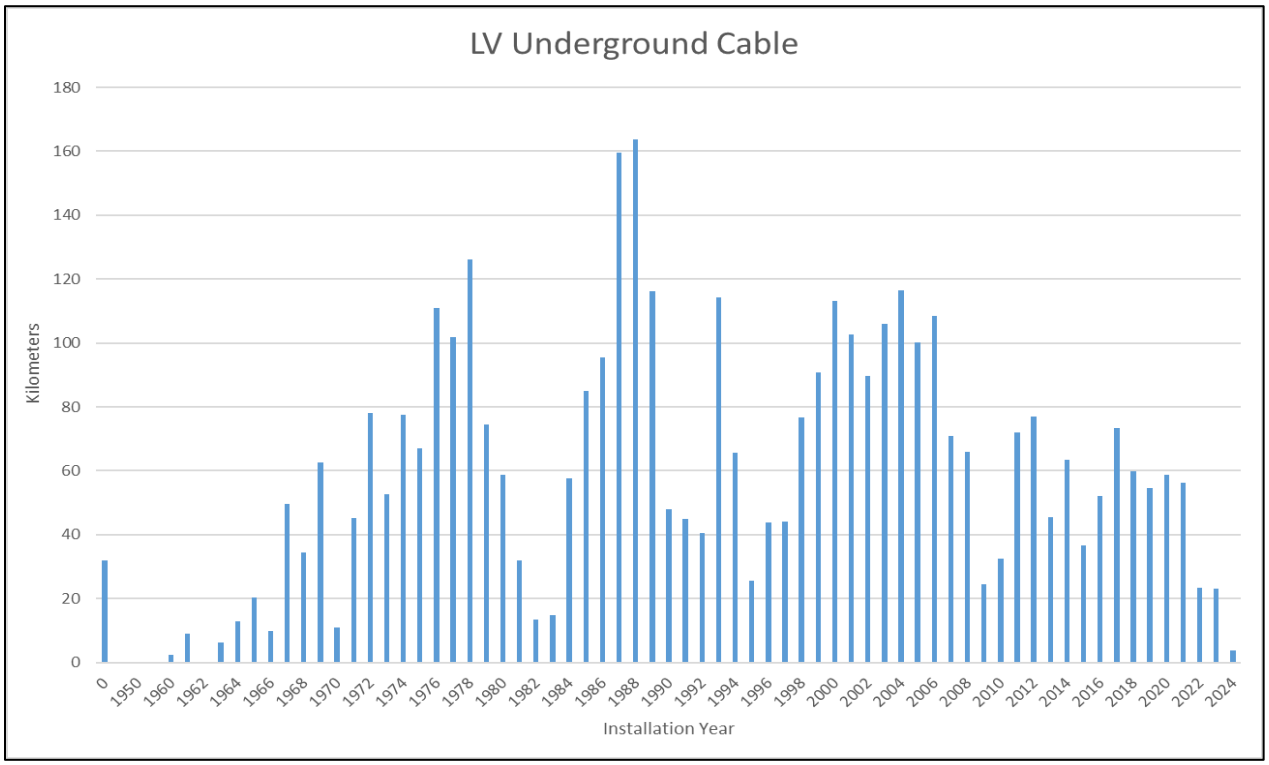


Figure 17-1. Age Distribution of LV Underground Cable

The average age of the London Hydro's LV underground cable is 31 years old.

In addition to LV underground cable, older residential subdivisions employ many pedestal assemblies, mounted on pads, for secondary conductor electrical connections. There were approximately 1600 pedestals in-service at the end of last year and, in addition, approximately 5000 pullboxes installed below grade that serve a similar purpose. Based on a search by age, more than 60% of the pedestals are over 30 years old but the industry has not established a life expectancy for these assets.

17.2 Inspection and Condition

There is no inspection program for underground secondary services since they are entirely buried, with the exception of the termination points at transformers. The condition of underground secondary cable is thought to be highly influenced by the surrounding environment and installation practices, rather than its insulation performance due to the reduced electrical stress operating at lower voltages. As a result, secondary cable faults observed over the years typically show no consistent pattern or clear correlation with the cable's years in service, indicating that the LV system may not yet be at that critical age where a large and consistent number of failures are occurring similar to the primary system. Further discussion on risk assessment related to secondary cable faults is provided in the next subsection.

Secondary cable faults are frequently caused by splice failures, which require excavation for repair or replacement. During this process, workers can evaluate the cable's condition – such as exposure to rocky soil, clay, moisture, or signs of aluminum corrosion. Based on these findings, Operations staff can determine whether to simply repair the splice or replace the entire secondary service cable.

Figure 17-2 below shows a failed underground secondary splice.



Figure 17-2. Secondary Splice Failure

A Health Index is not available for LV underground cables. However, a classification by vintage is provided below in Table 17-2 to give an indication of the major age groups. Notably over a quarter of the entire population of LV underground cable could be past 60 years of age in the next 20 years with almost 2% already exceeding that threshold currently.

Table 17-2. Demographics of Low Voltage Underground Cable

Conductor vintage	Over 60 years	40-60 years	20-40 years	0-20 years
Total length (km)	67	1,100	1,746	1,099
Total length (%)	1.7%	27.4%	43.5%	27.4%

A map identifying the single-phase LV underground cable by color code is presented in Appendix N.

As previously noted, London Hydro maintains a significant number of low-voltage pedestals that connect multiple single-phase residential service cables to an underground low-voltage common bus, typically a larger conductor size such as 4/0. Some of these pedestal enclosures have begun to corrode and deteriorate (Figure 17-3), with internal connections and barriers showing signs of failure. For safety reasons, these issues must be addressed. In recent years, London Hydro has addressed an increasing number of pedestal replacements; however, this remains a reactive approach with deteriorated pedestals being replaced primarily when customer-driven service upgrades are requested due to electrification or load increases.



Figure 17-3. Rusted LV Pedestal

17.3 Risk Assessment

A fault in a secondary service cable typically only affects part of the supply feeding a single customer, impacting individual customer reliability. London Hydro's current approach is to repair the failed cable, and proceed with a full replacement only when absolutely necessary, or after two splices were introduced already from previous faults.

Fault data on full secondary systems – from transformer to meter base – is available from 2012 onward in Figure 17-4 (with the blue dotted line being a two-year moving average). An average of 150 - 175 secondary faults per year is observed, which represents a very small fraction (0.2%) of the total estimated secondary services in operation. As previously noted, the likelihood of failure is influenced by various factors – such as corrosion, mechanical damage, and soil conditions – rather than age alone.

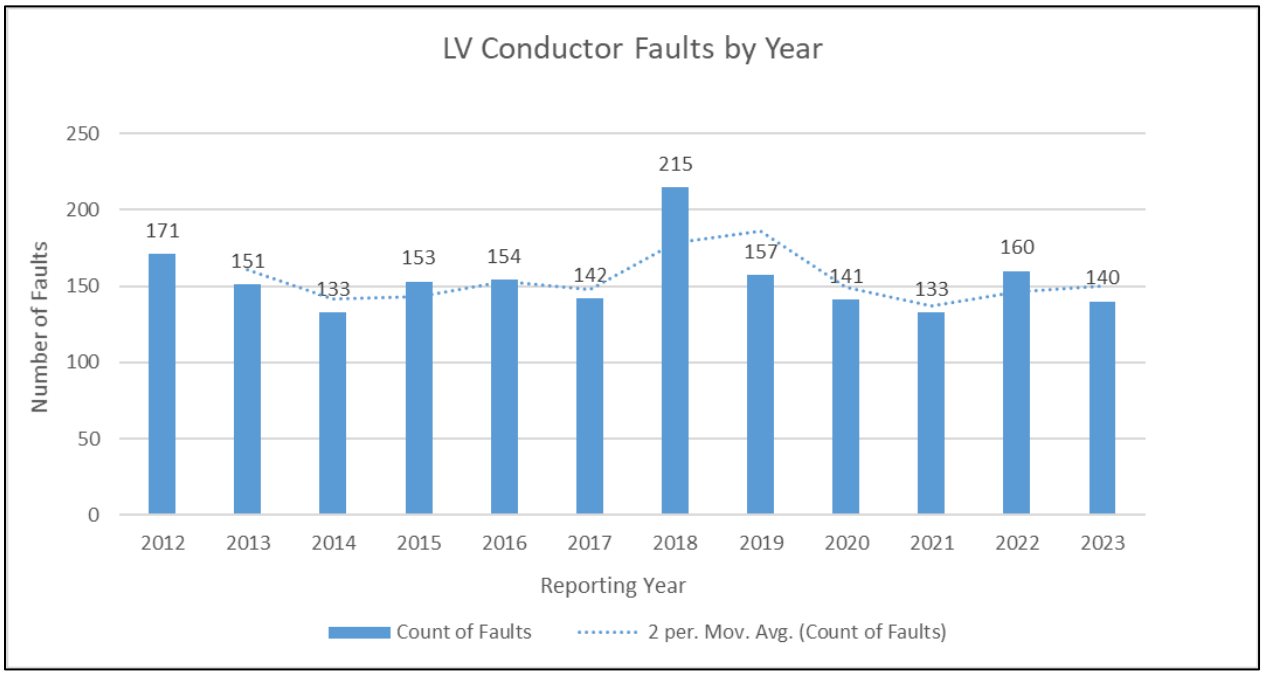


Figure 17-4. Failure Impact from LV Underground Cable Faults

An analysis of LV underground secondary system faults based on the cable's installation year at the time of failure reveals a notable trend: a significant number of failures occur in cable systems that are only 0 – 3 years old (Figure 17-5). The blue dotted line represents a three-year moving average. These cases are currently under review, with ongoing collaboration and discussion with Operations personnel to gather feedback and identify potential improvements.

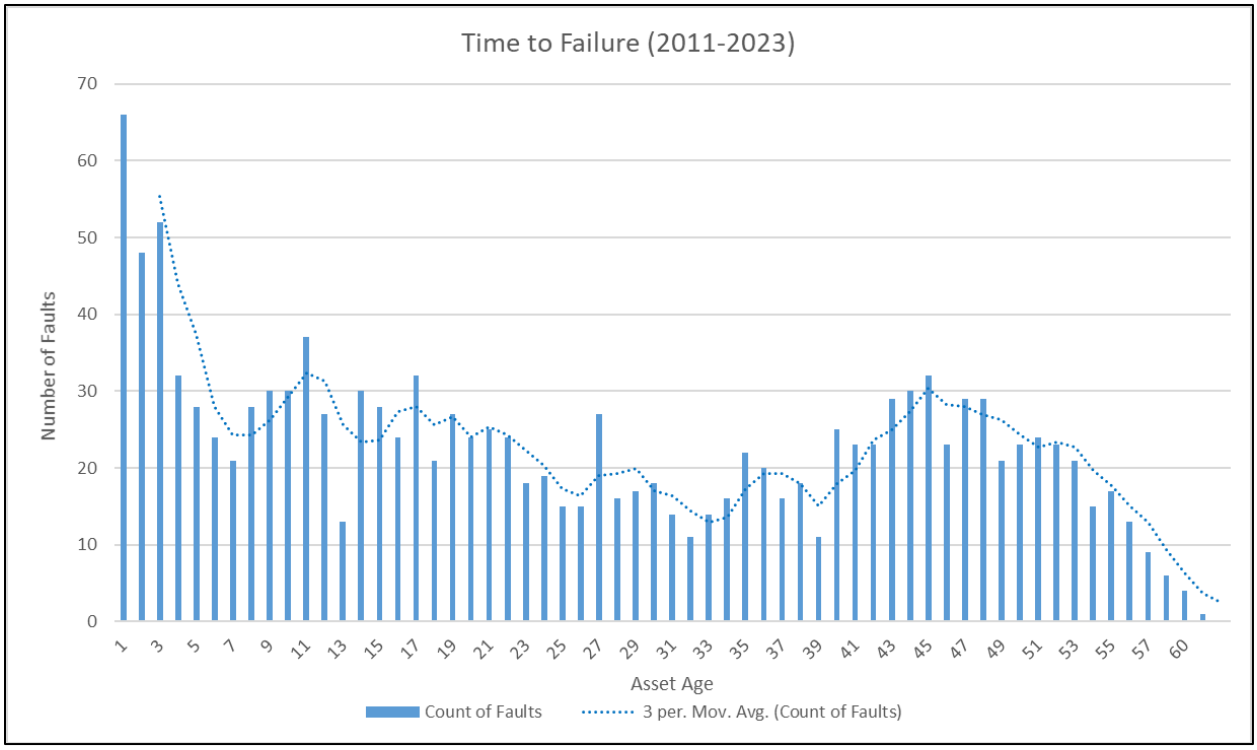


Figure 17-5. Performance Data on Secondary Systems

Currently, when an underground secondary cable fault occurs, the fault location is identified and excavated. Typically, only the damaged section is replaced, with splices made to the existing cable on both ends. A full cable replacement from the transformer to the customer's meter is generally not pursued due to high costs. Additionally, in roads right-of-way, multiple secondary cables are often buried together in the same trench, making it impractical and technically challenging to bore a new path for a single replacement cable. As repeated failures occur on the same cable and multiple splices accumulate from ongoing repairs, it will become necessary to develop a strategy for the full replacement of residential service cables.

Over the past 10 years, London Hydro has adopted a practice for new construction and subdivision rebuilds that involves installing both primary and secondary cables in ducts, along with an additional spare duct for potential future use. For short-term, unplanned replacements, the solution is well-considered and effectively addresses immediate needs.

Some residential secondary service cables, now up to 60 years old, may still be operating within their expected service life, as many original installations remain in use and the annual fault rate has remained relatively stable since 2012. In most cases, once subdivisions reach full development, load growth levels

off, allowing these original cables to continue performing as designed. However, the rise of electric vehicle (EV) chargers and other residential electrification trends is leading to increased electrical demand for certain customers. This often necessitates targeted service upgrades, while the rest of the secondary system remains unchanged.

17.4 Asset Sustainment Strategy

The costs associated with repairing faulted secondary cables are accounted for annually in the O&M budget, unless the replacement of the cable segment is deemed necessary in which case this would be a capital budget expense. These expenses are closely monitored, particularly as the LV secondary cables continue to age and the potential for increased failure rates grows.

In theory, these LV underground cables could have a life expectancy of more than 60 years. However, due to limited industry experience with the lifespan of secondary service cables, this timeline may shift when it comes to development of proactive replacement planning.

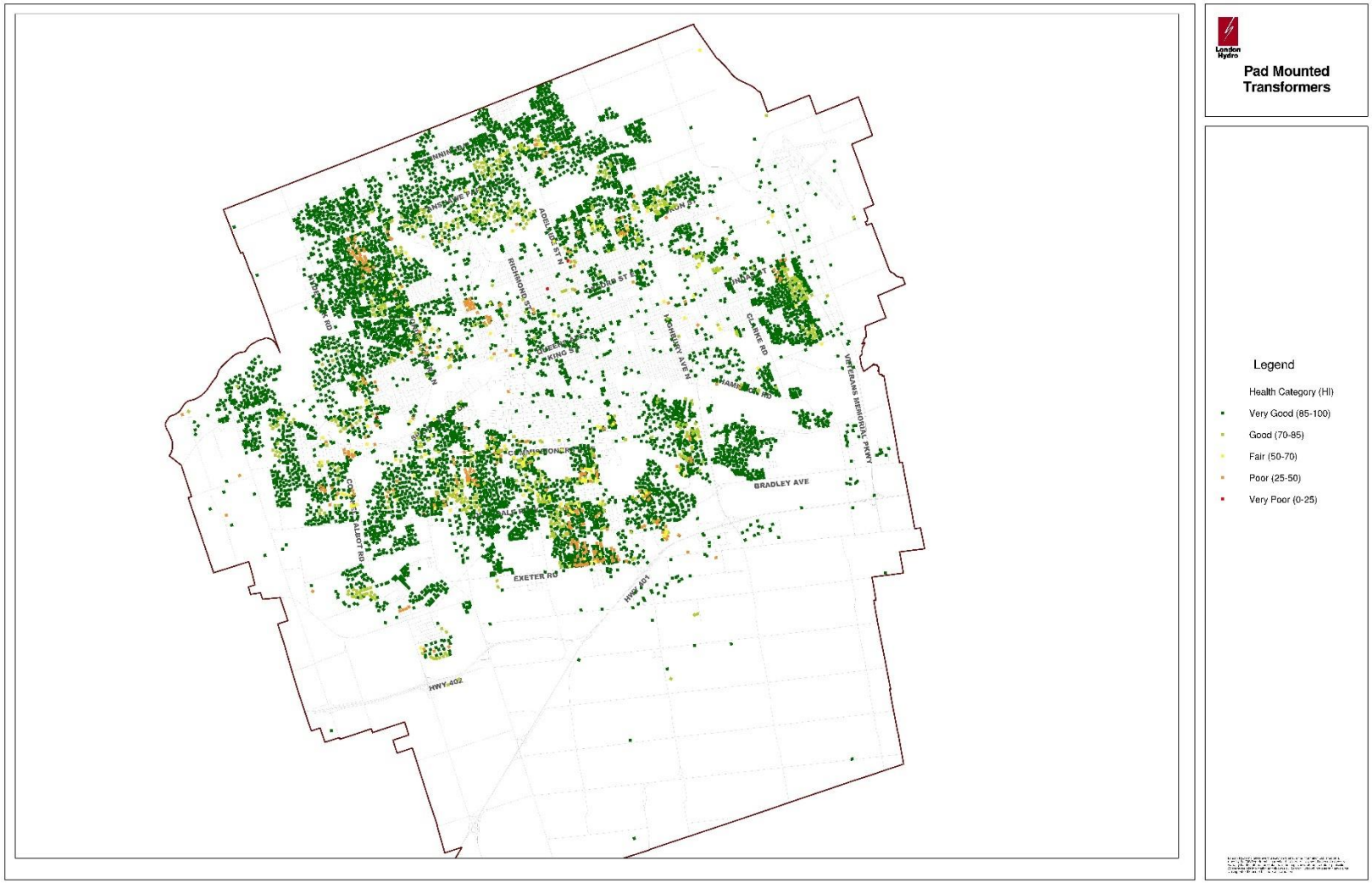
The report "Low Voltage (LV) Underground Conductor Risk Assessment and Asset Management Strategy" concludes that a variety of initiatives could assist in the longer-term asset sustainment strategy. For convenience, they are summarized below:

1. Improve cable fault data collection
2. Review cable and splice installation practices
3. Adopt new standards for new construction (larger cable size)
4. Continue to replace deteriorated pedestals: the current strategy of underground backyard rebuild involves the use of new pedestals installed to service existing backyard services that are not currently relocated to front yard.
5. Plan for at least one rehabilitation project of the LV underground cable in the next DSP to understand costs and design to help in future strategy development.

Currently, London Hydro replaces a minimum of 30 km of primary cable each year, and replacing the corresponding secondary cables (expecting a larger cumulative length) could result in significant costs. Coordinating the replacement of secondary cables with areas where primary cables are also due for replacement could help minimize costs of secondary rebuilds and minimize customer interruptions.

Appendices

Appendix A: Pad Mounted Transformer Map



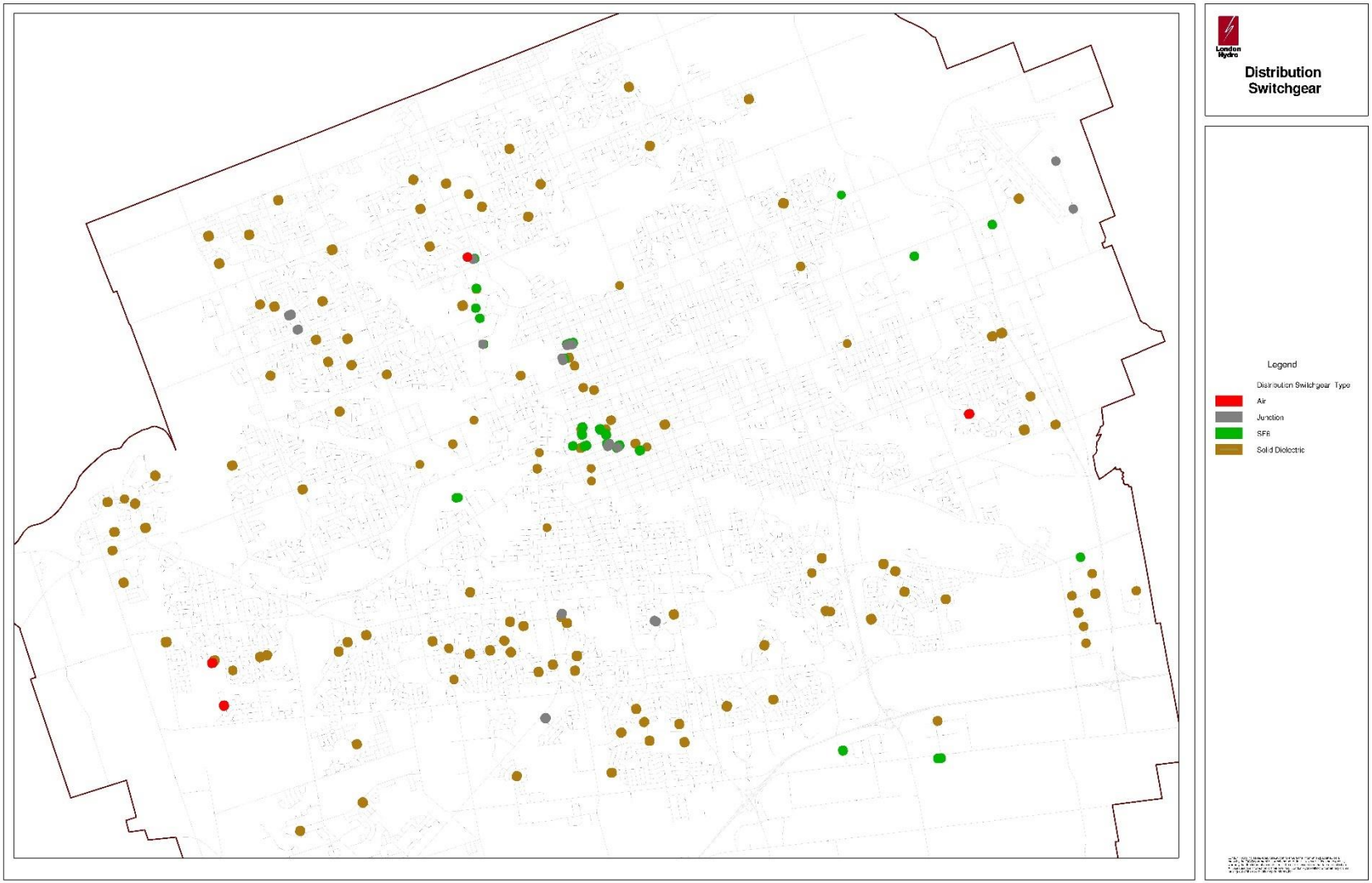
Appendix B: Vault Transformer Map



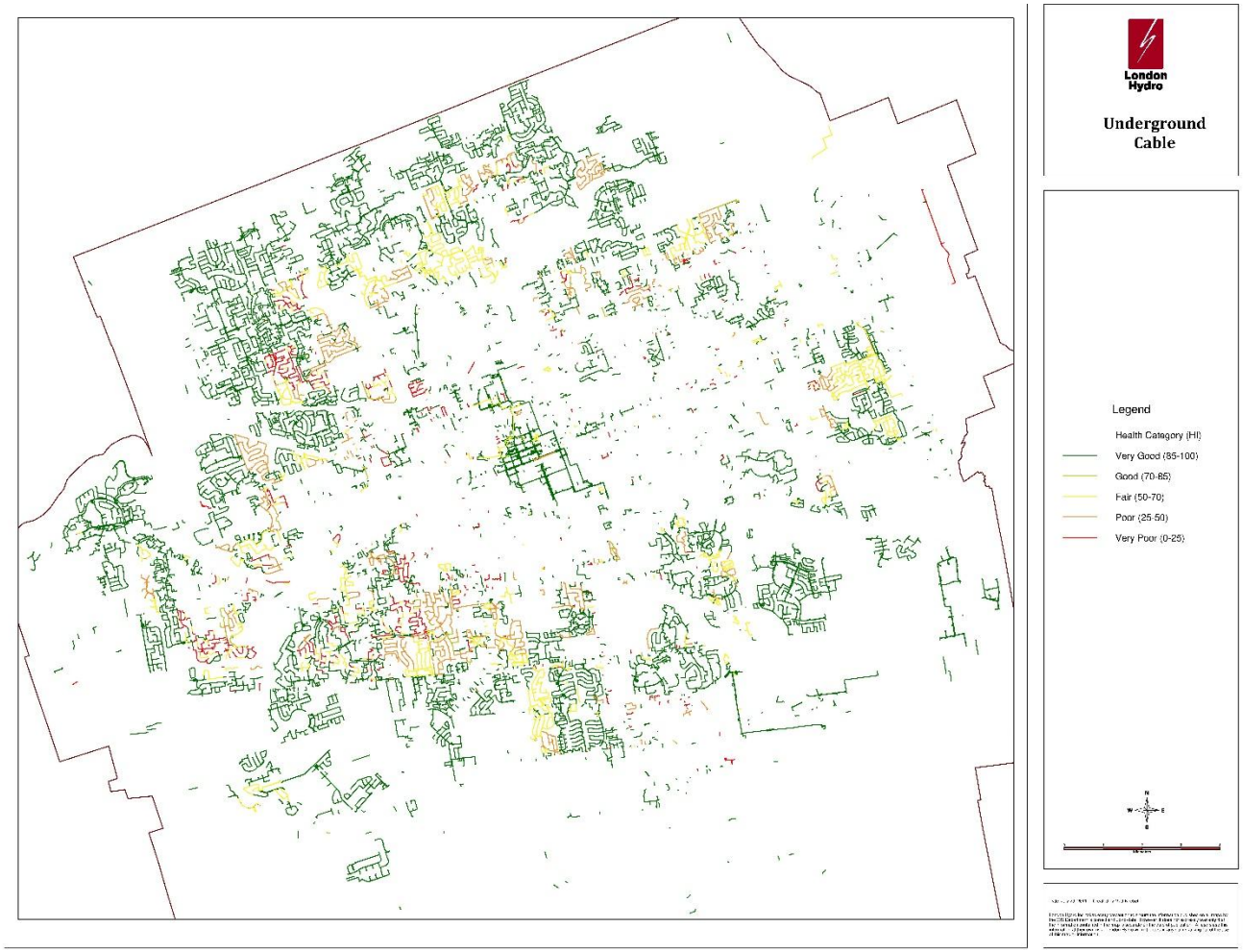
Appendix C: Network Transformer and Network Protector Map



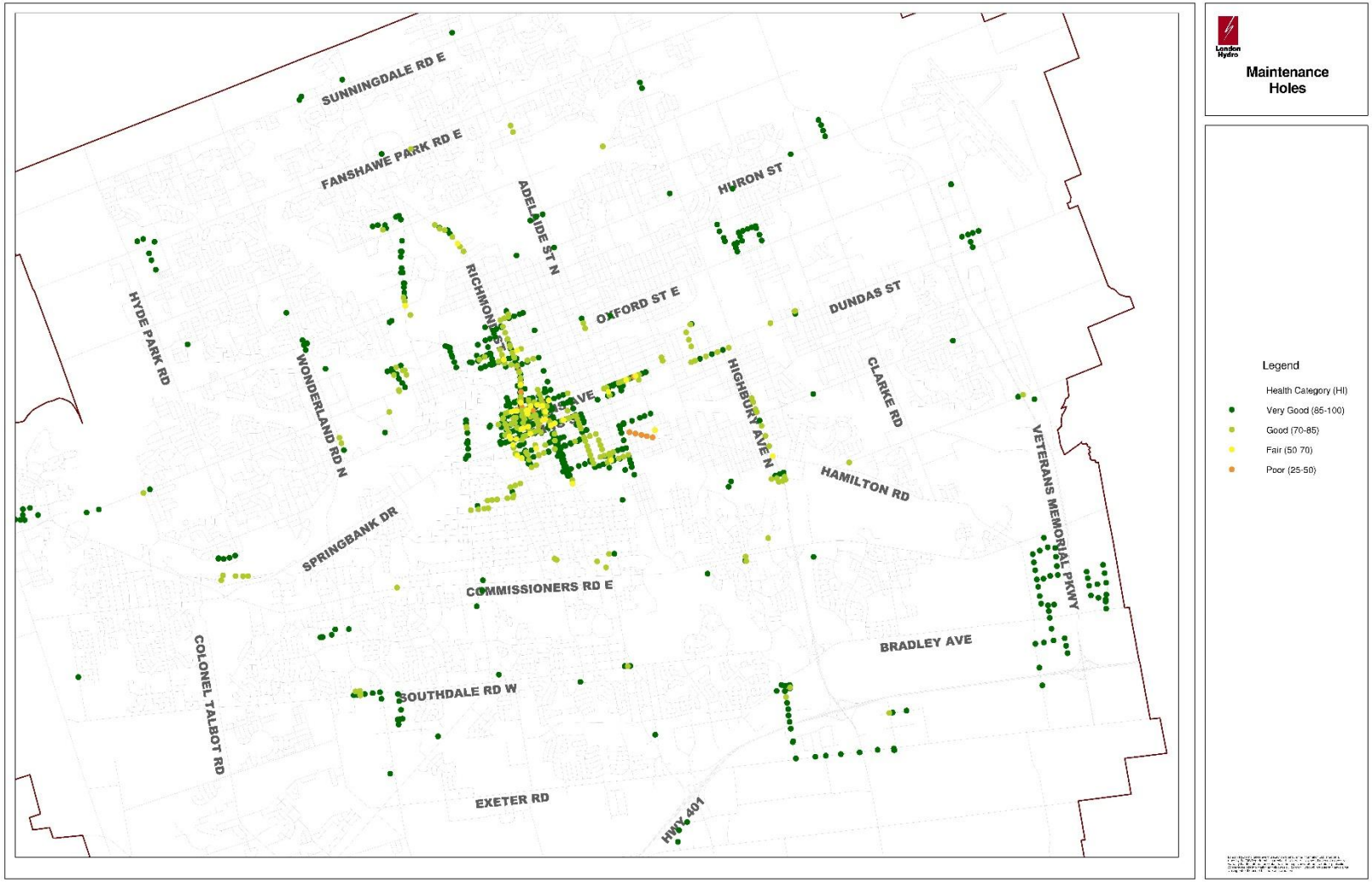
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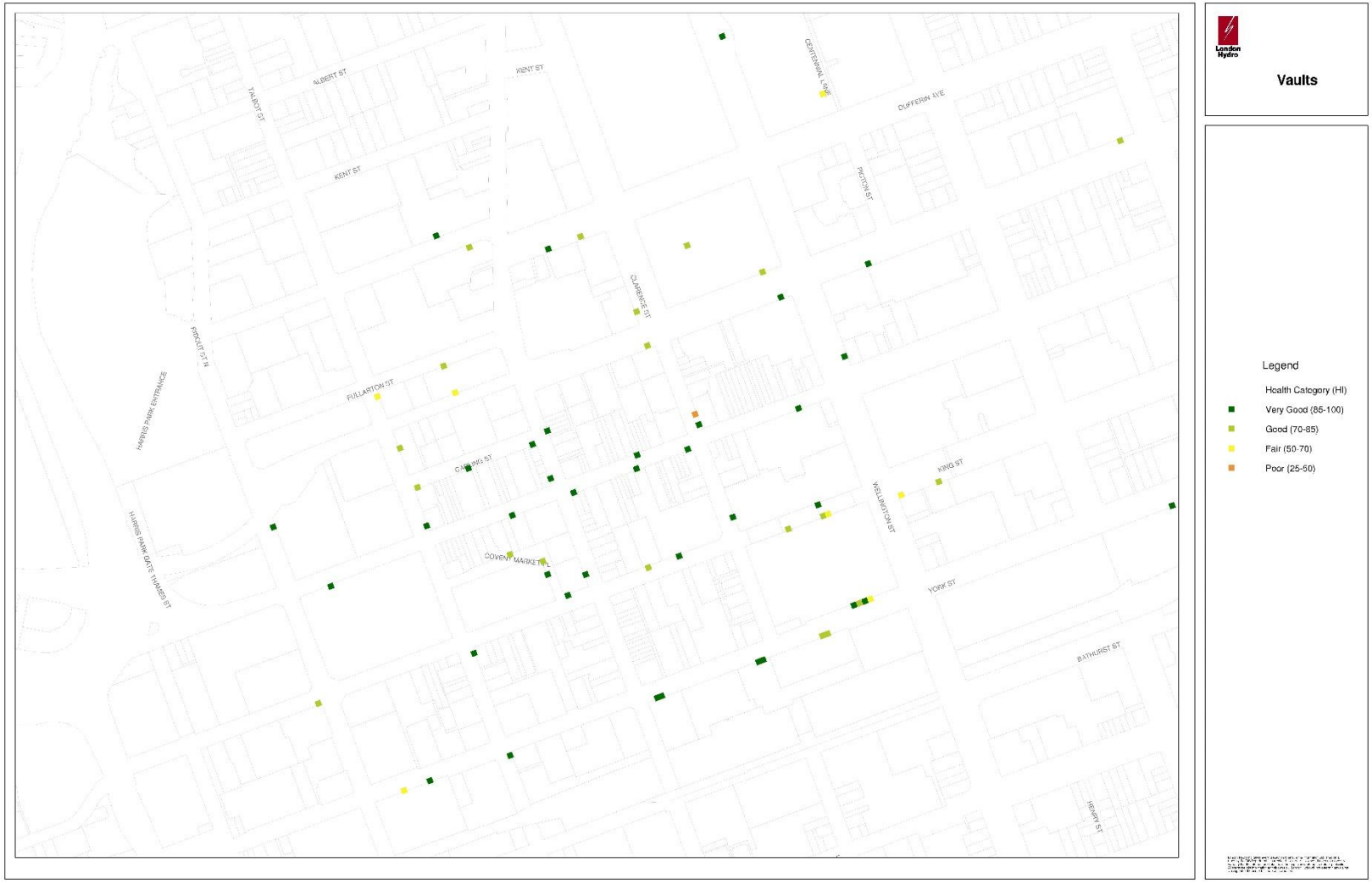
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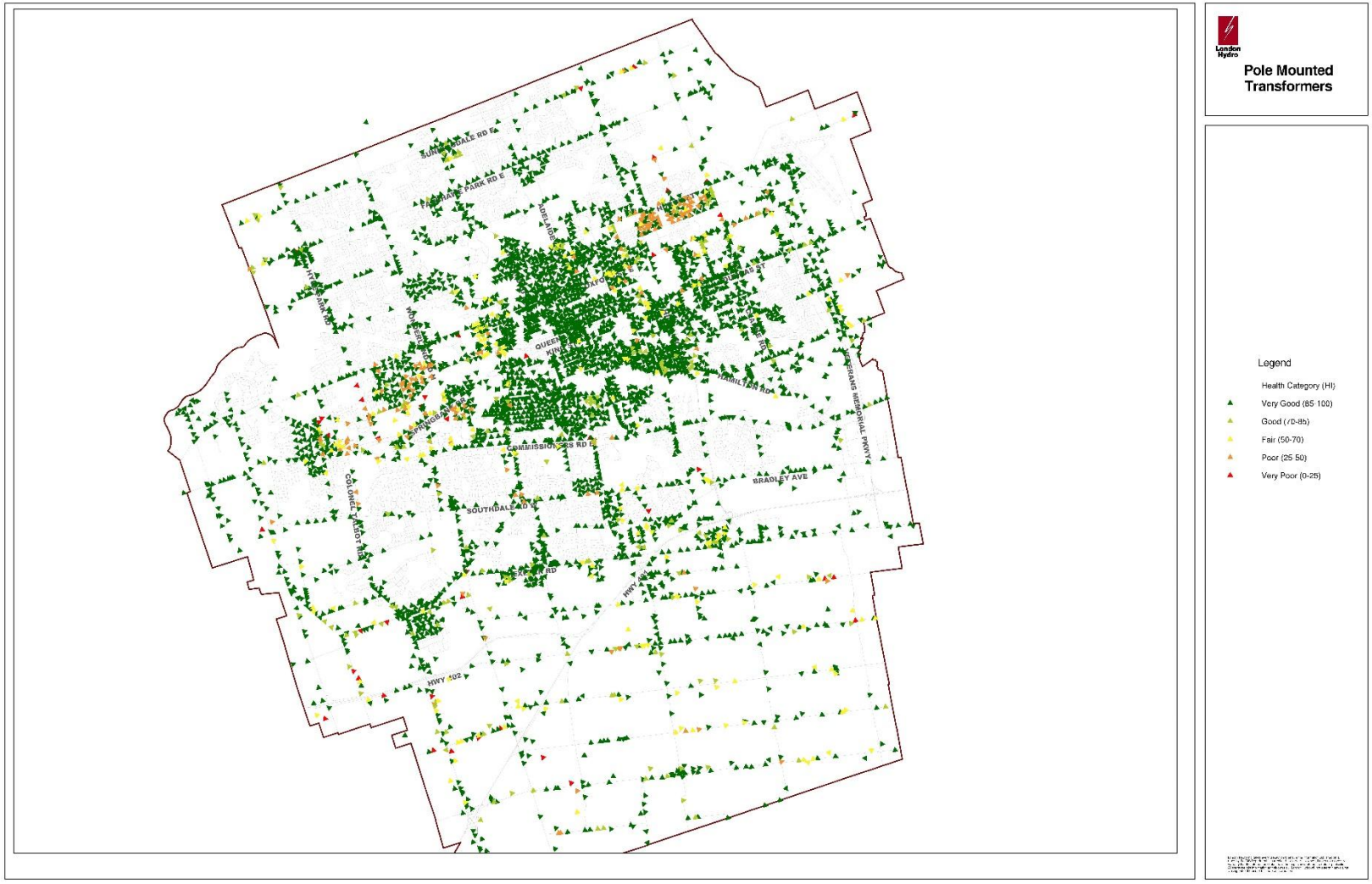
Appendix F: Maintenance Hole Map



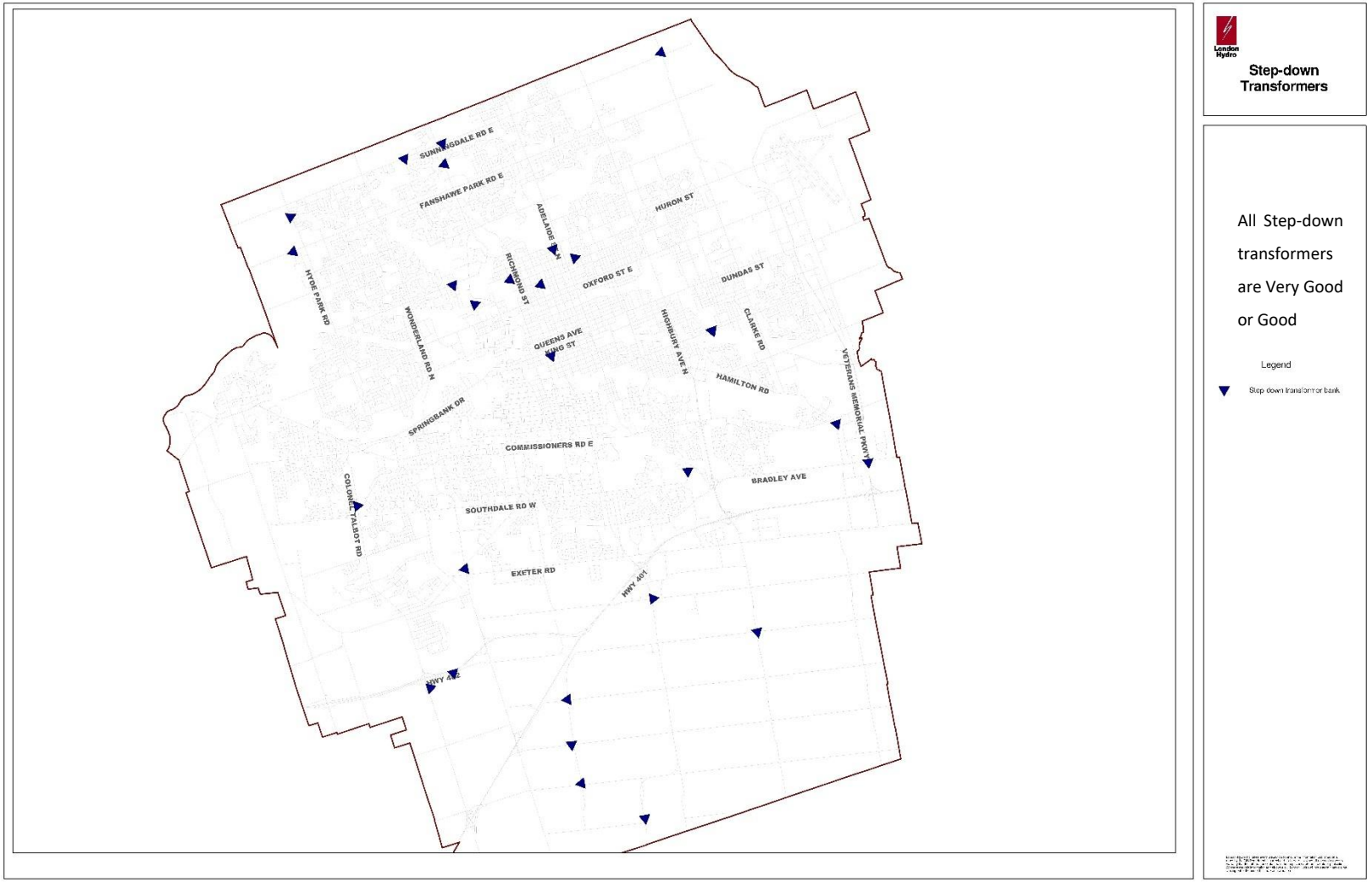
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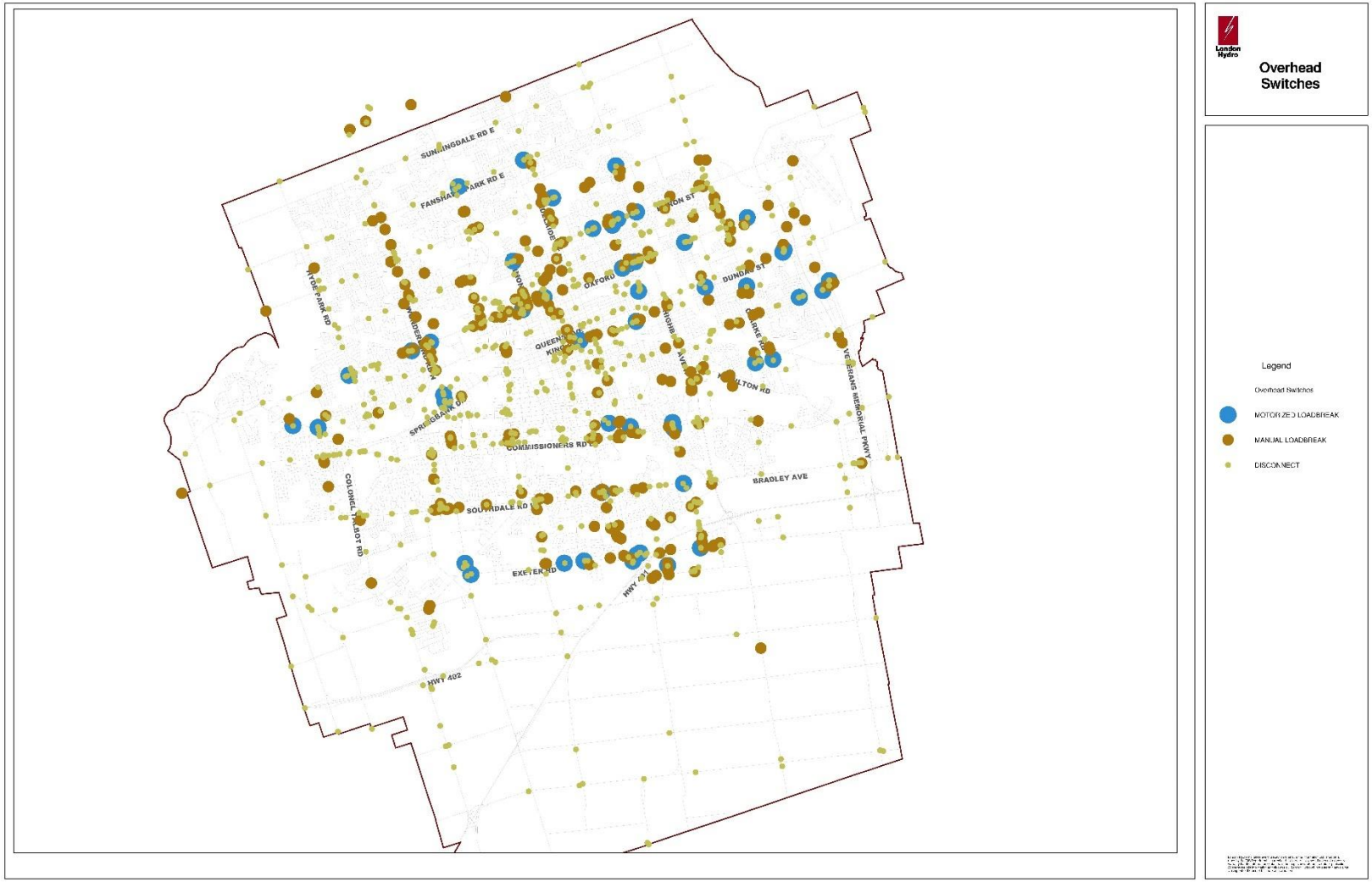
Appendix H: Pole Mounted Transformer Map



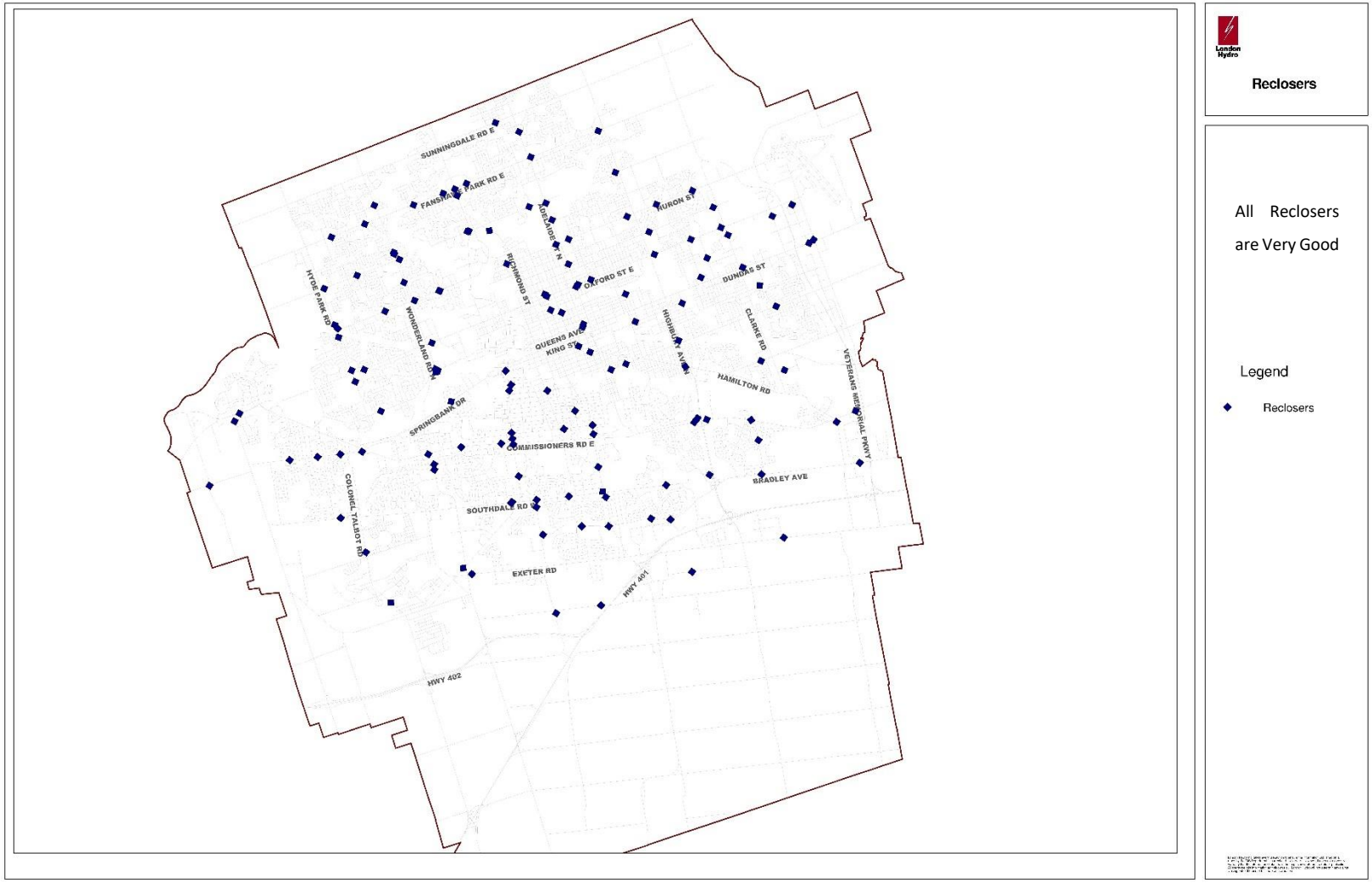
Appendix I: Step-down Transformer Map



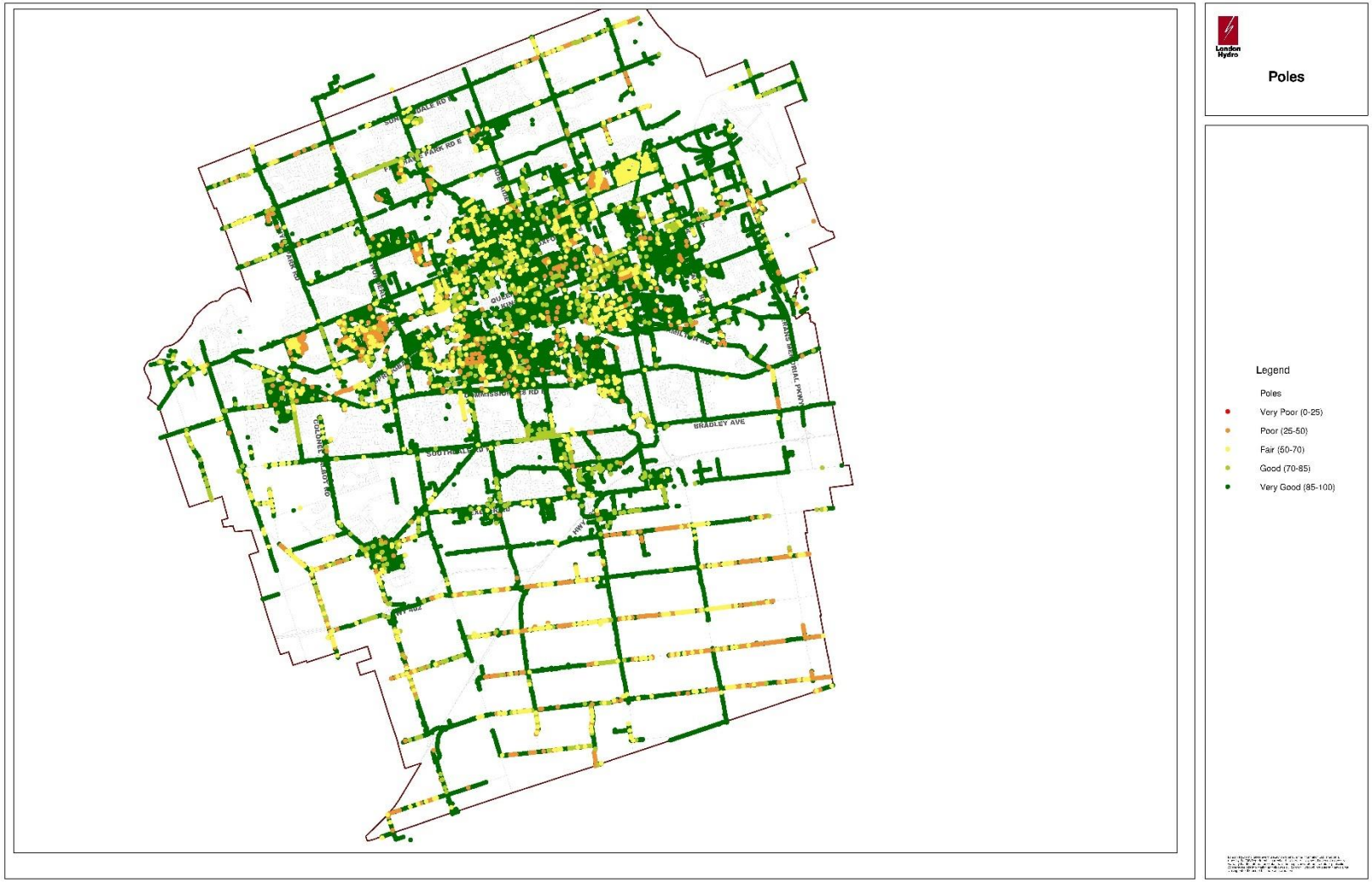
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Appendix K: Recloser Map



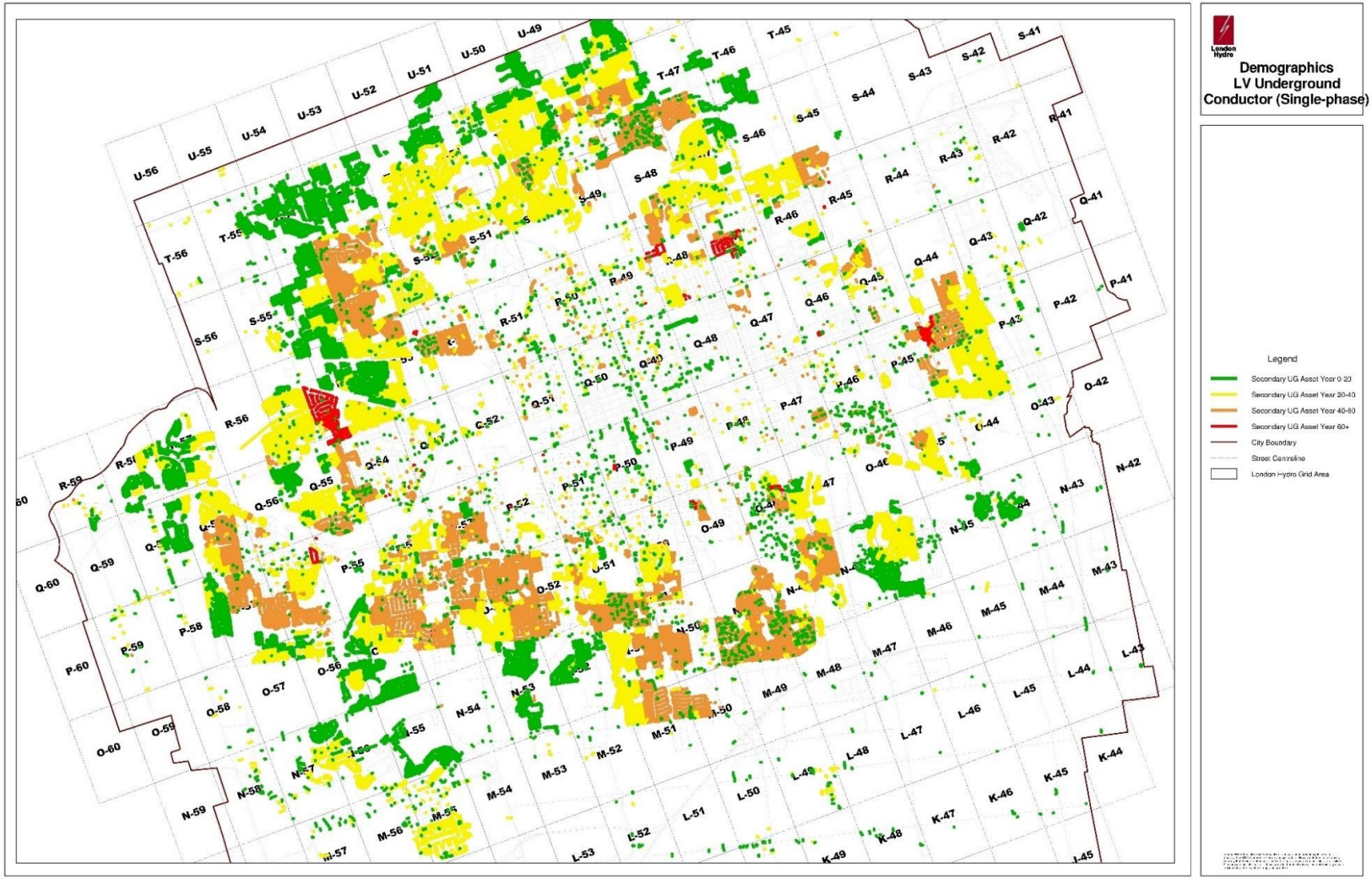
Appendix L: Pole Map



Appendix M: Substation Transformer Map (by Substation)



Appendix N: Low Voltage Underground Cable Map



London Hydro

APPENDIX D

Asset Condition Assessment (ACA): 2024

Electric Distribution System

2024 Asset Condition Assessment (ACA)

Issued December 2024

(Revised July 2026)

Prepared By:



Cristina Terek, P.Eng.
Senior Engineer Asset Management

Reviewed By:



Ali Juma, P.Eng.
Manager System Reliability

Approved By:



Ismail Sheikh, P.Eng.
Director Systems Engineering

Special acknowledgments are being made to Kathie Kuang (GIS Supervisor) for the extraordinary support in the execution of the work presented herein.

Executive Summary

The 2024 updated Asset Condition Assessment (ACA) for London Hydro builds on the 2019 ACA report by Kinectrics, and was prepared for the 2026 Cost of Service Application to the Ontario Energy Board (OEB). Using a methodology similar to the previous edition, the 2024 Asset Condition Assessment report evaluates major distribution assets based on demographic data and Health Indexing, identifying units within each asset class requiring future action.

This second ACA cycle utilized Engineered Intelligence's analytics platform (ENGIN™) to assess London Hydro's distribution assets. The study examined 16 asset classes, encompassing both electrical and civil components, including transformers, underground cables, switchgears, civil structures, poles, and substation equipment.

The study quantifies assets by age demographics and health. Health Indexing determines asset conditions using customized algorithms, combining condition data specific to each asset class and age. Health Index (HI) scores range from 0% (severely degraded) to 100% (no degradation) and categorize assets into five health categories: Very Poor (0-25%), Poor (25-50%), Fair (50-70%), Good (70-85%), and Very Good (85-100%).

The study found that the average asset age is 25.3 years. The overall average Health Index score is 89%. Detailed data for all 16 asset classes is provided in Appendix A. High-quality condition parameters ensure confidence in Health Index (HI) scores. Ongoing improvements to inspection programs and data collection are expected to enhance data quality further in the coming years.

Finally, the study identifies assets requiring action within 5-10 years as "Flagged For Action" (FFA). These assets may be addressed through replacement, refurbishment, closer monitoring and/or testing, or other techniques to extend their life and defer replacement. An overall summary of the findings can be found in Section 1 along with the recommended FFA plan.

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Abbreviations

ACA – Asset Condition Assessment

AM – Asset Management

DAI – Data Availability Index

DGA – Dissolved Gas Analysis

DSP – Distribution System Plan

EII – Engineered Intelligence Inc.

ENGIN – Software Platform by EII for ACA Analytics

FFA – Flag For Action

HI – Health Index:

- VP – Very Poor
- P – Poor
- F – Fair
- G – Good
- VG – Very Good

LDC – Local Distribution Company

LOL – Loss of Life

OEB – Ontario Energy Board

1. Summary and Recommendations

Asset Management applied to the utility industry allows for a standardized decision-making process to be used to maximize long-term effectiveness of investments, while maintaining a reliable level of service. Well defined Asset Management Plans (AMP) provide the rationale for financial investments to both internal and external stakeholders. An Asset Condition Assessment (ACA) is an important component of any AMP as it provides a path for determining future plans to sustain the aging distribution infrastructure of any electrical distribution utility.

This report presents an updated Asset Condition Assessment (ACA) for London Hydro, building on the previous 2019 edition by Kinectrics, in preparation for the upcoming 2026 Cost of Service Application to the Ontario Energy Board (OEB). The previous ACA assessed major distribution assets (asset classes) using demographic data and Health Indexing, and identified the number of units within each asset class that would require action in the coming years (Flagged For Action or FFA). The updated report follows a similar methodology.

For this second ACA cycle, Engineered Intelligence's (EII) analytics software platform (ENGIN™) was utilized to assess London Hydro's distribution assets. The study included 16 asset classes, covering both electrical and civil components of the distribution system, such as transformers, underground cables, distribution switchgears, civil structures, poles, and substation equipment.

In this study, assets are first quantified and analyzed based on their age demographics. Furthermore, Health Indexing quantifies equipment condition by applying customized algorithms in which condition data and age contribute proportionally to a final Health Index (HI) score. This proportion is unique to each asset class. The final HI scores measure between 0 and 100%, with 100% representing an asset that has not experienced any degradation. Assets in each asset class are then grouped into five Health Index categories that reflect their health: Very Poor (HI between 0 and 25%), Poor (HI between 25% and 50%), Fair (HI between 50% and 70%), Good (HI between 70% and 85%) and Very Good (HI between 85% and 100%).

It was found through the study that the average age of all assets is 25.3 years old. The average Health Index of all assets combined is 89%. Individual data is compiled in Appendix A for each of the 16 asset classes analyzed.

The latest asset and condition data available from the second quarter of 2024 was collected from London Hydro's GIS system and other internal sources to provide the basis of this analysis. Age based condition scores and degradation factor (condition parameter) scores contribute to the final Health Index. Examples of degradation factors include visual inspection conditions (e.g. transformer rust, pole grading), Loss of Life (LOL) based on transformer loading, and VLF Tan Delta cable condition testing for underground cables.

The quality of the data is evaluated through a Data Availability Index (DAI) which provides an indication of the level of completeness of the data used in the analysis. Not all the assets have their age known, and condition parameters are usually not available for 100% of the assets[1]. An asset with complete representation of all available condition parameter data will, by definition, have a DAI value of 100%. When the condition parameters included in the HI formula are of high quality and data gaps are minimal, there is strong confidence that the HI score accurately reflects the asset's condition. Enhancements to our inspection programs and data capturing have already led to improved data quality and will continue to do so over the next few years.

Finally, the number of units within each asset class that would require action in the near future (5-10 years) are identified as "Flagged For Action" (FFA). These units can be addressed either by replacement, refurbishment, testing or other asset management technique meant to extend their life. Asset replacement cannot be deferred indefinitely but the removals can be prioritized.

The following is a summary of key takeaways from the actions recommended in this ACA study:

1) Approximately 275 pad mounted and pole mounted transformers need to be addressed each year for the next 5-10 years, in addition to 2 vault transformers (dry-type), and potentially 1 network transformer and/or protector (as needed). No step-down transformers require condition-based replacement in the foreseeable future.

2) It is estimated that based on historical removal data, a minimum of 3 distribution switchgear units may be removed from the system annually.

3) Underground subdivision cable renewal program must continue with an average of 35 conductor kilometers proposed for replacement per year, and another 11 conductor kilometers proposed for condition cable testing per year. This equates to a total of 46 km Flagged For Action per year.

[1] For example, new / young assets may not have inspection data available at the time of the analysis.

4) Each year, up to three overhead switches (including motorized SCADA-MATE or JOSLYN switches, or manual gang-operated loadbreak switches) and one recloser will need to be replaced. These replacement rates have been consistent in recent years due to emergency failures.

5) Civil structures are aging and London Hydro will need to address 25 manholes per year that are Flagged For Action. The refurbishment of manholes has been an effective short-term solution at extending the life of civil structures, compared to the alternative of an expensive full rebuild. However, London Hydro will need to assess the effectiveness of refurbishment as a life extension strategy, and determine the optimal number of full rebuilds necessary to establish a balanced replacement rate, preventing a surge of future replacements.

6) Poles are an extremely important asset with over 29,600 wood poles existing in the system, <4% of which are categorized in Very Poor or Poor condition. This translates into a FFA of over 500 poles per year on average.

7) Substation assets on the 4.16 kV system are aging with many power transformers at or approaching their typical service life. Up to 17 substation transformers and 12 switchgears are in relatively poor condition. The 4.16 kV voltage conversion program planned to continue over the next 5-10 years will eliminate some of these assets. Maintenance of power transformers, switchgears and batteries will need to continue to extend the life of these assets that show signs of deterioration or under performance (i.e. transformer oil recycling, breaker maintenance, battery replacement, etc.).

London Hydro should continue its journey of asset sustainment following structured and justified capital plans for most of its assets. Cable and pole replacements are extremely important as insufficient levels of rehabilitation can lead to a balloon-like effect that will make future investments less manageable and more costly, as planned replacements are less expensive and easier to coordinate compared to unplanned replacements of assets. Attention should also be placed to manholes where refurbishment has delayed the replacement of the aged population with the oldest manhole in the city being 96 years old in calendar age.

London Hydro began collecting "reason for removal" data for all asset categories in 2024. It should continue to focus on improving the completeness and accuracy of new and existing condition data, and removal age and reason for removal, ensuring that future editions of the ACA are more refined. The integration of a risk-based assessment approach through future enhancements in ENGIN will support more effective Flag For Action planning.

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1.1 Flag For Action Plan

Table 1, Flag For Action Plan

Asset Class		Years (0-10)											Years (0-10) Average	Years (0-5) Average	Now (Year 0)		Population
		0	1	2	3	4	5	6	7	8	9	10			Number of Units	% of Population	
Pad Mounted Transformers		141	151	160	169	176	183	190	196	202	208	213	181	164	141	1.7%	8421
Vault Transformers		2	2	2	2	2	2	0	0	0	0	0	1	2	2	4.5%	44
Network Transformers		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1.6%	64
Network Protectors		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1.6%	64
Distribution Switchgears		3	3	3	3	3	3	3	3	3	3	3	3	3	3	1.7%	180
Underground Cables	Polymeric (cond-km)	73	56	53	50	46	43	41	38	36	34	33	46	53	73	3.6%	2011
	Large Polymeric (cond-km)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	1	1	0.3%	164
Manholes		19	21	22	24	25	26	27	28	29	29	29	25	23	19	1.9%	1028
Vaults		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1.5%	67
Pole Mounted Transformers		81	83	86	89	92	95	98	101	104	106	109	95	87	81	1.1%	7532
Step-down Transformers		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0%	57
Overhead Switches		3	3	3	3	3	3	3	3	3	3	3	3	3	3	0.2%	1223
Overhead Reclosers		1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.7%	141
Poles		457	476	495	515	536	557	580	603	627	652	678	561	506	457	1.5%	29640
Substation Transformers		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1.6%	63
Switchgears		1	1	1	1	1	1	1	1	1	1	1	1	1	1	2.9%	35
Batteries		1	1	1	1	1	1	1	1	1	1	1	1	1	1	5.6%	18

2. Introduction

London Hydro is a Local Distribution Company (LDC) that services the City of London, Ontario, Canada. With a summer monthly peak load of 673 MW with Generation (Net) in 2024, London Hydro delivers electricity to over 167,000 customers from the residential, commercial, institutional, and industrial sectors, through over 5,500 conductor km of overhead and underground medium voltage conductors, spanning 420 square km of service territory. It is a wholly-owned subsidiary company that operates as a private entity under the Ontario Business Corporation Act. Its sole shareholder is the City of London. In keeping with a commitment to strategic and prudent investment planning, London Hydro recognizes the need to continue to enhance its asset management strategy for its key distribution assets.

London Hydro will be preparing for the next Cost of Service Application with the Ontario Energy Board (OEB) in 2026 and, as such, year 2025 is the preparatory year for the Distribution System Plan (DSP) that includes the Asset Condition Assessment (ACA), an integral part of the Asset Management Plan. The ACA provides a systematic process for determining and justifying capital and maintenance expenditures as long-term sustainment needs. It focuses on organizing asset inventories based on their overall health, and prioritizing replacements of those assets that have reached end of life, or are presenting an operational risk based on their age and/or condition. Health Indexing and risk assessment form the basis of the ACA process. The Health Index (HI) expresses the condition of an asset as a single number from 0 to 100%. Using this process, the quantities of assets that will require attention in the next 5-10 years can be estimated.

Subsequent to the previous 2019 Asset Condition Assessment by Kinectrics[2], London Hydro engaged Engineered Intelligence (EII) to leverage their AM analytics software platform[3] (ENGIN™) to conduct an independent ACA of London Hydro's key distribution assets (*2024 Asset Condition Assessment*). This report presents the new 2024 ACA findings.

[2] Kinectrics, London Hydro 2019 Asset Condition Assessment K-814195-RA-0001 R01, 2020-Apr-28

[3] There are 4 modules in ENGIN: Analyzer, Optimizer, Forecaster and Geospatial Planner. London Hydro acquired the Analyzer and Geospatial Planner modules in Phase 1 of the ACA implementation.

3. Asset Condition Assessment (ACA) Analysis

3.1 Objective and Scope of Work

The objective of the work was to conduct an independent Asset Condition Assessment (ACA) of London Hydro's key distribution assets. The ACA was designed to quantify the extent of aging and deterioration, the HI distribution, and to estimate the number of assets that likely need to be addressed (Flag For Action) in the near future.

Sixteen (16) asset classes were included in this study as follows:

1. Pad Mounted Transformers (UGTX)
2. Vault Transformers (VAULTTX)
3. Network Transformers (NTX)
4. Network Protectors (NPROTECTOR)
5. Distribution Switchgears (DISTSWGR)
6. Underground Cables (UGCABLE)
7. Manholes (MANHOLE)
8. Vaults (VAULT)
9. Pole Mounted Transformers (OHTX)
10. Step-down Transformers (STEPTX)
11. Overhead Switches (OHSW)
12. Overhead Reclosers (OHRECLOSER)
13. Poles (POLE)
14. Substation Transformers (PTX)
15. Switchgears (SWGR)
16. Batteries (BATTERY)

For each asset class described in detail in Appendix A, the following are included:

- Demographics
- Health Summary
- Health Index Analysis
- Flag For Action (FFA) Plan
- Data Assessment

3.2 Health Index Methodology

As stated previously, an asset's Health Index (HI) is given as a percentage, with 100% representing a brand-new condition. In the approach implemented for this ACA analysis, **the HI is calculated if there is a known asset age, or if some condition data is available to process (or both).**

Equipment condition data is based on various parameters that are related to the degradation that leads to an asset's end of service life. In the analytical platform used, these condition parameters are referred to as *Degradation Factors* in the Asset Health Index Breakdown. Incorporating a diverse set of condition data in the final HI calculation provides a measure of long-term degradation that considers an asset's health based on more than just age. This condition data (degradation factors) differs from defect management whose objective is to find deficiencies that need correction (ex. for a pole: grounds disconnected).

Data gaps in the condition data identified in the previous ACA edition (2019) have been analyzed prior to this ACA cycle to determine what can be addressed. A multitude of gaps were categorized as defect management, which London Hydro addresses either with urgent or timely correction priority (within a year), to maintain asset functionality, or through established maintenance programs. For example, defects identified on manual load-break switches, such as arcing horn interrupter deficiencies, are managed through maintenance and corrective action processes and are not considered condition data gaps associated with long-term asset degradation. As a result, defect management activities resolved on a priority basis are not considered to materially influence forward-looking condition assessments used to support the upcoming DSP planning period.

Based on this review, London Hydro refined its definition of a data gap to include only information that is feasible to collect, provides value for Asset Management purposes, and excludes activities that are impractical or cost-prohibitive (e.g., inspection of overhead transformer primary and secondary terminations from ground level). Following this categorization, actionable data gaps associated with tests, inspections, and condition assessment activities were addressed prior to the current ACA cycle.

Degradation Factors, or condition parameters, as defined by traditional Asset Management, are asset condition characteristics or properties used to assess various aspects of the overall asset health (ex. in power transformers: DGA, Oil Quality, Winding Resistance, etc.). Depending on the asset class, some of the following types of degradation factors, in addition to age, may be available:

- Testing results that provide scientific interpretation of condition (e.g. DGA, oil quality, pole's remaining strength measured through an acceptable industry standard, such as the resistograph method, cable condition testing for underground cables such as Tan-Delta condition cable testing)
- Engineering inspections and evaluations (e.g. manhole civil inspections conducted by third-party engineers)
- Electrical loading calculated to assess operational loading related degradation (e.g. calculated Loss of Life[4] based on the model and thermodynamic equations identified in IEEE Std. C57.91-2011[5] whereby hourly transformer loading data, ambient temperature, design characteristics of the transformer, and operating limits are used to determine oil temperatures and an ageing acceleration factor to inform if a transformer is considered overloaded relative to its typical service life)
- Visual inspection parameters of key equipment components (e.g. oil leaks, enclosure rust, insulator condition)

The degradation factor score for a particular condition parameter is a numeric evaluation of the asset. The scale that is used to determine an asset's score for a particular parameter is called the *condition score*. Similar to the 2019 ACA methodology, a *condition* scoring system of 0 through 4 is used, except for the case of the age-based condition score which is out of 100. A score of 0 is the 'worst' possible score, while a score of 4 is the 'best' score.

The aged-based condition score is derived from the asset's life curve, which is a model of an assets' service life whereby the frequency of removals grows exponentially with age. Based on the removal rate models provided in Kinectrics' 2019 ACA report, the cumulative likelihood of removal over time can be determined, with the complement being the likelihood of survival at a given age.

An example survival curve is presented in Figure 1 below. The interpretation that can be derived from this example (which is characteristic for each asset) is that at age 0, the age score is 100% (which is maintained until almost 40 years of age in this case), while at age 100 the age score approaches zero (0%). In between, a likelihood of removal from service is modeled, which represents the cumulative removal probability at a given age of an asset group. For example, at 50 years there is a 20% likelihood of removal (equivalent to an age score of 80%), and at 60 years, that removal probability reaches 95% (equivalent to an age score

[4] Proprietary to London Hydro
[5] IEEE Std C57.91 "Guide for Loading Mineral Oil-Immersed Transformers and Step-Voltage Regulators"

of 5%). This particular curve has a very steep drop-off and it represents the survival curve of a power transformer. This is an indication that for a power transformer, aging between 50 and 60-years old results in a drastic deterioration measured by a very reduced likelihood of survival between these two ages. Additional points on the survival curve provide various age score values at corresponding ages. Life curves for all the assets are illustrated in Appendix B.

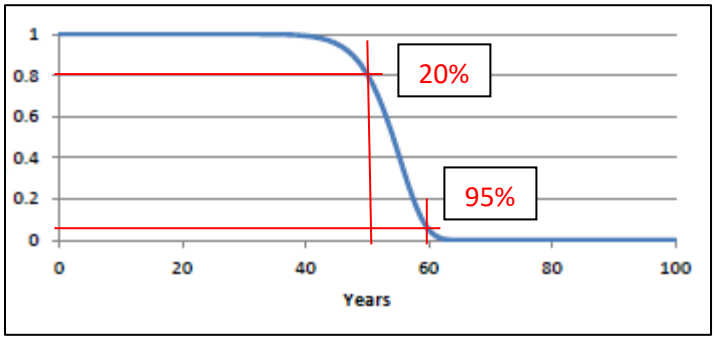


Figure 1, Survival Curve

In formulating a HI based on available condition data, the unique degradation factors are prioritized through the assignment of *weights,* based on their partial contribution to asset degradation. The relative weights of non-aged based condition parameters are in general based on the 2019 ACA study but shifted to a percentage (%) as opposed to numeric values. The contribution percentages (%) of the age score and the aggregate score of the other condition data are given in Table 2 based on the strength and quality of the existing condition data, with emphasis or higher weight being placed if some form of scientific interpretation or engineering analysis for condition data was available.

The final HI is calculated based on the product of condition parameter scores and weights, and normalized to the sum of weighted condition parameter scores.

Table 2, Condition and Age Score Contributions in Final HI Calculation

Asset Class	Final HI Contribution		Notes
	Condition Score	Age Score	
UGCABLE	80%	20%	Age and Test
POLES	70%	30%	Age, Test and Visual
BATTERY	60%	40%	Age and Test
MANHOLE	60%	40%	Age and Civil inspection
VAULT	60%	40%	Age and Civil inspection
PTX	40%	60%	Age, Test and Visual, Loading
UGTX	40%	60%	Age, Visual and Loss of Life
OHTX	40%	60%	Age, Loss of Life
NTX	20%	80%	Age and Visual
NPROTECTOR	20%	80%	Age and Visual
DISTSWGR	20%	80%	Age and Visual
STEPTX	0%	100%	Age only
OHSWITCH	0%	100%	Age only
OHRECLOSER	0%	100%	Age only
VAULTTX	0%	100%	Age only
SWGR	0%	100%	Age only

The HI distribution given for each asset class illustrates the overall health of that particular asset group. The results are aggregated in five (5) HI Categories for each asset class as follows:

Very Poor (VP): HI <25%
Poor (P): 25% ≤ HI < 50%
Fair (F): 50% ≤ HI < 70%
Good (G): 70% ≤ HI < 85%
Very Good (VG): 85% ≤ HI < 100%

It is important to note that, under this methodology, although an asset might be quite aged, its final HI may be higher given strong health indication from the other condition parameters. Conversely, a younger asset may have a lower final HI due to one or more poor condition parameters.

Figure 2 provides an exemplification of how the final HI is calculated using the methodology above. The Asset Health Index Breakdown example is for a substation power transformer (age 59). Based on the asset's life curve, this asset has an age score of 10 out of 100. The weight (contribution) of the age score to the final HI is 60% as per Table 2 (PTX). The remaining degradation factors score between 0 and 4, in the proportions represented inside the red oval, totalling 40% of the final HI. "Visual – Fans" degradation factor is not available in this case so its weight is ignored (1 out of 100). The final calculated HI value is 41.13/99, rounded to a HI = 41.5% (Poor).



Asset Health Index Breakdown

Degradation Factors

Degradation Factor	Data Available	Data Valid	Weight	Score	Degradation Factor Score
Age Score	☑	☑	60	10	6 / 60
Dissolved Gas Analysis	☑	☑	8.5	4	8.5 / 8.5
Oil Quality	☑	☑	7	3	5.25 / 7
Turns Ratio	☑	☑	2.5	4	2.5 / 2.5
Winding Resistance	☑	☑	2.5	4	2.5 / 2.5
Visual - Temperature Gauge	☑	☑	1	4	1 / 1
Visual - Bus/Elbow Connections	☑	☑	1	4	1 / 1
Visual - Fans	☐	☐	1	0	0 / 0
Visual - Arrester	☑	☑	1	4	1 / 1
Visual - Insulators	☑	☑	1	4	1 / 1
Visual - Oil Leaks	☑	☑	1	4	1 / 1
Visual - Paint/Corrosion	☑	☑	1	4	1 / 1
Load History	☑	☑	4	4	4 / 4
Furan Analysis	☑	☑	8.5	3	6.38 / 8.5
Data Availability Index = 99%					99 / 100
Data Validity Index = 99%					99 / 100
Gateway condition [met: false]: multiply HI by pre-processed value MULTIPLIER which is 1					
Health Index = 41.5%					41.13 / 99

Figure 2, Asset Health Index Breakdown Example

3.3 Data Assessment

The asset data and condition data used in this study was extracted from London Hydro's GIS and other ad-hoc storage systems and included the following:

- Asset Properties (e.g. age, equipment class and sub-class, phase, location information: lat., lon.)
- Test Results (e.g. DGA, oil quality, PTX turns ratio, pole strength, cable condition testing)
- Loading Information or Loss of Life for transformers
- Inspection and Maintenance records (e.g. manhole civil inspection)

The two dimensions for assessing the availability and completeness of data used in this study are the Data Availability Index (DAI) and Data Gaps.

$$DAI = \frac{\sum Weights\ of\ Degradation\ Factors\ with\ Available\ Data}{\sum Weights\ of\ Degradation\ Factors}$$

DAI is a measure of the amount of condition parameter data that assets have, as measured against the condition parameter (degradation factor) included in the Health Index (HI) methodology. In the above

example, the power transformer has all the condition data but "Visual – Fans". Given the weight of 1% for "Visual – Fans", the DAI is 99%. An asset class must have all condition parameter data represented for the DAI value to be 100% (regardless of its HI score). Provided that the condition parameters used in the HI formula are of good quality, with a higher DAI there will be a higher degree of confidence that a HI score accurately reflects an asset's health condition.

An example of the data quality for substation transformers is given in Figure 3. All the assets (63 sample size) had at least 80% of the data available, and fewer assets had 90% or even 100% of data available for assessment.

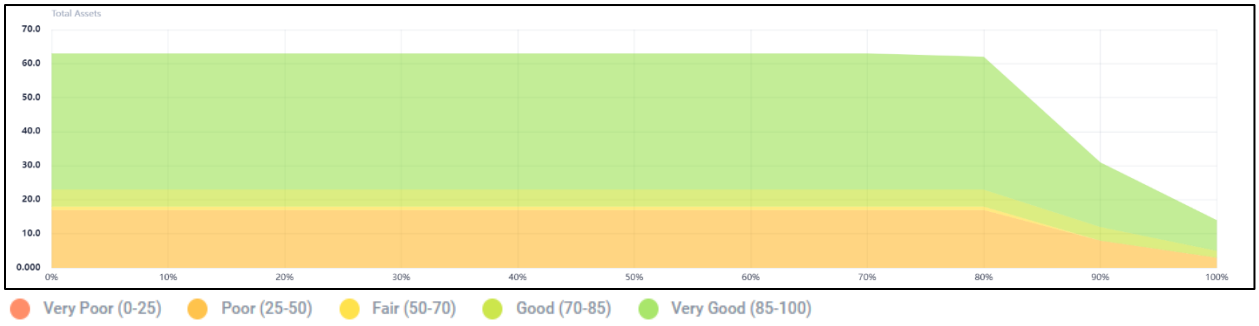


Figure 3, Data Quality Threshold Example

Data gaps of high importance have been identified in this study, if existing. In the 2019 Kinectrics' methodology, data gaps were additional relevant condition data that London Hydro was not collecting for a particular asset group. The actionable data gaps identified in 2019 have been addressed by expanding the inspection processes to include these additional elements[6]. However, it will take several inspection cycles over the next few years to collect the additional data for all assets.

It is recognized that, while a particular asset group may have a high overall DAI, there may still not be a complete set of information for this asset group. While higher priority condition data have been addressed since the previous ACA, opportunities may exist for the evaluation of the feasibility to gather further data points to be used in the calculation of final HI. This could eventually impact the weighting of degradation factors prioritized to determine the final HI.

3.4 Flag For Action (FFA)

The FFA Plan estimates the number of units expected to require attention in a given year. To avoid large swings in the FFA, as it would not be feasible or practical to instantly scale resources to accommodate the

[6] An example would be primary and secondary terminations for pad mounted transformers.

fluctuations in the yearly FFA, a levelized action plan is provided, with the required quantities distributed over multiple years. This plan is summarized in Table 1.

It is important to note that requiring attention does not necessarily mean direct replacement: it can include testing, refurbishment, maintenance or other AM techniques meant to extend an asset's end of life.

FFA is determined using the aforementioned asset life curves as described in Kinectrics' 2019 ACA report. Based on these models, asset specific removal rates (i.e. percentage of removals associated with a certain age) can be extracted, which London Hydro has used to determine the annual rate of replacement for assets in a given year over the following 10 years. These yearly removal quantities for each asset group are what defines the FFA. Health Index is not a static measure of an asset's degradation. Over the next 10 years, assets are expected to continue to deteriorate beyond the current health index assessment, increasing their probability of removal with each passing year.

It is important to note that, based on the model definitions in the Kinectrics' 2019 ACA report, historical removals can be described as an asset being removed from service for any reason, whether failure based, proactive, condition based, City work driven, etc.

Since historical removals for large asset groups (such as poles) can be influenced by external factors, a condition-based risk approach was applied to the removal rate driven FFA where applicable. Because removal rate methods can sometimes be conservative – especially when many assets are still relatively young – this approach helps focus on the cohorts that require condition-based attention. A future assessment is required into the other enhancement modules (ex. risk module) within ENGIN to determine if a criticality and risk-based approach can be applied directly within their platform for future planning.

4. Asset Condition Assessment (ACA) Results

4.1 ACA Combined Results

As noted in Section 3.1 Objective and Scope of Work, 16 asset classes were analyzed for this ACA study. This section summarizes the combined results of the ACA study. The following statistics are provided below for all 16 asset classes combined. Individual assessments by asset class are provided in Appendix A.

More than 65,600 unique assets in the 16 asset classes have been analyzed with asset and/or condition data for the calculation of their Heath Index, resulting in 65,000 assets (99%) having their Health Index calculated[7]. Only 1% of the assets have the age unknown.

The Calendar Age Demographics (age distribution) of all the assets combined is depicted in Figure 4. The oldest asset in the system is a 96 year old manhole (installed in 1928). For all the assets with a known age, the average age is 25.3 years old.

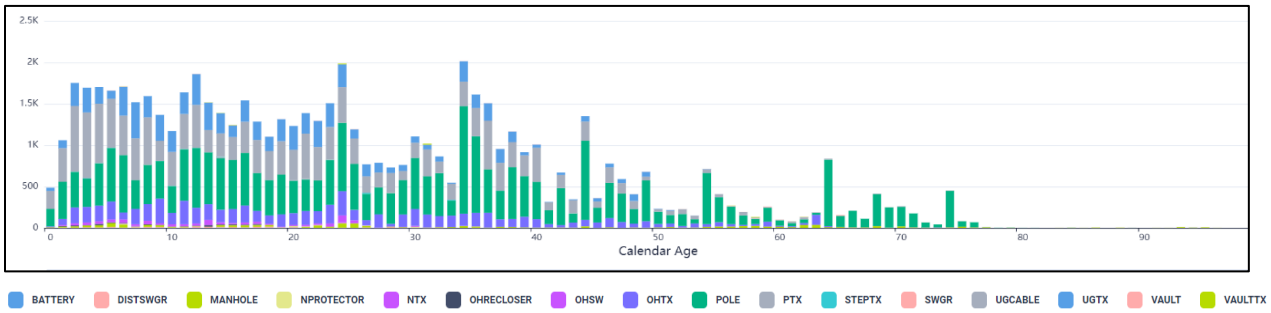


Figure 4, Calendar Age Demographics - 16 Asset Classes

The Health Summary for all assets combined is found below in Figure 5.

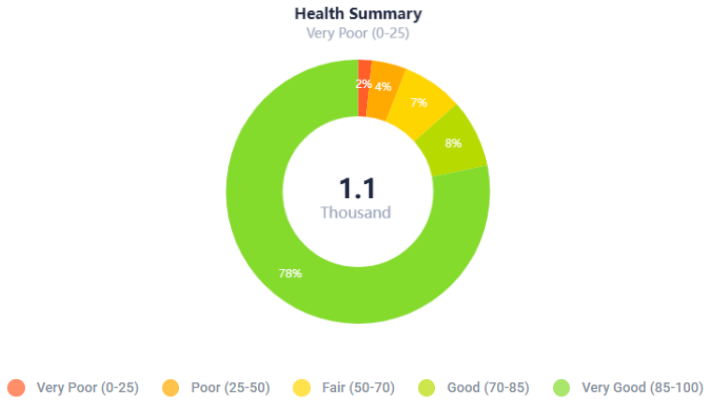


Figure 5, Health Summary - 16 Asset Classes

The Health Demographics of all assets in the 16 asset classes are represented in Figure 6. Assets with HI = 100% (over 35,000 units) are stacked in the last column. A magnified view of the same graph with the HI only between 0% and 99% is presented to allow the scale on the y-axis to better illustrate the HI distribution of the remaining assets. The average Health Index of all the assets combined is 89%.

[7] Majority of the assets without HI came from a small population of wood poles without an asset year or condition data, and from overhead switches without an installation year (e.g. disconnects).

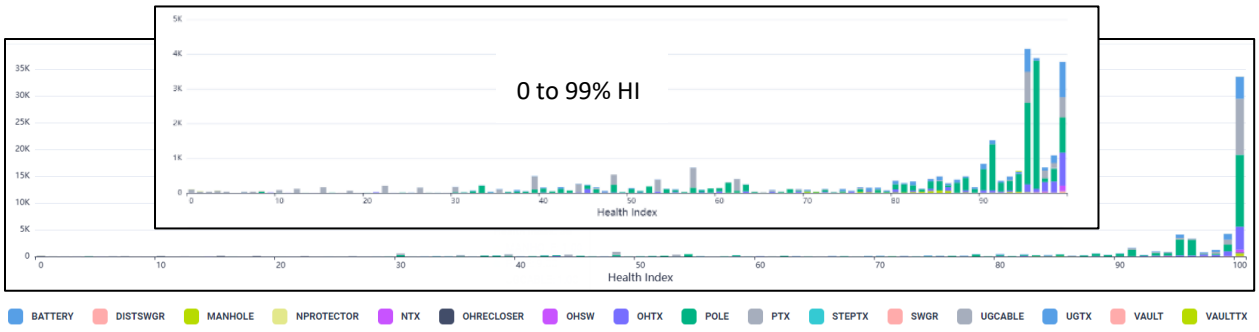


Figure 6, Health Demographics - 16 Asset Classes

The Data Quality graph that was presented earlier for substation transformers is represented below in Figure 7, cumulated for all assets based on the data that was available at the time of the study. The completeness of both asset and condition data will increase over time as more information is collected as part of the cyclical inspection and maintenance activities.

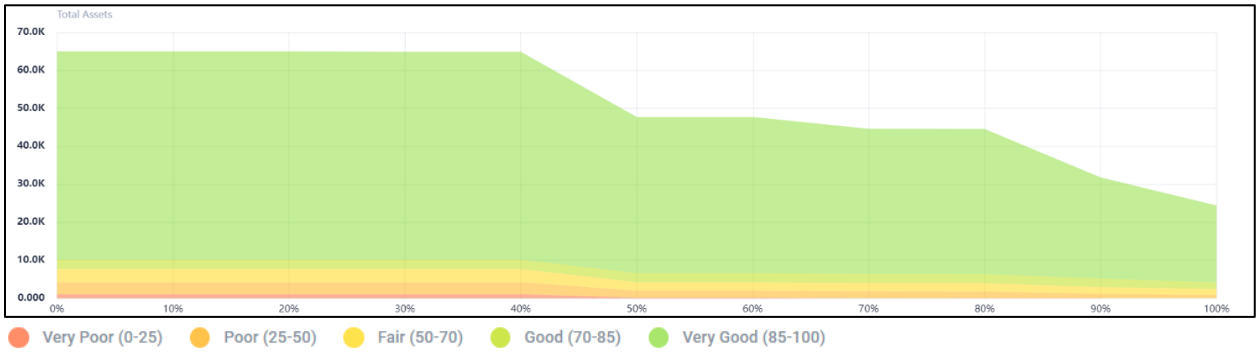


Figure 7, Data Quality - 16 Asset Classes

4.2 ACA Results Summary by Asset Class

The overall health status for each asset class is given by the percentage distribution of their Health Index (HI) categories in Figure 8. On the x-axis is the Health Index distribution between 0 and 100% for each asset class, while the y-axis lists each asset class along with the population of units (sample size) that had their HI calculated (in brackets). This percentage representation is calculated separately for each asset class and it highlights problematic assets relative to the total population of that asset class. For underground cable (UGCABLE), the units were converted to length in circuit-km (i.e. 1629 km). Appendix A details the underground cable in conductor-km for consistency with previous analyses.

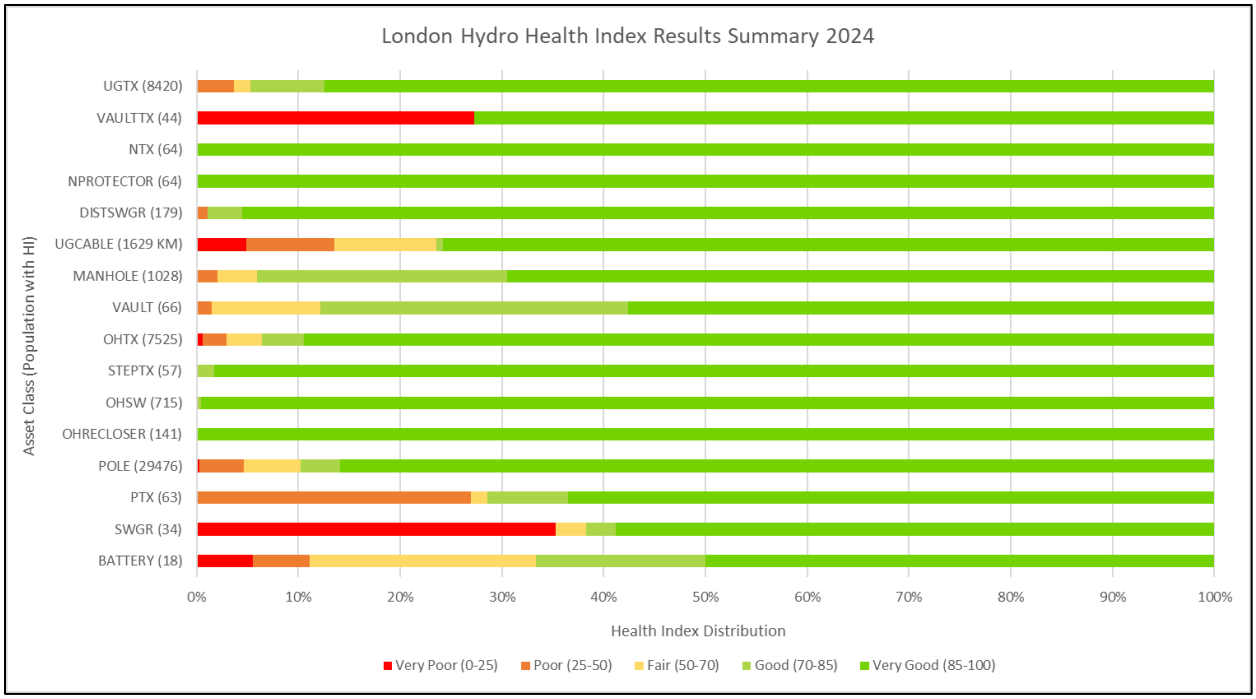


Figure 8, Health Index Distribution - 16 Asset Classes

The above HI distribution represents a snapshot in time and assets in Very Poor and Poor condition can increase over the years. Details for each asset class are presented next in Appendix A.

Appendix A: ACA Results for Each Asset Class

The ACA results for each individual asset class are detailed in this Appendix.

1. Pad Mounted Transformers (UGTX)

There were 8421 pad mounted transformers in-service: 6954 single-phase units and 1467 three-phase units.

The Calendar Age distribution of these transformers is graphically represented in Figure 9. The average age from all the units with known age (8418 units) is 18.4 years old.

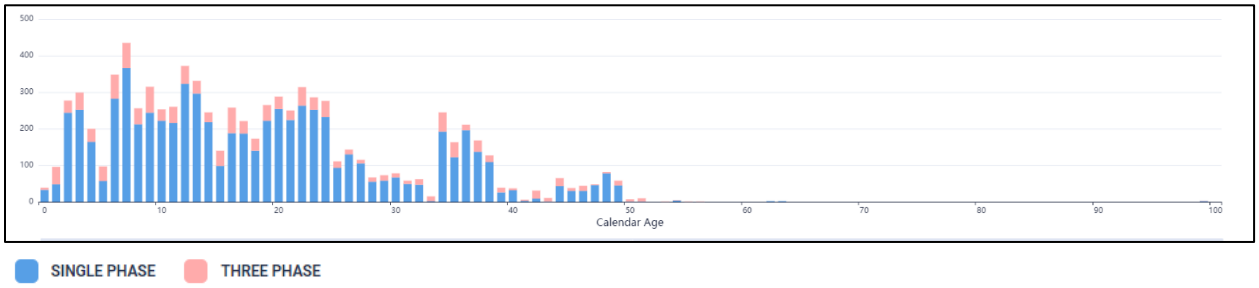


Figure 9, Calendar Age Demographics Pad Mounted Transformers

The Health Summary is given below in Figure 10 for the single-phase and three-phase transformers combined.

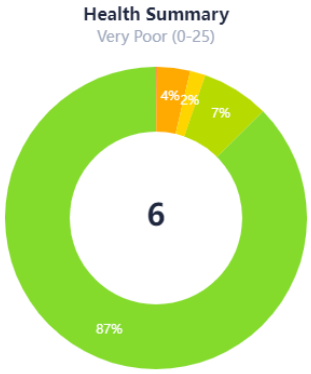


Figure 10, Health Summary Pad Mounted Transformers

1.1 Health Index Analysis

Of the total number of units analyzed, 8420 units (nearly 100%) had sufficient data to calculate a Health Index (HI). The totalized HI distribution by number of units and percentages is given below in Table 3.

Single-phase units' HI distribution is found in Table 4, while Table 5 details the HI distribution for three-phase units. It is noticeable that less than 5% of them combined are in the Very Poor or Poor Health Index category. The average Health Index of pad mounted transformers is 94%.

Table 3, Health Index Distribution - Pad Mounted Transformers (Single-phase and Three-phase)

	Health Index Distribution by Number of Units (8420)				
	Very Poor	Poor	Fair	Good	Very Good
Quantities	(<25%)	(25% - <50%)	(50% - <70%)	(70% - < 85%)	(>=85% - 100%)
Units	6	301	140	608	7365
Percentage	< 1%	4%	2%	7%	87%

Table 4, Health Index Distribution - Pad Mounted Transformers (Single-phase)

	Health Index Distribution by Number of Units (6954)				
	Very Poor	Poor	Fair	Good	Very Good
Quantities	(<25%)	(25% - <50%)	(50% - <70%)	(70% - < 85%)	(>=85% - 100%)
Units	1	241	82	511	6119
Percentage	< 1%	3%	1%	7%	88%

Table 5, Health Index Distribution - Pad Mounted Transformers (Three-phase)

	Health Index Distribution by Number of Units (1466)				
	Very Poor	Poor	Fair	Good	Very Good
Quantities	(<25%)	(25% - <50%)	(50% - <70%)	(70% - < 85%)	(>=85% - 100%)
Units	5	60	58	97	1246
Percentage	< 1%	4%	4%	7%	85%

Asset Health Index Breakdown

The final calculation of the Health Index represents a weighted average between the age score and the other degradation factors (from visual inspection parameters and the calculated Loss of Life due to loading) in percentage of 60/40, respectively. An example of a pad mounted transformer Health Index Breakdown is found in Figure 11; it is for a live-front transformer TE 138 (54 years old). Barriers and Insulators apply only to live-front transformers and not to dead-front units.

Asset Health Index Breakdown

Degradation Factors

Degradation Factor	Data Available	Data Valid	Weight	Score	Degradation Factor Score
Age Score	☑	☑	60	1	0.6 / 60
Loss of Life	☑	☑	5	4	5 / 5
Paint Corrosion	☑	☑	6.5	2	3.25 / 6.5
Placement on Slab or Vault	☑	☑	1	4	1 / 1
Grade Changes	☑	☑	1	4	1 / 1
Oil Leaks	☑	☑	11	4	11 / 11
Barriers	☑	☑	4	0	0 / 4
Insulators	☑	☑	4	0	0 / 4
Primary Termination	☐	☐	2	0	0 / 0
Secondary Termination	☐	☐	2	0	0 / 0
Environmental Risk	☐	☐	3.5	0	0 / 0
Data Availability Index = 92.5%					92.5 / 100
Data Validity Index = 92.5%					92.5 / 100
Health Index = 23.6%					21.85 / 92.5

Figure 11, Asset Health Index Breakdown Pad Mounted Transformers (Live-front)

1.2 Flag For Action (FFA) Plan

As mentioned in Section 3.4 Flag For Action (FFA), equipment removal rates for single and three-phase pad mounted transformers, combined, were calculated for years 0-10 using cumulative likelihood of removals, and the number of units that will require attention are captured in Figure 12.

While the removals increase over the years due to the aging population, an average removal rate is established at 181 pad mounted transformers (single and three-phase combined) addressed every year for the next 10 years, with year 0 being the current year.

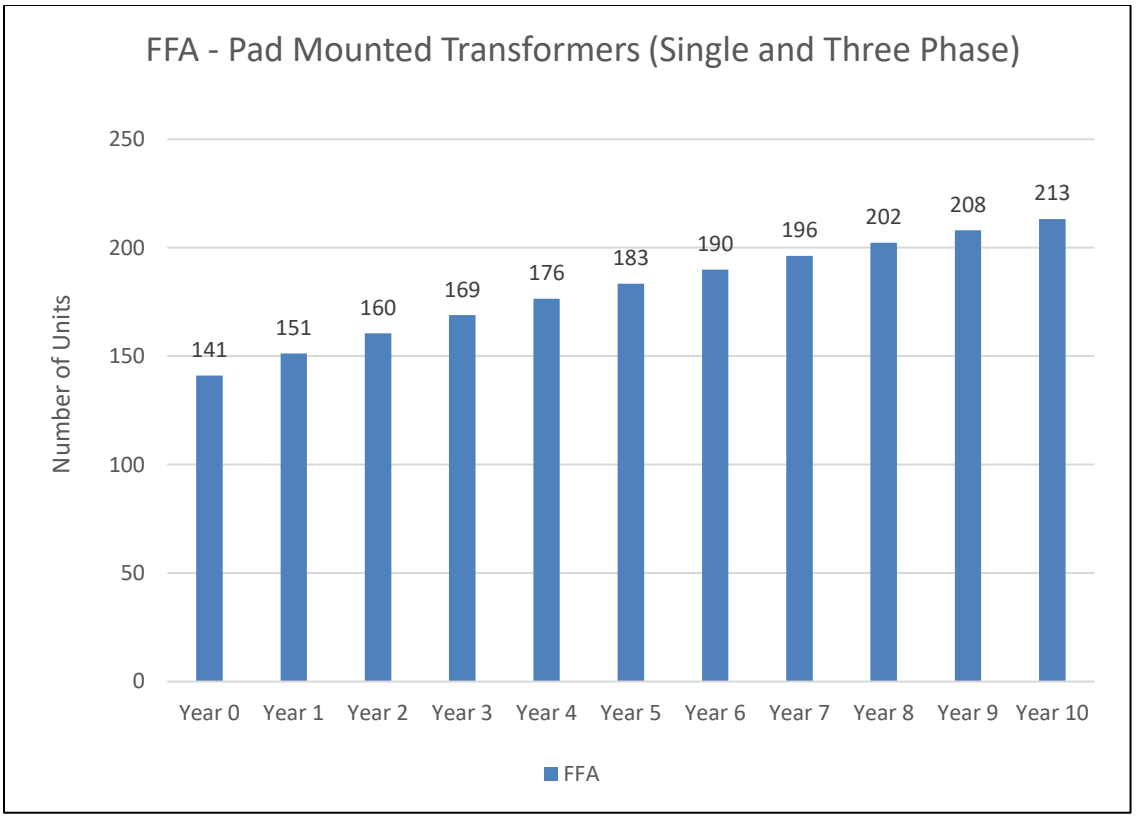


Figure 12, Flag For Action Pad Mounted Transformers

1.3 Data Assessment

The Data Availability Index (DAI) is 91%. This number is expected to increase with the implementation of the new guidelines for inspection and maintenance of the pad mounted transformers. Additional elements[8] are being collected as condition parameters which will take a full 3-year cycle of inspections to capture a visit to every equipment location. There are no current data gaps in the analysis of pad mounted transformers.

2. Vault Transformers (VAULTTX)

There were 44 vault transformers in-service, single-phase and three-phase banks. London Hydro maintains 4 types of vault transformers based on design and insulation:

[8] Primary and secondary terminations, as well as Environmental Risk have been added to the visual inspection list in 2024.

- Dry-type (12)
- R-Temp pole mounted (21)
- FR3 pole mounted (9)
- Submersible (2)

The Calendar Age distribution of these transformers is graphically represented in Figure 13. All the units have their age known. The submersible transformers are the most recent units while the dry-type are the oldest units (around 60 years old). The RTEMP and FR3 pole mounted units are relatively young as well. The average age is 32.6 years old.

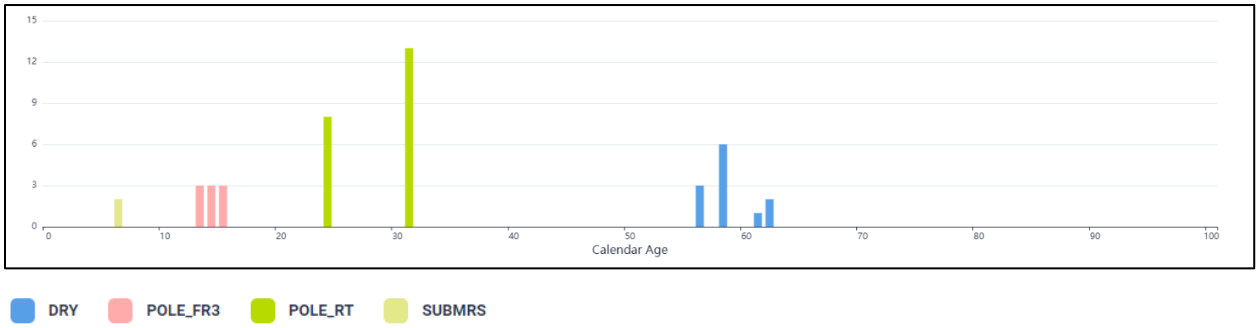


Figure 13, Calendar Age Demographics Vault Transformers

The Health Summary is given below in Figure 14.

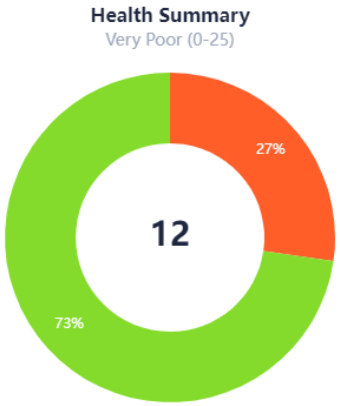


Figure 14, Health Summary Vault Transformers

2.1 Health Index Analysis

All the units had sufficient data to calculate a Health Index (HI). The HI distribution by number of units and percentages is given below in Table 6. In this case 27% (12 units) are in the Very Poor HI category, while

32 units are in Very Good HI category. All of the VP units are the remaining dry-type transformers, which are planned for decommissioning in future capital budget plans.

The average Health Index of vault transformers is 71%, partly because of the low HI of the dry-type units (1.25% combined from the 12 units).

Table 6, Health Index Distribution - Vault Transformers

	Health Index Distribution by Number of Units (44)				
	Very Poor	Poor	Fair	Good	Very Good
Quantities	(<25%)	(25% - <50%)	(50% - <70%)	(70% - < 85%)	(>=85% - 100%)
Units	12	0	0	0	32
Percentage	27%	0%	0%	0%	73%

Asset Health Index Breakdown

The calculation of the Health Index is currently only based on the age score. Other degradation factors will be added to the Health Index methodology in the future. An example of a vault transformer Health Index Breakdown is found in Figure 15. It is for a dry-type transformer TV 662 (56 years old).

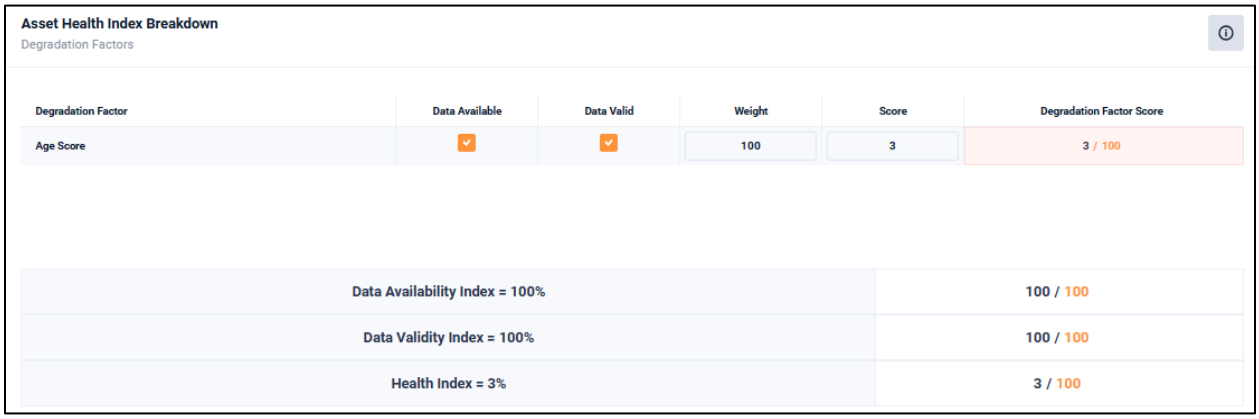


Figure 15, Asset Health Index Breakdown Vault Transformers

2.2 Flag For Action (FFA) Plan

Vault transformers are in either VP condition (the dry-types) or VG condition. Therefore, removals of the VP units are forecasted over a 5-year interval (Figure 16) in addition to the current year's removals. All 12 units can be replaced at an accelerated pace in the 5-year forecast. The dry-type installations are found on the 4.16 kV voltage system which is gradually being converted and eliminated. Some removals of dry-type transformers corelate with plans of voltage conversion and as such, some installations could be delayed but still accomplished over the next 10 years.

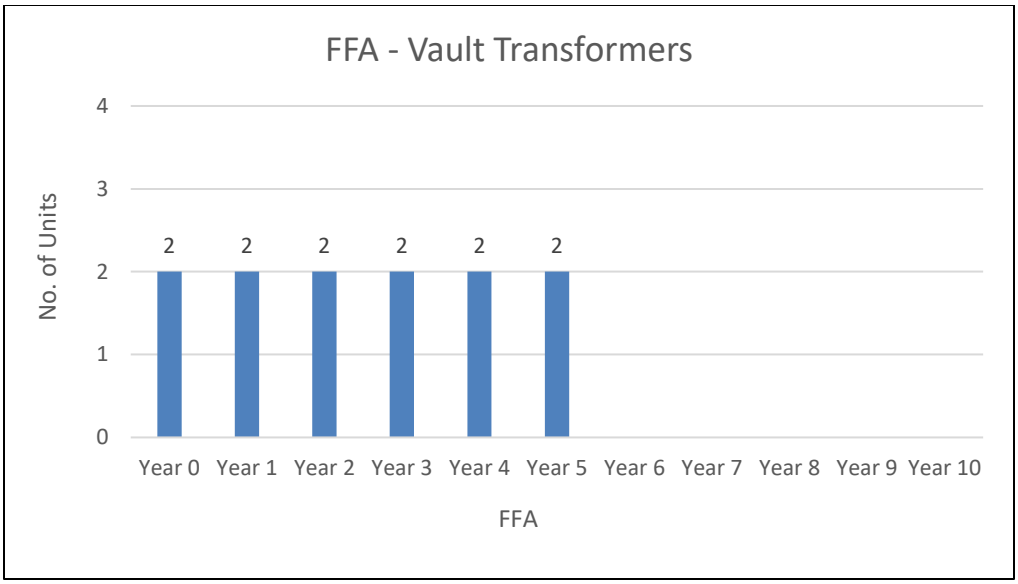


Figure 16, Flag For Action Vault Transformers

2.3 Data Assessment

Other than age, no visual degradation factors were available. Certain visual condition criteria started to be collected in 2024, and in future editions of the ACA, visual inspection parameters will be available to enhance the data assessment with additional degradation factors. The data gaps will be closed in this process.

3. Network Transformers (NTX)

There were 64 network transformers in-service, all three-phase units.

The Calendar Age distribution of these transformers is graphically represented in Figure 17. Age is known for all the units. The average age is 19.8 years old.

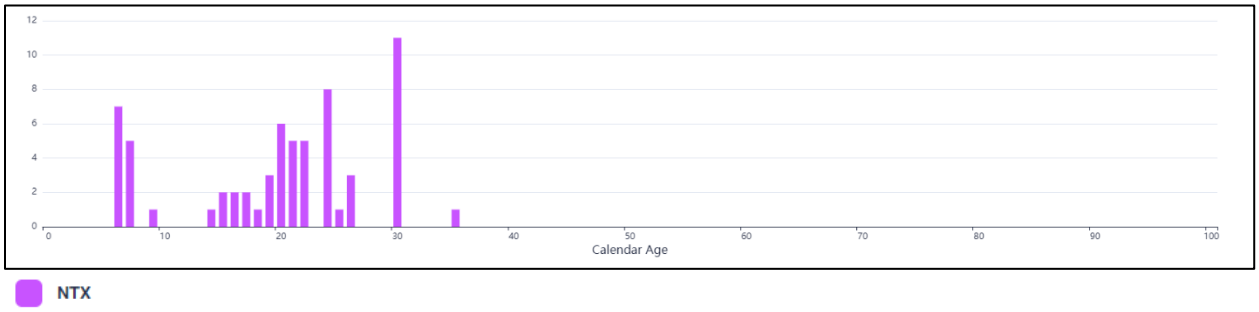


Figure 17, Calendar Age Demographics Network Transformers

The Health Summary is given below in Figure 18.

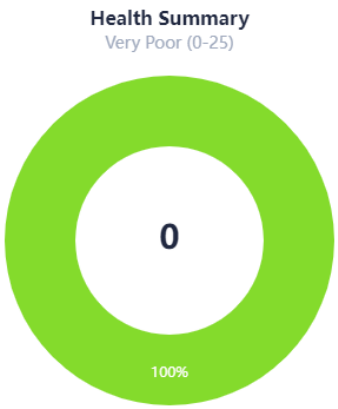


Figure 18, Health Summary Network Transformers

3.1 Health Index Analysis

All the units had enough data to calculate a Health Index. The HI distribution by number of units and percentages is given below in Table 7. The average Health Index of network transformers is 100%.

Table 7, Health Index Distribution - Network Transformers

	Health Index Distribution by Number of Units (64)				
	Very Poor	Poor	Fair	Good	Very Good
Quantities	(<25%)	(25% - <50%)	(50% - <70%)	(70% - < 85%)	(>=85% - 100%)
Units	0	0	0	0	64
Percentage	0%	0%	0%	0%	100%

Asset Health Index Breakdown

The final calculation of the Health Index represents a weighted average between the age score and the degradation factors in percentage of 80/20, respectively. An example of a network transformer Health Index Breakdown is found in Figure 19. It is for NT 107 (35 years old).

Asset Health Index Breakdown

Degradation Factors

Degradation Factor	Data Available	Data Valid	Weight	Score	Degradation Factor Score
Age Score	☑	☑	80	95	76 / 80
HT Oil Levels	☑	☑	3	4	3 / 3
MT Oil Levels	☑	☑	3	4	3 / 3
Oil Leaks	☑	☑	3	4	3 / 3
TC Oil Levels	☑	☑	3	4	3 / 3
TX Paint Condition	☐	☐	0	0	0 / 0
TX Rust	☑	☑	3	4	3 / 3
Primary Termination	☐	☐	3	0	0 / 0
Secondary Termination	☐	☐	3	0	0 / 0
Data Availability Index = 94.1%					95 / 101
Data Validity Index = 94.1%					95 / 101
Health Index = 95.8%					91 / 95

Figure 19, Asset Health Index Breakdown Network Transformers

3.2 Flag For Action (FFA) Plan

Since there are no units identified in Very Poor or Poor Health Index category, no units are Flagged For Action over the next 5-10 years. Every year all network transformers are inspected and if one unit becomes susceptible to underperformance (i.e., too much rust), it is added for replacement/refurbishment in the capital budget of the following year. An FFA of 1 unit every year is a conservative forecast.

3.3 Data Assessment

The Data Availability Index (DAI) is 93%. This number is expected to increase with the implementation of the new guidelines for inspection and maintenance of the network transformers. Additional elements[9] will be collected as condition parameters in future inspections. There are no current data gaps in the analysis of network transformers.

4. Network Protectors (NPROTECTOR)

There were 64 network protectors in-service; the age of these assets was not available at the time of this study. For the purpose of this study, their age was inferred to be the same as the corresponding network

[9] Primary and Secondary Terminations have been added as visual inspection parameters in 2024.

transformer, which is a reasonable inference. Data on installation year of these assets started being collected as of this year.

The Calendar Age distribution of the network protectors is graphically represented in Figure 20. The average inferred age is 19.8 years old.

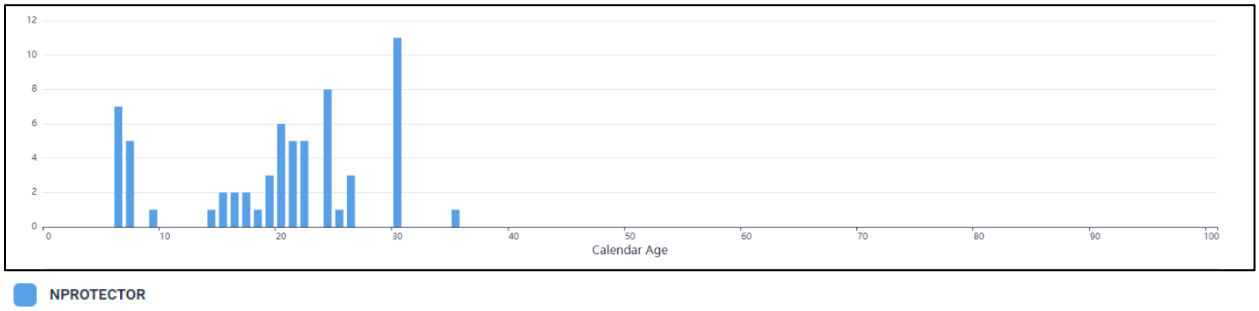


Figure 20, Calendar Age Demographics Network Protectors

The Health Summary is given below in Figure 21.

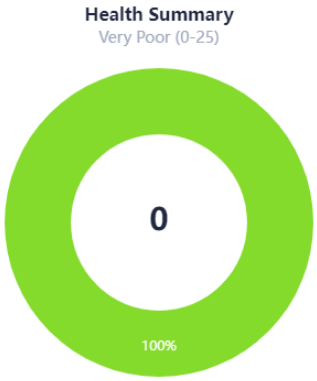


Figure 21, Health Summary Network Protectors

4.1 Health Index Analysis

All the units had enough data to calculate a Health Index. The Health Index distribution by number of units and percentages is reproduced below in Table 8. The average Health Index of network protectors is also 100%, like that of network transformers.

Table 8, Health Index Distribution - Network Protectors

	Health Index Distribution by Number of Units (64)				
	Very Poor	Poor	Fair	Good	Very Good
Quantities	(<25%)	(25% - <50%)	(50% - <70%)	(70% - < 85%)	(>=85% - 100%)
Units	0	0	0	0	64
Percentage	0%	0%	0%	0%	100%

Asset Health Index Breakdown

The final calculation of the Health Index represents a weighted average between the age score and the other degradation factors in percentage of 80/20, respectively. An example of a network protector Health Index Breakdown is found in Figure 22; it is for NT 107 NP (35 years old).

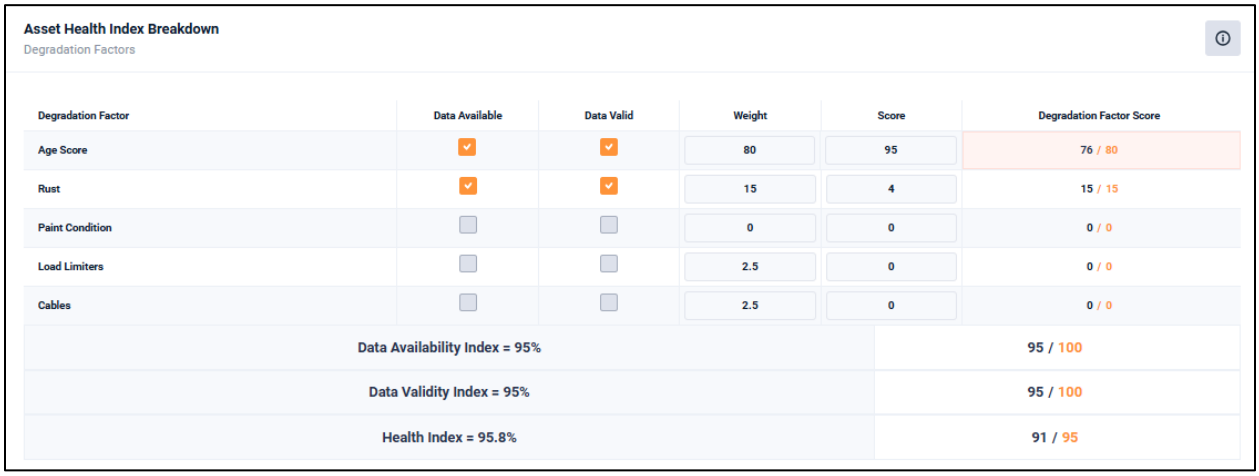


Figure 22, Asset Health Index Breakdown Network Protectors

4.2 Flag For Action (FFA) Plan

Since there are no units identified of Very Poor or Poor Health Index category, no units are Flagged For Action over the next 5-10 years. Every year all network protectors are inspected and if one unit becomes susceptible to any operational issues, it is added for replacement/refurbishment in the capital budget of the following year. An FFA of 1 unit every year is a conservative forecast.

4.3 Data Assessment

The Data Availability Index (DAI) is 95%. This number is expected to increase with the implementation of the new guidelines for inspection and maintenance of the network protectors. Additional elements[10] will be collected as condition parameters in future inspections. There are no current data gaps in the analysis of network protectors.

[10] Cables and secondary terminations have been added as visual inspection parameters in 2024.

5. Distribution Switchgears (DISTSWGR)

There were 180 distribution switchgear units in-service, with very few live-front units remaining and the majority being dead-front style. London Hydro maintains 3 types of distribution switchgear based on design and insulation: the live-front air-insulated (SEs), the dead-front solid-dielectric and SF6 insulated switchgear (LCs). There are some legacy junction style switchgears ("Other") that are also considered dead-front.

The Calendar Age distribution of distribution switchgear is graphically represented in Figure 23. There are very few units of unknown age (1.7% or 3 units out of 180), i.e., Hydro One grand-fathered junctions. The air-insulated units are the among the oldest, together with some SF6 units (with the oldest original SF6 units as old as 35 years); majority of the solid dielectric population is relatively new. The average age of all the units of known age (177 units) is 14.1 years old.

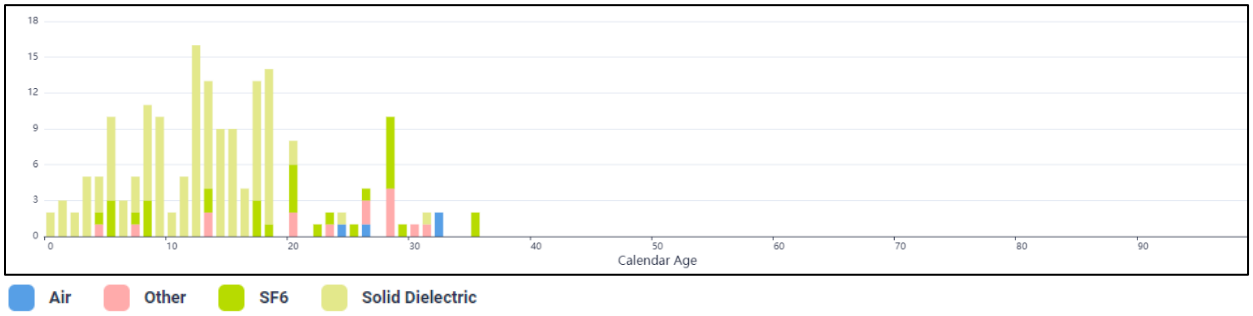


Figure 23, Calendar Age Demographics Distribution Switchgears

The Health Summary is given below in Figure 24 cumulated for all distribution switchgear types.

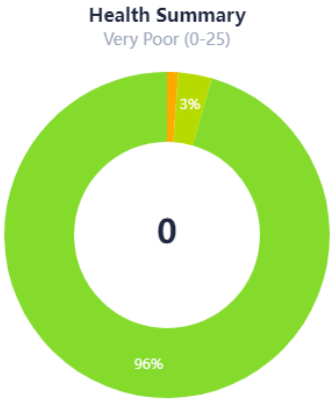


Figure 24, Health Summary Distribution Switchgears

5.1 Health Index Analysis

Of the total number of units analyzed, 179 units (nearly 100%) had sufficient data to calculate a Health Index. The HI distribution by number of units and percentages is given below in Table 9. The average Health Index of distribution switchgear is 97%.

Table 9, Health Index Distribution - Distribution Switchgears

	Health Index Distribution by Number of Units (179)				
	Very Poor	Poor	Fair	Good	Very Good
Quantities	(<25%)	(25% - <50%)	(50% - <70%)	(70% - < 85%)	(>=85% - 100%)
Units	0	2	0	6	171
Percentage	0%	1%	0%	3%	96%

In the case of distribution switchgear none are in Very Poor condition and only 1% (2 units) are in the Poor Health Index category.

Asset Health Index Breakdown

The final calculation of the Health Index represents a weighted average between the age score and the other degradation factors in percentage of 80/20, respectively. An example of a distribution switchgear Health Index Breakdown is found in Figure 25. It is for an air-insulated unit SE 5296 (32 years old). Barriers and Insulators are applicable only to live-front units (similarly to live-front transformers), and not to the dead-front units.

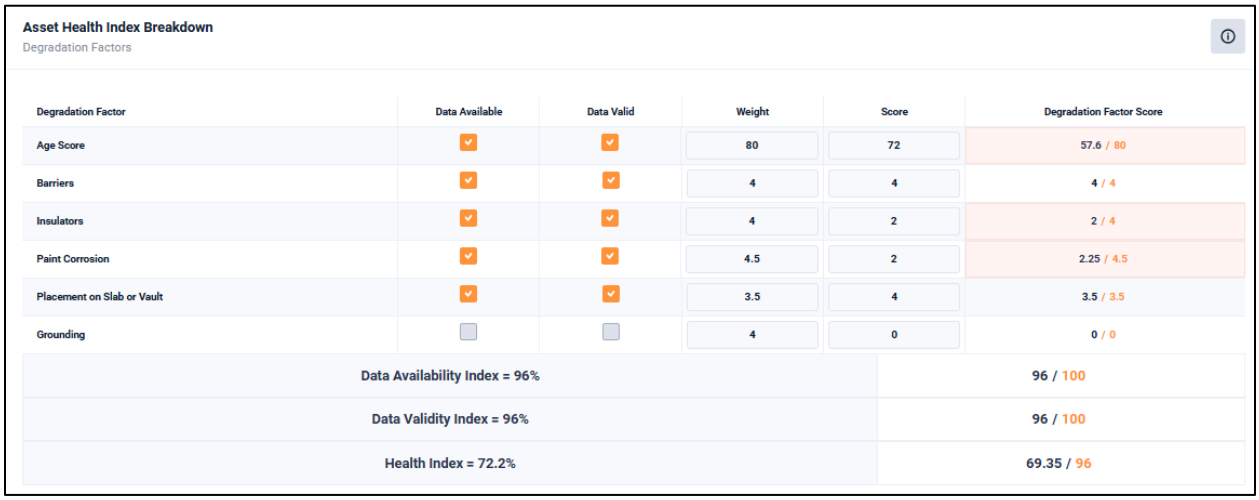


Figure 25, Asset Health Index Breakdown Distribution Switchgears (Live-front)

5.2 Flag For Action (FFA) Plan

The FFA plan includes an average of 3 removals per year between years 0-10. This rate of replacement matches history of failures up until the present time. Current annual distribution switchgear replacements are meeting the quantities anticipated in the FFA plan.

5.3 Data Assessment

The Data Availability Index (DAI) is 90%. Inspection records were enhanced[11] in 2024 and in future editions of the ACA, more comprehensive data will be available. There are no current data gaps in the analysis of distribution switchgear.

6. Underground Cables (UGCABLE)

There were 17114 segments of underground primary cable totalling approximately 1629 km of circuit length. London Hydro maintains 4 types of underground primary cable based on insulation and usage:

- Paper Insulated Lead Cable (PILC)[12]
- Ethylene Propylene Rubber (EPR)[13]
- Polymeric (PE, RUBBER, XLPE, TR-XLPE)[14]
- Large Polymeric (XLPE, TR-XLPE) [15]

The Calendar Age distribution for underground cable[16] is graphically represented in Figure 26. Nearly 100% (99.99% or ~1629 km) of the underground cable has the age known. The average age is 20.1 years old.

[11] Terminations and Grounding were added as visual inspection parameters in 2024.
[12] PILC is generally used on 4.16 kV egress cables and on the 13.8 kV system downtown.
[13] EPR is a new standard cable replacing the obsolete PILC.
[14] This is typical residential subdivision cable.
[15] Large polymeric cable is conductor 1000 kcmil Al or 750 kcmil Cu used as egress main feeders at stations.
[16] TR-XLPE was introduced in 1990 at London Hydro, so in 2024 the oldest TR-XLPE is 34 years old, and most of the XLPE is older than 34 years.

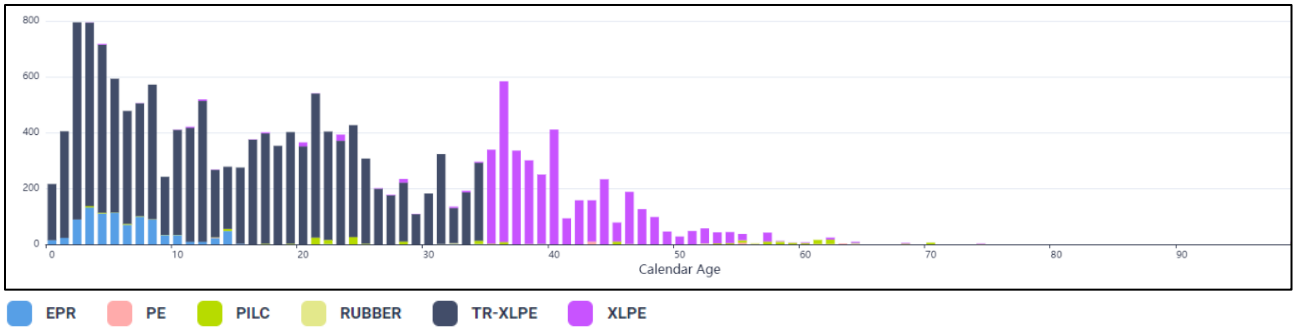


Figure 26, Calendar Age Demographics Underground Cables

The Health Summary is given below in Figure 27.

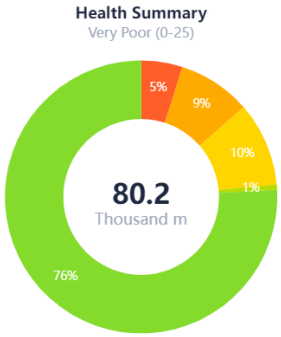


Figure 27, Health Summary Underground Cables[17]

6.1 Health Index Analysis

Nearly all the cable had sufficient data to calculate a Health Index (HI). The HI distribution by total conductor-km[18] and percentages is given in Table 10, totalling approximately 2208 conductor-km, out of which approximately 277 (113 + 164) conductor-km are in Very Poor or Poor HI category. The average Health Index is 87%.

Table 10, Health Index Distribution - Underground Cables (Total conductor-km)

	Health Index Distribution by Number of Units (2260)				
	Very Poor	Poor	Fair	Good	Very Good
Quantities	(<25%)	(25% - <50%)	(50% - <70%)	(70% - < 85%)	(>=85% - 100%)
Units	113	164	202	11	1718
Percentage	5%	7%	9%	0%	78%

[17] The circuit length of the VP cable is 80 km, equivalent to 113 conductor-km.
[18] Conductor-km of cable was calculated from circuit-km. All the cables, except PILC and EPR, have the RWB phase circuit length multiplied by 3 to obtain conductor length.

Following are the approximate lengths of underground cable in circuit-km for PILC and EPR, and in conductor-km for Large Polymeric (Egress) and Polymeric (Subdivision) underground cable.

Table 11, Health Index Distribution - Underground Cables (PILC circuit-km)

	Health Index Distribution by Number of Units (6.1)				
	Very Poor	Poor	Fair	Good	Very Good
Quantities	(<25%)	(25% - <50%)	(50% - <70%)	(70% - < 85%)	(>=85% - 100%)
Units	0.2	0.9	0.7	1.1	3.2
Percentage	3%	15%	11%	18%	52%

Table 12, Health Index Distribution - Underground Cables (EPR circuit-km)

	Health Index Distribution by Number of Units (78)				
	Very Poor	Poor	Fair	Good	Very Good
Quantities	(<25%)	(25% - <50%)	(50% - <70%)	(70% - < 85%)	(>=85% - 100%)
Units	0	0	0	0	26
Percentage	0%	0%	0%	0%	100%

Table 13, Health Index Distribution - Underground Cables (Large Polymeric conductor-km)

	Health Index Distribution by Number of Units (164)				
	Very Poor	Poor	Fair	Good	Very Good
Quantities	(<25%)	(25% - <50%)	(50% - <70%)	(70% - < 85%)	(>=85% - 100%)
Units	0	0.6	2.5	0.6	160
Percentage	<1%	<1%	2%	<1%	98%

Table 14, Health Index Distribution - Underground Cables (Polymeric conductor-km)

	Health Index Distribution by Number of Units (2011)				
	Very Poor	Poor	Fair	Good	Very Good
Quantities	(<25%)	(25% - <50%)	(50% - <70%)	(70% - < 85%)	(>=85% - 100%)
Units	112	162	199	9	1529
Percentage	6%	8%	10%	<1%	76%

Asset Health Index Breakdown

The final calculation of the Health Index represents a weighted average between the age score and the degradation factors (cable condition testing) in percentage of 20/80, respectively. An example of an underground cable Health Index Breakdown with cable testing data is found in Figure 28 (17 years old polymeric cable).



Asset Health Index Breakdown

Degradation Factors

Degradation Factor	Data Available	Data Valid	Weight	Score	Degradation Factor Score
Age Score	☑	☑	20	100	20 / 20
Cable Testing	☑	☑	80	1	20 / 80

Data Availability Index = 100%	100 / 100
Data Validity Index = 100%	100 / 100
Health Index = 40%	40 / 100

Figure 28, Asset Health Index Breakdown Underground Cables

6.2 Flag For Action (FFA) Plan

Based on the analysis done in the previous section, the FFA plan is being developed according to the various cable types.

PILC cable is being removed from the system with every opportunity (failed cable is usually replaced or spliced in with EPR), therefore no quantities are Flagged For Action in the next 5-10 years.

EPR cable does not require attention for the foreseeable future, therefore no quantities are Flagged For Action in the next 5-10 years.

Large Polymeric (Egress) cable requires a very small quantity to be addressed every year based on its condition. However, given the criticality of these main feeders, 0.5 km of cable addressed per year is included in the FFA plan (Figure 29).

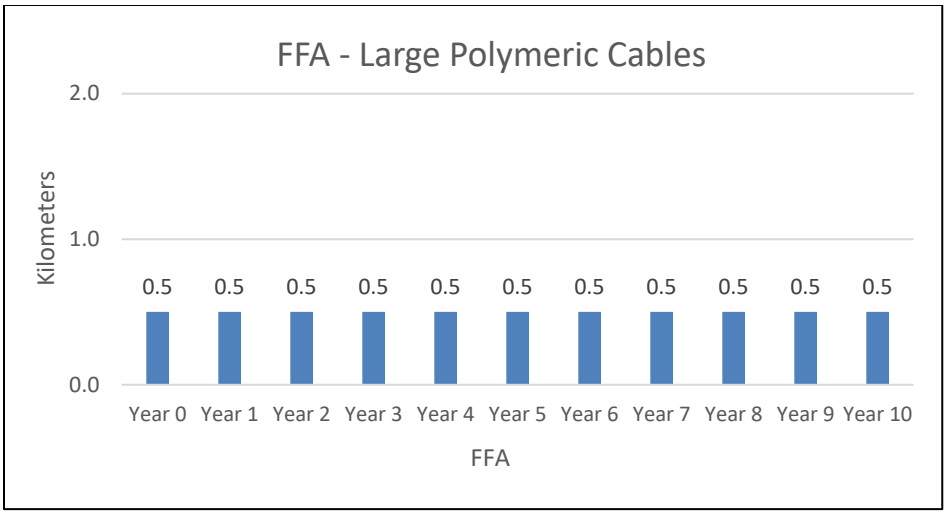


Figure 29, Flag For Action Large Polymeric Cables

Polymeric cable FFA plan includes addressing both XLPE and TR-XLPE cable based on their removal rates as function of asset age. Combined these 2 cable types yield to an average quantity of 46 km of polymeric cable addressed every year for the next 10 years. The annual quantities are represented in Figure 30. Larger levels of annual condition cable testing data can potentially defer some of the replacements until a later time, or continue to help prioritize cable replacement driven by condition as well as age.

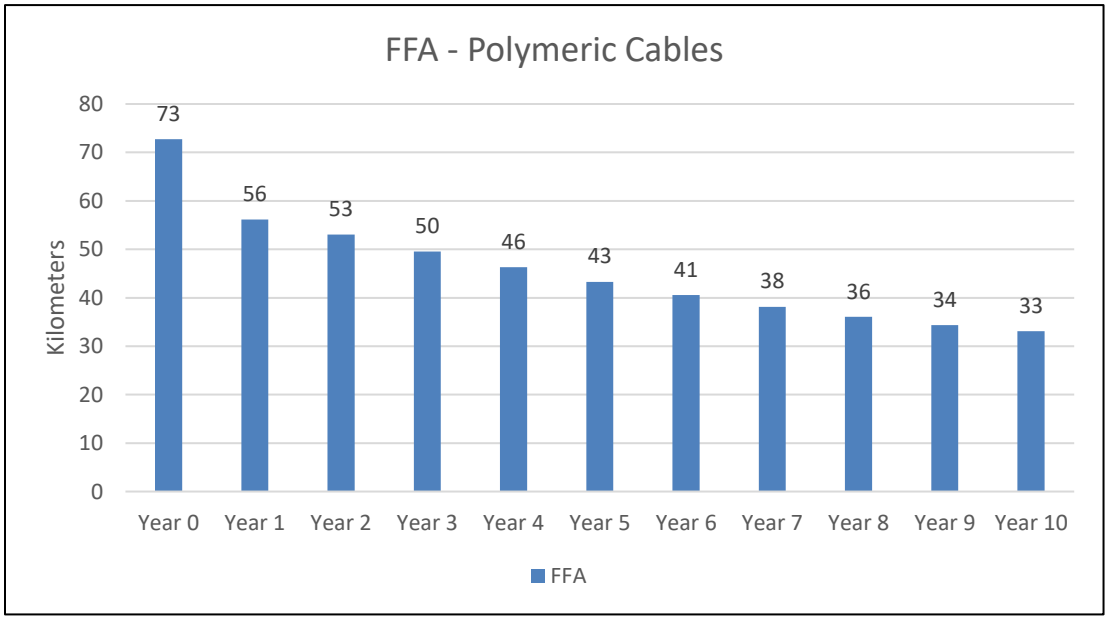


Figure 30, Flag For Action Polymeric Cables

6.3 Data Assessment

The Data Availability Index (DAI) is 22%. Condition cable testing data (i.e. VLF Tan Delta) is highly influential to cable health based on 80% weight of test and age. However, it is not feasible to test the entire population of 2200+ km of cable as this would be cost-prohibitive and not result in material value for the customer reliability. Therefore, a sample testing methodology is used, whereby only a limited population of cable within projected subdivision candidates are tested. This sampling methodology cost effectively confirms the general condition of cable within a subdivision, thereby allowing the prioritization of projects without diminishing the overall quality of data.

7. Manholes (MANHOLE)

There were 1028 manholes in-service. Manholes, together with vaults, are part of the civil structures that London Hydro utilizes for underground conductors (specifically in the downtown core area). Manholes are maintained, refurbished or rebuilt when necessary.

The Calendar Age distribution is graphically represented in Figure 31. Age is known for all the manholes. The average age is 35.3 years old.

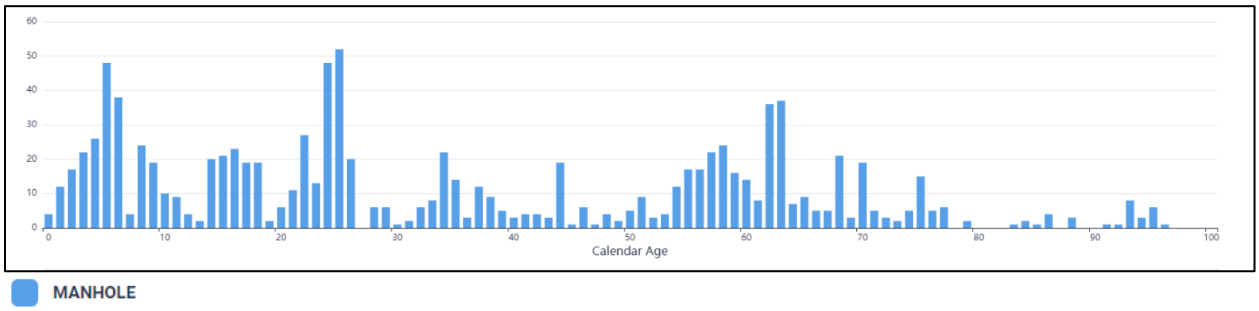


Figure 31, Calendar Age Demographics Manholes

The Health Summary is given below in Figure 32.

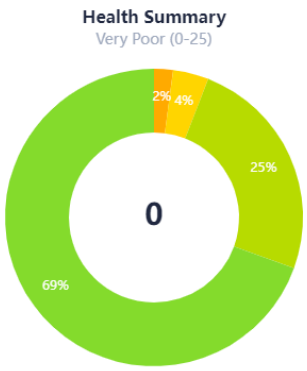


Figure 32, Health Summary Manholes

7.1 Health Index Analysis

All the manholes had sufficient data to calculate a Health Index (HI). The HI distribution by number of units and percentages is given below in Table 15. It is noticeable that none of them are in the Very Poor HI category and only 2% (21 units) are Poor. The average Health Index of manholes is 90%.

Table 15, Health Index Distribution - Manholes

	Health Index Distribution by Number of Units (1028)				
	Very Poor	Poor	Fair	Good	Very Good
Quantities	(<25%)	(25% - <50%)	(50% - <70%)	(70% - < 85%)	(>=85% - 100%)
Units	0	21	40	253	714
Percentage	0%	2%	4%	25%	69%

Asset Health Index Breakdown

The final calculation of the Health Index represents a weighted average between the age score and the other degradation factors (from inspection parameters) in percentage of 40/60, respectively. Manholes, as civil structures, have a very rigorous program of annual inspection by a civil engineer and the condition of the asset has more weight in the methodology than its age. An example of a manhole Health Index Breakdown is found in Figure 33; it is for MH 193 (88 years old).



Asset Health Index Breakdown

Degradation Factors

Degradation Factor	Data Available	Data Valid	Weight	Score	Degradation Factor Score
Age Score	☑	☑	40	28	11.2 / 40
Roof Condition	☑	☑	33	3	24.75 / 33
Wall Condition	☑	☑	21	3	15.75 / 21
Floor Condition	☑	☑	6	2	3 / 6

Data Availability Index = 100%	100 / 100
Data Validity Index = 100%	100 / 100
Health Index = 54.7%	54.7 / 100

Figure 33, Asset Health Index Breakdown Manholes

7.2 Flag For Action (FFA) Plan

The FFA plan includes an average of 25 units to be addressed every year. The annual quantities are represented in Figure 34. Addressing a manhole in poorer condition is usually done via refurbishment or simply replacing its roof slab, depending on its condition as assessed by the civil engineer performing the inspections. This process has permitted London Hydro to delay the complete replacement of the aged units that experience a poor condition. However, it is recognized that refurbishment cannot prolong the end of life for the civil structures indefinitely. In order to prevent a balloon-like effect, London Hydro will, at some point in time, have to decide for how long a manhole can be allowed to remain in service based on its age and condition.

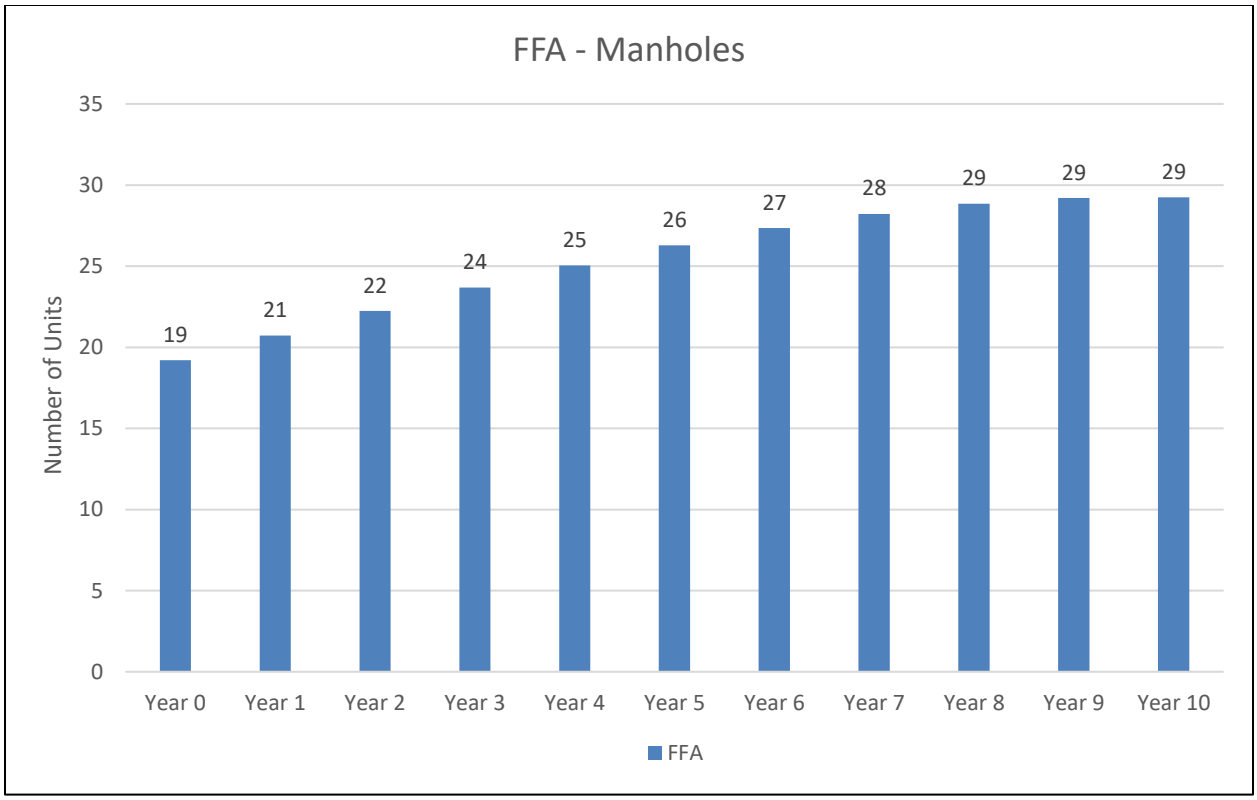


Figure 34, Flag For Action Manholes

7.3 Data Assessment

The Data Availability Index (DAI) is 77%. Manholes are inspected based on a combination of age and risk criteria; a manhole will not be inspected by a civil engineer until it is 25 years old. The frequency of inspections is based on the test results and the risk criteria. Only a subset of manholes is receiving a civil inspection every year based on age, location criticality (ex. under main road) and previous condition parameters. There are no current data gaps in the analysis of manholes.

8. Vaults (VAULT)

There were 67 vaults in-service. The vaults house the network transformers downtown. They represent civil structures together with the manholes.

The Calendar Age distribution is graphically represented in Figure 35. The average age for the vaults with a known year of installation (66 units) is 46.8 years old, with certain vaults as old as 80-90 years old.

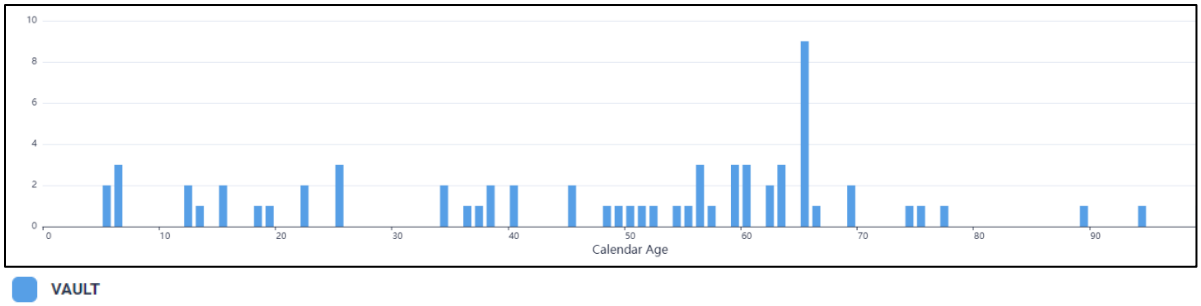


Figure 35, Calendar Age Demographics Vaults

The Health Summary is given below in Figure 36.

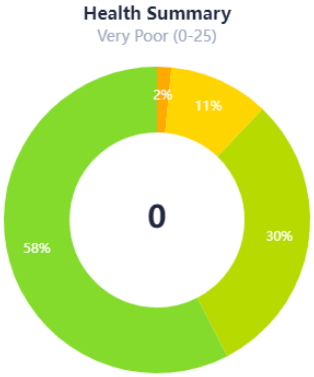


Figure 36, Health Summary Vaults

8.1 Health Index Analysis

Of all the units analyzed, 66 units (nearly 100%) had sufficient data to calculate a Health Index (HI). The HI distribution by number of units and percentages is given below in Table 16. It is noticeable that none of them are in the Very Poor HI category. One is in the Poor category. The average Health Index of vaults is 86%.

Table 16, Health Index Distribution - Vaults

	Health Index Distribution by Number of Units (66)				
	Very Poor	Poor	Fair	Good	Very Good
Quantities	(<25%)	(25% - <50%)	(50% - <70%)	(70% - < 85%)	(>=85% - 100%)
Units	0	1	7	20	38
Percentage	0%	2%	11%	30%	58%

Asset Health Index Breakdown

The final calculation of the Health Index represents a weighted average between the age score and the other degradation factors (from inspection parameters) in percentage of 40/60, respectively. Vaults, as

civil structures, have a very rigorous program of annual inspection by a civil engineer and the condition of the asset has more weight in the methodology than its age. An example of a vault Health Index Breakdown is found in Figure 37; it is for VT 041 (40 years old).



Asset Health Index Breakdown

Degradation Factors

Degradation Factor	Data Available	Data Valid	Weight	Score	Degradation Factor Score
Age Score	☑	☑	40	100	40 / 40
Roof Condition	☑	☑	33	2	16.5 / 33
Wall Condition	☑	☑	21	1	5.25 / 21
Floor Condition	☑	☑	6	2	3 / 6

Data Availability Index = 100%	100 / 100
Data Validity Index = 100%	100 / 100
Health Index = 64.8%	64.75 / 100

Figure 37, Asset Health Index Breakdown Vaults

8.2 Flag For Action (FFA) Plan

Most of the vaults, as an asset class, unlike manholes, are characterized in sound condition. Since 1 unit is in Poor HI category and 7 are Fair, a conservative removal rate of 1 unit per year is included in the 10-year FFA plan.

8.3 Data Assessment

The Data Availability Index (DAI) is 91%. Vaults, like manholes, are inspected based on a combination of age and risk criteria. There are no current data gaps in the analysis of vaults.

9. Pole Mounted Transformers (OHTX)

There were 7532 pole mounted transformers in-service: 3796 single-phase and 3736 units[19] in three-phase installations (1246 three-phase banks).

The Calendar Age distribution is graphically represented in Figure 38. The average age of the units where the installation year is known (7522 units) is 24 years old.

[19] There are a few installations of 2 units in a bank.

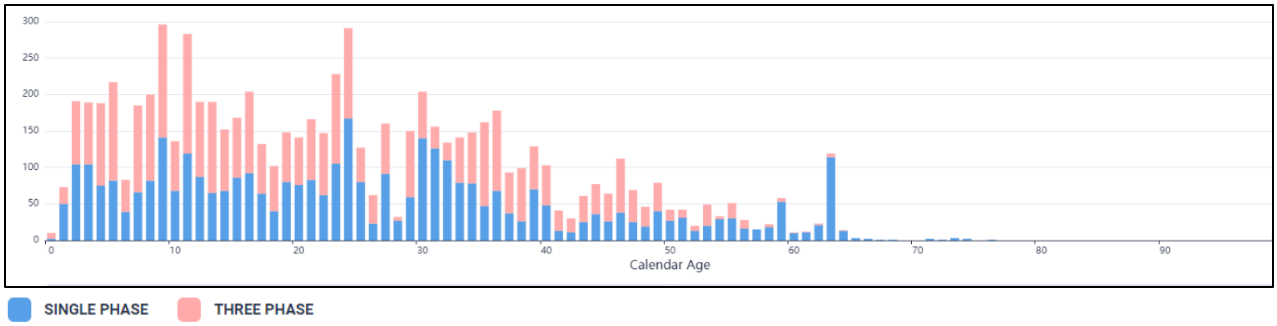


Figure 38, Calendar Age Demographics Pole Mounted Transformers

The Health Summary is given in Figure 39 for the single-phase and three-phase transformers combined.

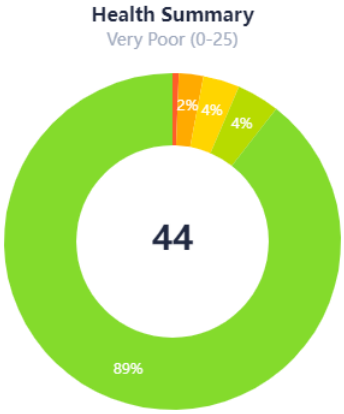


Figure 39, Health Summary Pole Mounted Transformers

9.1 Health Index Analysis

Of the total of number of units analyzed, 7525 units (nearly 100%) had sufficient data to calculate a Health Index (HI). The HI distribution by number of units and percentages for single-phase transformers and three-phase transformers combined are given below in Table 17. Table 18 and Table 19 show the counts by number of phases. Only 3% overall are in the Very Poor or Poor HI categories. The average Health Index of pole mounted transformers is 95%.

Table 17, Health Index Distribution - Pole Mounted Transformers (Single-phase and Three-phase)

	Health Index Distribution by Number of Units (7525)				
	Very Poor	Poor	Fair	Good	Very Good
Quantities	(<25%)	(25% - <50%)	(50% - <70%)	(70% - < 85%)	(>=85% - 100%)
Units	44	177	264	311	6729
Percentage	1%	2%	4%	4%	89%

Table 18, Health Index Distribution - Pole Mounted Transformers (Single-phase)

	Health Index Distribution by Number of Units (3789)				
	Very Poor	Poor	Fair	Good	Very Good
Quantities	(<25%)	(25% - <50%)	(50% - <70%)	(70% - < 85%)	(>=85% - 100%)
Units	43	165	167	163	3251
Percentage	<1%	4%	4%	4%	86%

Table 19, Health Index Distribution - Pole Mounted Transformers (Three-phase)

	Health Index Distribution by Number of Units (3736)				
	Very Poor	Poor	Fair	Good	Very Good
Quantities	(<25%)	(25% - <50%)	(50% - <70%)	(70% - < 85%)	(>=85% - 100%)
Units	1	12	97	148	3478
Percentage	<1%	<1%	3%	4%	93%

Asset Health Index Breakdown

The final calculation of the Health Index represents a weighted average between the age score and the only other degradation factor (Loss of Life due to loading) in percentage of 60/40, respectively. An example of a pole mounted transformer Health Index Breakdown is found in Figure 40, T 9045 (44 years old).



Figure 40, Asset Health Index Breakdown Pole Mounted Transformers

9.2 Flag For Action (FFA) Plan

As part of the Flag For Action (FFA), an average removal rate of 95 units (single and three phase combined), is established every year of the 10-year plan. The annual quantities are represented in Figure 41. It is important to note that there are other considerations that could influence London Hydro's asset management plan in addressing pole mounted transformers, such as voltage conversions.

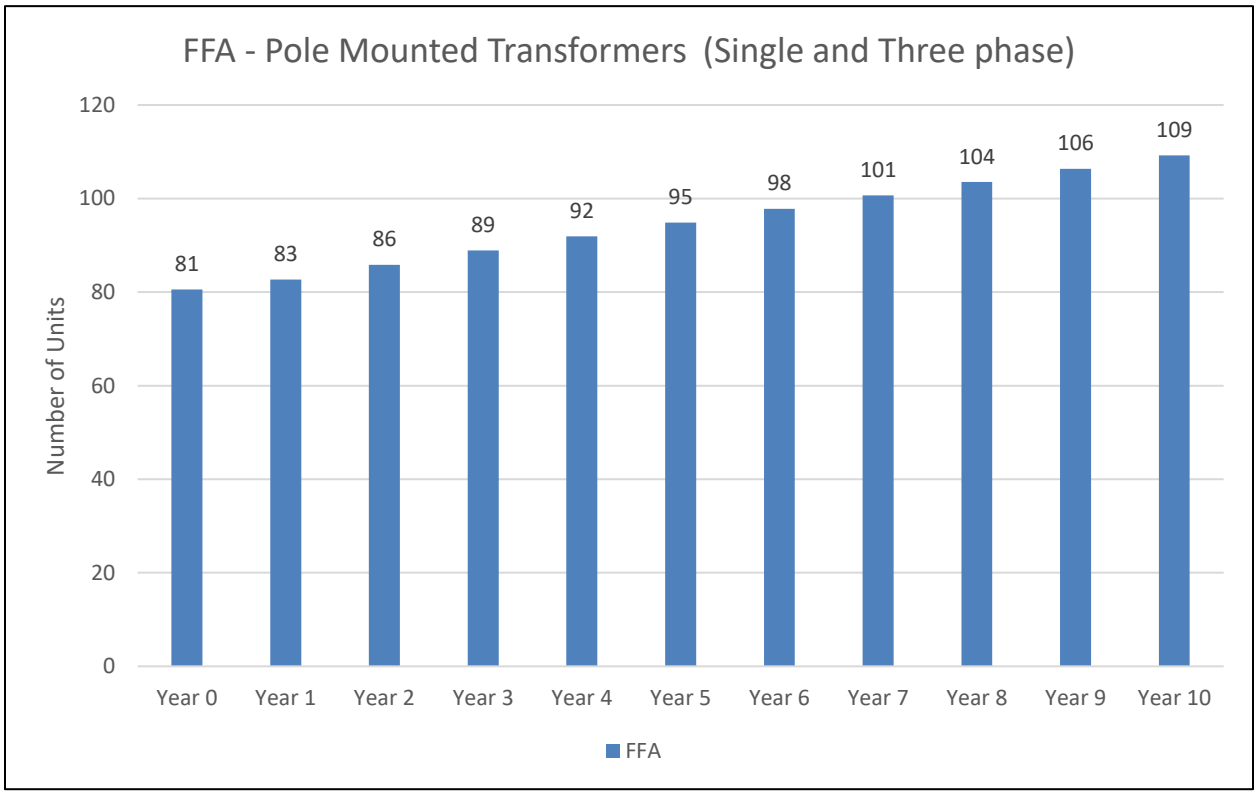


Figure 41, Flag For Action Pole Mounted Transformers

9.3 Data Assessment

The Data Availability Index (DAI) is 96%. Age and LOL were unavailable for a subset of pole mounted transformers. Additional elements[20] will be collected as condition parameters starting in 2025, and future editions of ACA will have more complete data for Health Indexing.

[20] New degradation factors such as tank condition and leaking oil will be added in 2025.

10. Step-down Transformers (STEPTX)

There were 57 step-down transformers in-service, 16 single-phase units and 41 in three-phase installations[21] (15 three-phase banks).

The Calendar Age distribution is graphically represented in Figure 42. All the units have their age known. The average age is 20.2 years old.

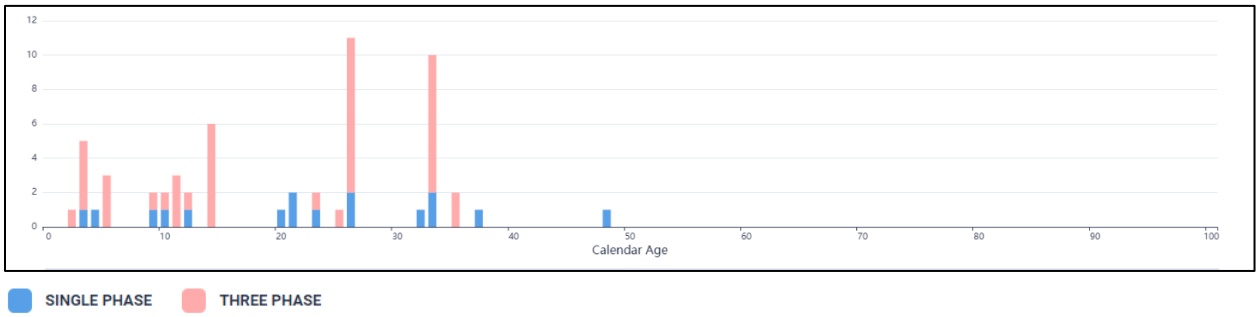


Figure 42, Calendar Age Demographics Step-down Transformers

The Health Summary is given below in Figure 43.

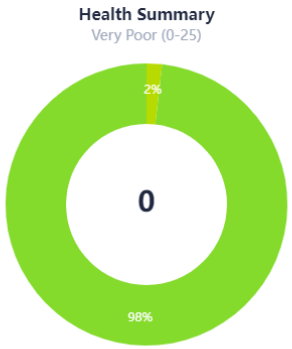


Figure 43, Health Summary Step-down Transformers

10.1 Health Index Analysis

All the units had sufficient data to calculate a Health Index (HI). The HI distribution by number of units and percentages is given in Table 20. There are no units in the Very Poor or Poor HI categories. The average Health Index of step-down transformers is 99%.

[21] Some data errors prevented the export of four units in 3-phase banks out of a total of 45 units. This will be rectified at the next data upload.

Table 20, Health Index Distribution - Step-down Transformers

	Health Index Distribution by Number of Units (57)				
	Very Poor	Poor	Fair	Good	Very Good
Quantities	(<25%)	(25% - <50%)	(50% - <70%)	(70% - < 85%)	(>=85% - 100%)
Units	0	0	0	1	56
Percentage	0%	0%	0%	2%	98%

Asset Health Index Breakdown

The final calculation of the Health Index is based only on the age score. An example of a step-down transformer Health Index Breakdown is found in Figure 44, for T 8248 (48 years old).



Figure 44, Asset Health Index Breakdown Step-down Transformers

10.2 Flag For Action (FFA) Plan

There are no units needed to be addressed based on condition in the FFA plan within the next 5-10 years.

10.3 Data Assessment

Only age was available; there are no data gaps in the data assessment of step-down transformers.

11. Overhead Switches (OHSW)

There were 1223 overhead switches in-service. London Hydro maintains 5 types of overhead switches:

- Air break (1)
- Line opener (4)
- Disconnect (892)
- Gang operated loadbreak (276)
- Motorized loadbreak (50)

The Calendar Age distribution of overhead switches is graphically represented in Figure 45 but many switches did not have a known year of installation (41%). The motorized loadbreak switches are among the oldest in the system (with their average age over 20 years old). For all the switches of known age (715 units) the average age is 13.5 years old but it is assumed that many switches without a known age[22] are in fact much older so the average of 13.5 years is optimistic.

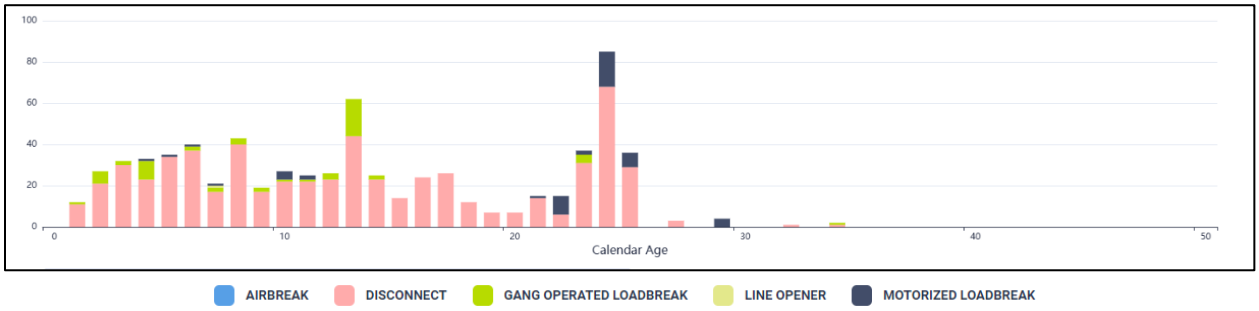


Figure 45, Calendar Age Demographics Overhead Switches

The Health Summary is given below in Figure 46.

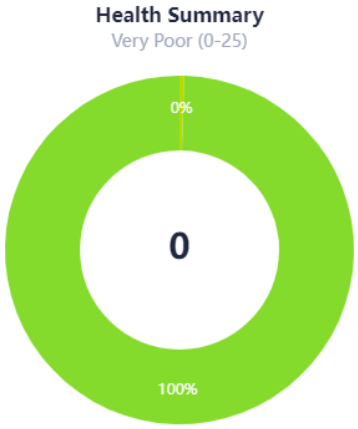


Figure 46, Health Summary Overhead Switches

11.1 Health Index Analysis

Of the total number of units analyzed, only 715 units (or 59%) had sufficient data (age) to calculate a Health Index (HI). The HI distribution by number of units and percentages for the units where a HI was calculated is given below in Table 21. The average Health Index of overhead switches is 100% although only a subset of them had information to calculate the HI.

[22] Majority of them are disconnect and gang-operated loadbreak switches

Table 21, Health Index Distribution - Overhead Switches

	Health Index Distribution by Number of Units (715)				
	Very Poor	Poor	Fair	Good	Very Good
Quantities	(<25%)	(25% - <50%)	(50% - <70%)	(70% - < 85%)	(>=85% - 100%)
Units	0	0	0	3	712
Percentage	0%	0%	0%	0%	100%

Almost all of the overhead switches are in Very Good category because age was the only determining factor as there was no condition data available. There are planned enhancements to the overhead inspections and, starting in 2025, visual degradation factors will be collected that can be used in future ACA editions.

Asset Health Index Breakdown

The calculation of the Health Index is currently based on the age score only. Other degradation factors will be added to the Health Index methodology in the future to reflect condition. An example of an overhead switch Health Index Breakdown is found in Figure 47; it is for the motorized loadbreak switch Q48A-3 (29 years old).



Figure 47, Asset Health Index Breakdown Overhead Switches

11.2 Flag For Action (FFA) Plan

For overhead switches, in the category of gang-operated loadbreak type, almost 80% of the switches did not have data for health indexing, therefore an accurate FFA plan cannot be established. The motorized switches (all in Very Good condition) include the SCADA-MATE and JOSLYN brands that have consistently experience 1-2 failures per year in the last 5 years. In effect, a conservative removal rate of 3 overhead switches per year could be considered in the 10-year FFA plan in this case, to accommodate replacements

due to failure of equipment. Also, important to note for this asset class, failure could sometimes result in abandoning the switch location, or replacing a gang operated loadbreak switch with a disconnect switch.

11.3 Data Assessment

Only age was available at the time of the ACA study. Although collection of enhanced visual inspections data has already started, it will take the completion of the maintenance cycle (3-5 years) to have a full set of data available.

12. Overhead Reclosers (OHRECLOSER)

There were 141 overhead reclosers in-service. London Hydro maintains 2 types:

- Oil (2)
- Vacuum (139)

The Calendar Age distribution of overhead reclosers is graphically represented in Figure 48. Age is known for all the assets. The average age is 9.2 years old.

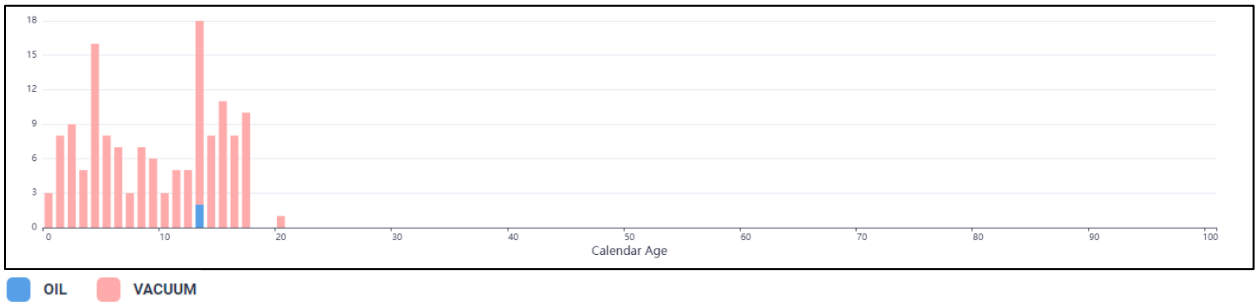


Figure 48, Calendar Age Demographics Overhead Reclosers

The Health Summary is given below in Figure 49.

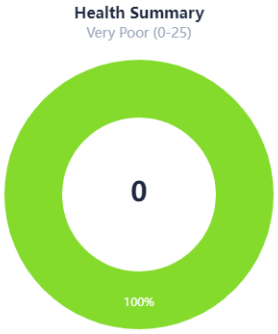


Figure 49, Health Summary Overhead Reclosers

12.1 Health Index Analysis

All the units had sufficient data (age) to calculate a Health Index (HI). The HI distribution by number of units and percentages is given below in Table 22. The average Health Index is 100%.

Table 22, Health Index Distribution - Overhead Reclosers

	Health Index Distribution by Number of Units (141)				
	Very Poor	Poor	Fair	Good	Very Good
Quantities	(<25%)	(25% - <50%)	(50% - <70%)	(70% - < 85%)	(>=85% - 100%)
Units	0	0	0	0	141
Percentage	0%	0%	0%	0%	100%

In the case of overhead reclosers, all of them are in the Very Good category because age was the only determining factor and they are less than 20 years old, which is considered below service life based on industry practice; however, there was no condition data available. There are planned enhancements to the overhead inspections and, starting in 2025, visual degradation factors will be collected that can be used in future ACA editions.

Asset Health Index Breakdown

The calculation of the Health Index is currently based on the age score only. Other degradation factors will be added to the Health Index methodology in the future to reflect condition. An example of an overhead recloser Health Index Breakdown is found in Figure 50; it is for M46R-1 (15 years old).



Figure 50, Asset Health Index Breakdown Overhead Reclosers

12.2 Flag For Action (FFA) Plan

One removal per year is identified as FFA over the next 10 years to account for in-service failures, based on historical failures.

12.3 Data Assessment

Only age was available at the time of the ACA study. Although collection of enhanced visual inspections has already started, it will take the completion of the maintenance cycle (3-5 years) to have a full set of data available.

13. Poles (POLE)

There were 29640 poles in service. London Hydro's poles are made of 5 materials, with the vast majority being wood poles (>99%):

- Aluminium (4)
- Composite (8)
- Steel (54)
- Concrete (135)
- Wood (29439)

Of the total number of wood poles, 2280 are Bell's poles. They are included in the analysis of this section since London Hydro has infrastructure on them but London Hydro is not responsible for their maintenance or replacement.

The Calendar Age distribution of all the poles combined is graphically represented in Figure 51. There are approximately 300 poles (1%) of unknown year of installation[23], not represented in the graph. For the poles with known age, the average age is 30.7 years old.

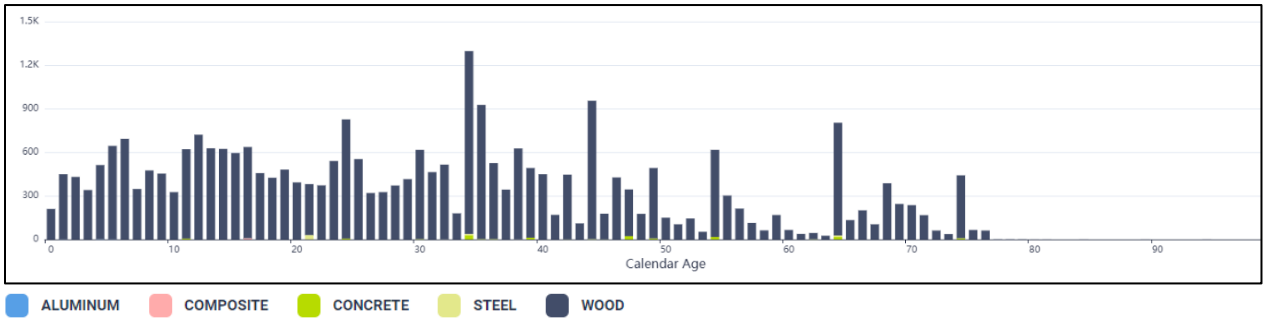


Figure 51, Calendar Age Demographics Poles

The Health Summary is given below in Figure 52 cumulated for all pole types combined.

[23] Of these 300 poles, 200 are owned by Bell, and the 100 owned by London Hydro have been audited but have no installation year tag.

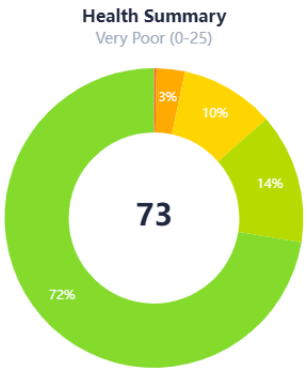


Figure 52, Health Summary Poles

13.1 Health Index Analysis

Of the total number of poles, 29476 units[24] (99%) had sufficient data to calculate a Health Index (HI). Since the wood poles and the concrete poles are the top two most numerous types, the HI distribution by number of units and percentages for the units that had the HI calculated is given below in Table 23 for wood poles and in Table 24 for concrete poles, respectively. The average Health Index of all the poles combined is 88%.

Table 23, Health Index Distribution - Poles (Wood)

	Health Index Distribution by Number of Units (29275)				
	Very Poor	Poor	Fair	Good	Very Good
Quantities	(<25%)	(25% - <50%)	(50% - <70%)	(70% - < 85%)	(>=85% - 100%)
Units	73	916	2988	4120	21178
Percentage	<1%	3%	10%	14%	72%

Table 24, Health Index Distribution - Poles (Concrete)

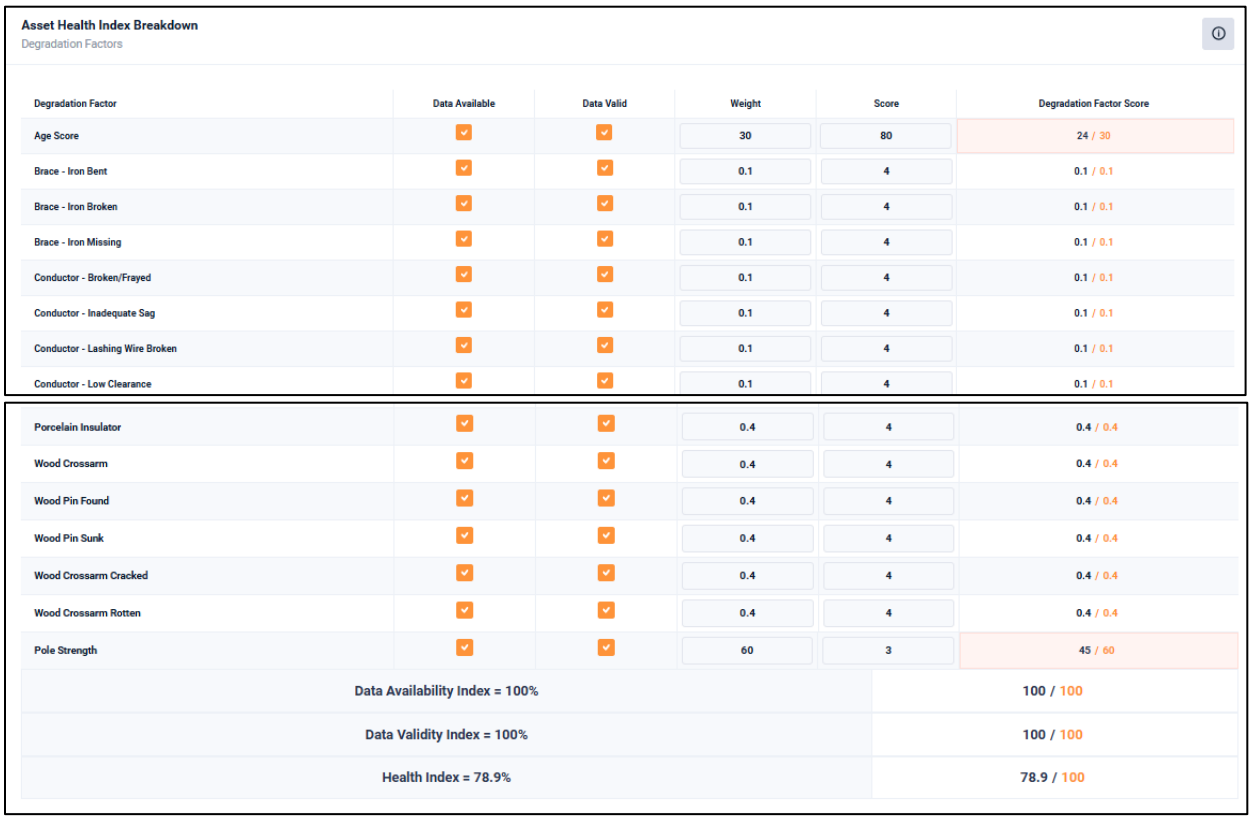
	Health Index Distribution by Number of Units (135)				
	Very Poor	Poor	Fair	Good	Very Good
Quantities	(<25%)	(25% - <50%)	(50% - <70%)	(70% - < 85%)	(>=85% - 100%)
Units	0	0	8	18	109
Percentage	0%	0%	6%	13%	81%

Across all the pole types, less than 1% are in the Very Poor HI category and approximately 3% are in Poor with another 10% in the Fair category. Together these three HI categories account for almost 4000 poles.

Asset Health Index Breakdown

[24] Over 160 poles did not have their HI calculated because they were missing both age and condition data.

The final calculation of the Health Index represents a weighted average between the age score and numerous degradation factors in percentage of 30/70, respectively. One very important condition parameter for wood poles that weighs in 60% of the total HI calculation is the remaining pole strength, as determined by contractors through the pole resistograph, a more advanced method than sound and bore, currently used by London Hydro since 2023. An example of a pole Health Index Breakdown is found in Figure 53. It is for the pole 9138 (55 years old). Various examples of pole degradation factors are provided for illustration purposes[25], including the pole strength.



Asset Health Index Breakdown

Degradation Factors

Degradation Factor	Data Available	Data Valid	Weight	Score	Degradation Factor Score
Age Score	☑	☑	30	80	24 / 30
Brace - Iron Bent	☑	☑	0.1	4	0.1 / 0.1
Brace - Iron Broken	☑	☑	0.1	4	0.1 / 0.1
Brace - Iron Missing	☑	☑	0.1	4	0.1 / 0.1
Conductor - Broken/Frayed	☑	☑	0.1	4	0.1 / 0.1
Conductor - Inadequate Sag	☑	☑	0.1	4	0.1 / 0.1
Conductor - Lashing Wire Broken	☑	☑	0.1	4	0.1 / 0.1
Conductor - Low Clearance	☑	☑	0.1	4	0.1 / 0.1
Porcelain Insulator	☑	☑	0.4	4	0.4 / 0.4
Wood Crossarm	☑	☑	0.4	4	0.4 / 0.4
Wood Pin Found	☑	☑	0.4	4	0.4 / 0.4
Wood Pin Sunk	☑	☑	0.4	4	0.4 / 0.4
Wood Crossarm Cracked	☑	☑	0.4	4	0.4 / 0.4
Wood Crossarm Rotten	☑	☑	0.4	4	0.4 / 0.4
Pole Strength	☑	☑	60	3	45 / 60
Data Availability Index = 100%					100 / 100
Data Validity Index = 100%					100 / 100
Health Index = 78.9%					78.9 / 100

Figure 53, Asset Health Index Breakdown Poles

13.2 Flag For Action (FFA) Plan

The FFA plan for the next 10 years includes an average number of 561 poles addressed per year for the next 10 years. Annual quantities are presented in Figure 54. This FFA plan is primarily constituted of wood poles, and concrete poles that are gradually eliminated as their degradation deems them unsafe. Poles made of other materials don't add significantly to the FFA plan.

[25] The complete list of degradation factors was truncated.

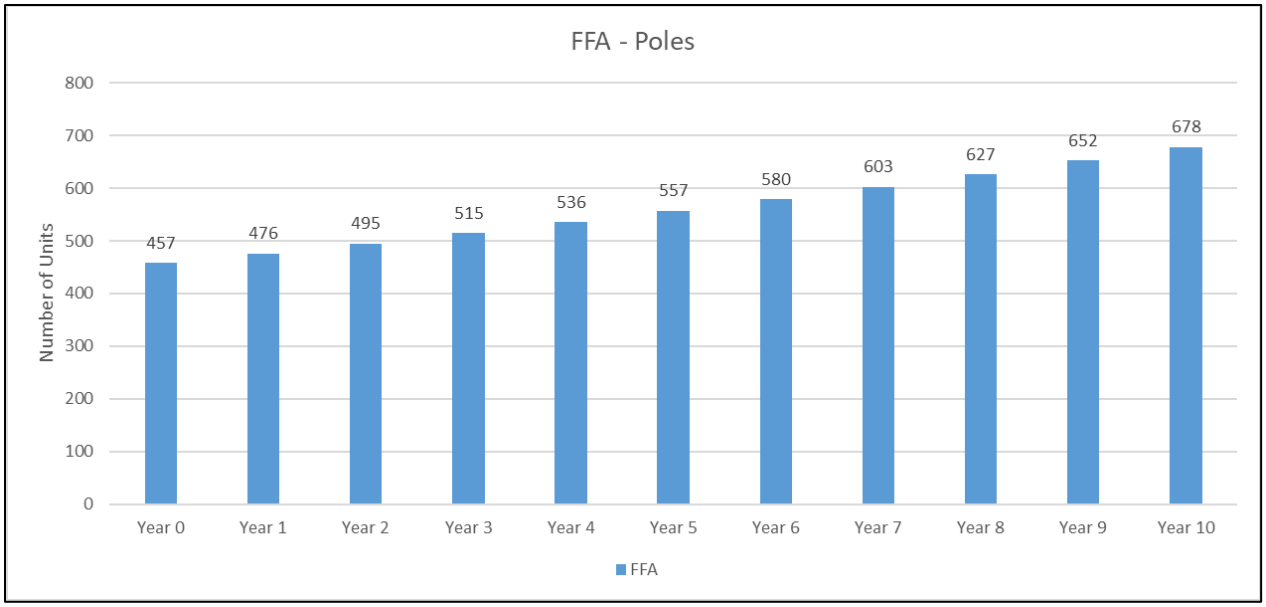


Figure 54, Flag For Action Poles

13.3 Data Assessment

The Data Availability Index (DAI) is 70%. Poles less than 20 years old are not tested for strength[26] which is 60% weight, lowering the DAI. There are no current data gaps in the analysis of poles.

14. Substation Transformers (PTX)

There was a total of 63 substation transformers in-service. London Hydro has 32 power transformers installed on the 4.16 kV and 13.8 kV systems at municipal substations, and 31 customer dedicated transformers that were all included in this study.

The Calendar Age distribution of substation transformers is graphically represented in Figure 55. The age is known for all the units. The average age is 28.2 years old.

[26] It is noted that of all the poles with condition data, over 14000 are missing the pole strength parameter because only poles over 20 years of age are tested by the contractors.

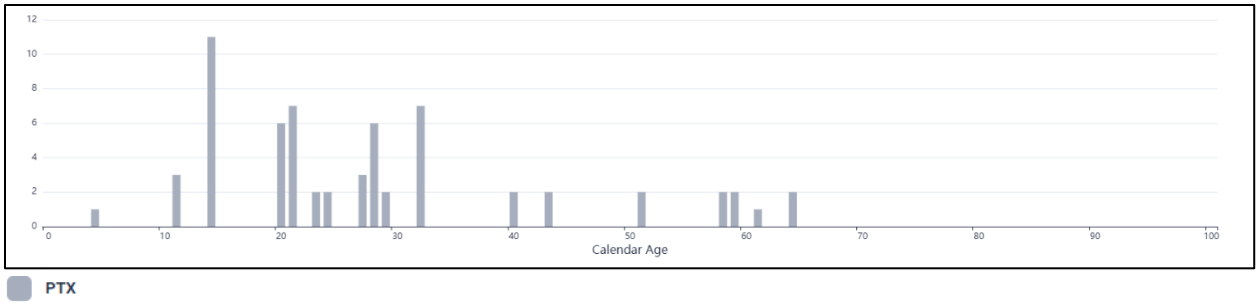


Figure 55, Calendar Age Demographics Substation Transformers

The Health Summary is given below in Figure 56.

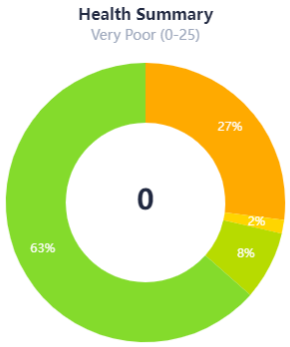


Figure 56, Health Summary Substation Transformers

14.1 Health Index Analysis

All substation transformers had sufficient data to have a Health Index (HI) calculated. The HI distribution by number of units and percentages is given below in Table 25. The average Health Index of substation transformers is 80%.

Table 25, Health Index Distribution - Substation Transformers

Health Index Distribution by Number of Units (63)				
Very Poor (<25%)	Poor (25% - <50%)	Fair (50% - <70%)	Good (70% - < 85%)	Very Good (85% - 100%)
0	17	1	5	40
0%	27%	2%	8%	63%

In the case of these assets, after calculating their HI using the defined methodology, none of the units are in the Very Poor HI category but as many as 17 units (27%) are in the Poor category.

Asset Health Index Breakdown

The final calculation of the Health Index represents a weighted average between the age score and the degradation factors in percentage of 60/40, respectively. For substation transformers, there are 4 categories of degradation factors considered in addition to age:

(i) results from oil analysis (DGA, oil quality and Furan test)

(ii) tests and measurements (turns ratio and winding resistance)

(iii) visual parameters

(iv) loading history

An example of a substation transformer Health Index Breakdown is found in Figure 57. It is for the 27T1 (61 years old) located at Sub-27.



Asset Health Index Breakdown

Degradation Factors

Degradation Factor	Data Available	Data Valid	Weight	Score	Degradation Factor Score
Age Score	☑	☑	60	5	3 / 60
Dissolved Gas Analysis	☑	☑	8.5	4	8.5 / 8.5
Oil Quality	☑	☑	7	2	3.5 / 7
Turns Ratio	☑	☑	2.5	4	2.5 / 2.5
Winding Resistance	☑	☑	2.5	4	2.5 / 2.5
Visual - Temperature Gauge	☑	☑	1	4	1 / 1
Visual - Bus/Elbow Connections	☑	☑	1	4	1 / 1
Visual - Fans	☐	☐	1	0	0 / 0
Visual - Arrester	☑	☑	1	4	1 / 1
Visual - Insulators	☑	☑	1	4	1 / 1
Visual - Oil Leaks	☑	☑	1	4	1 / 1
Visual - Paint/Corrosion	☑	☑	1	4	1 / 1
Load History	☑	☑	4	4	4 / 4
Furan Analysis	☑	☑	8.5	0	0 / 8.5
Data Availability Index = 99%					99 / 100
Data Validity Index = 99%					99 / 100
Gateway condition [met: false]: multiply HI by pre-processed value MULTIPLIER which is 1					
Health Index = 30.3%					30 / 99

Figure 57, Asset Health Index Breakdown Substation Transformers

14.2 Flag For Action (FFA) Plan

Substation transformers that are in Poor condition continue to be monitored annually and if the oil test results require, oil is analyzed more often than once a year.

A conservative number of two to three removals over the next 5 years can be included in the FFA plan of substation transformers.

14.3 Data Assessment

The Data Availability Index (DAI) is 92%. Some ACA condition data has been enhanced through additional testing (e.g., oil Furan analysis every 3 years). The remaining data gaps (electrical tests such as power factor, insulation resistance, etc.) are being addressed through a suite of condition assessment tests currently performed under the substation maintenance program every 5 years, with results planned to be digitized and expected to be available for the next asset condition assessment cycle.

15. Switchgears (SWGR)

There were 35 switchgears at substations in-service. London Hydro maintains 7 styles of substation switchgear based on the equipment type:

- Circuit Breakers (14)
- Oil Reclosers (3)
- Oil Switch[27] (1)
- Pad-mounted Switchgear Solid-Dielectric 600A (4)
- Pad-mounted Switchgear SF6 (7)
- Overhead Recloser Solid-Dielectric (1)
- Pad-mounted Recloser (5)

The Calendar Age distribution of switchgear assets is graphically represented in Figure 58. The average age of all the units of known age (34 units) is 37.3 years old.

[27] One obsolete oil switch at Sub-7 remains in service short-term which is scheduled for removal (its age is undetermined and its HI was not calculated).

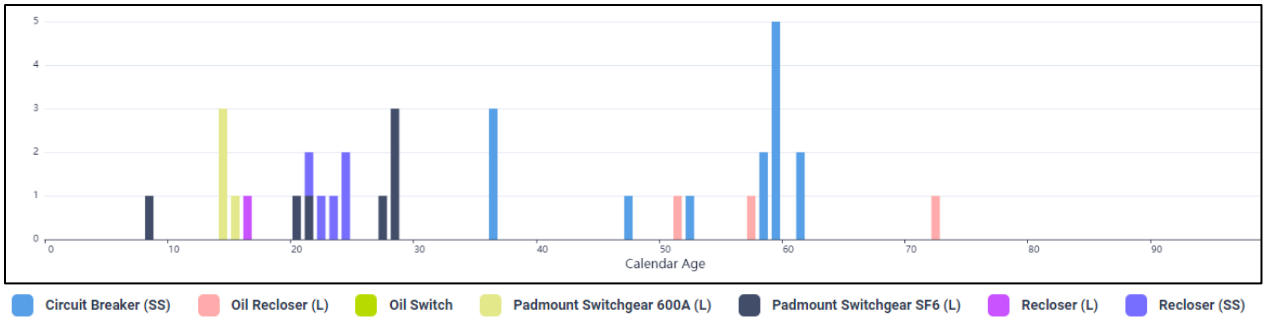


Figure 58, Calendar Age Demographics Switchgears

The Health Summary is given below in Figure 59 for all the switchgear types combined.

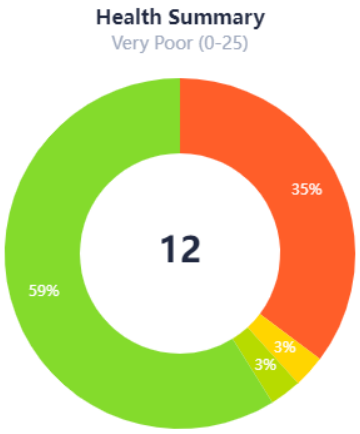


Figure 59, Health Summary Switchgears

15.1 Health Index Analysis

All but one switchgear had sufficient data to calculate a Health Index (HI). The HI distribution of switchgears by number of units and percentages is given below in Table 26. The average Health Index is 64%.

Table 26, Health Index Distribution - Switchgears

	Health Index Distribution by Number of Units (34)				
	Very Poor	Poor	Fair	Good	Very Good
Quantities	(<25%)	(25% - <50%)	(50% - <70%)	(70% - < 85%)	(>=85% - 100%)
Units	12	0	1	1	20
Percentage	35%	0%	3%	3%	59%

In the case of these assets, a large 35% (12 units) are in the Very Poor Health Index category. Of the 12 units, 9 are old circuit breakers (59 years old on average) and 3 are oil reclosers (60 years old on average).

Asset Health Index Breakdown

The final calculation of the Health Index is based on the age score only. An example of a switchgear unit Health Index Breakdown is found in Figure 60. It is for the circuit breaker at Sub-52 (58 years old).

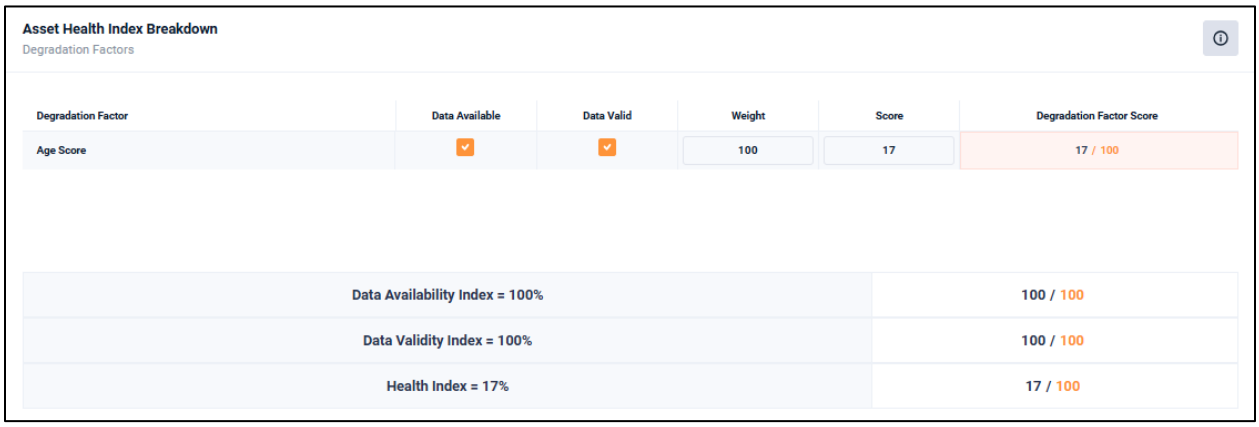


Figure 60, Asset Health Index Breakdown Switchgears

15.2 Flag For Action (FFA) Plan

Switchgear assets are addressed/maintained in co-ordination with their respective substation transformer, batteries and other infrastructure as applicable.

In alignment with substation transformers, a conservative number of two to three switchgear removals over the next 5 years can be included in their FFA plan.

15.3 Data Assessment

Only age was available. Given the association of a switchgear with the substation transformer, their elimination will be a consequence of substation removals based on the condition of the power transformers.

16. Batteries (BATTERY)

There were 18 battery banks in-service at substations.

The Calendar Age distribution of batteries is graphically represented in Figure 61. All units have their age known. The average age is 13.4 years old.

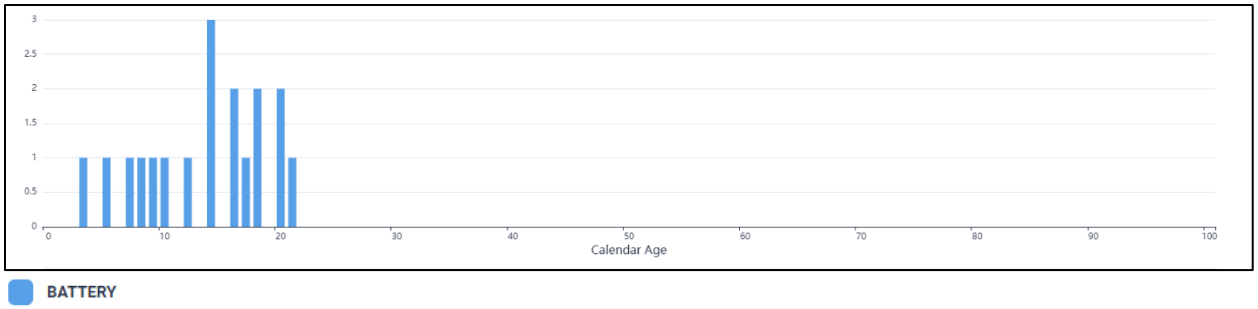


Figure 61, Calendar Age Demographics Batteries

The Health Summary is given below in Figure 62.

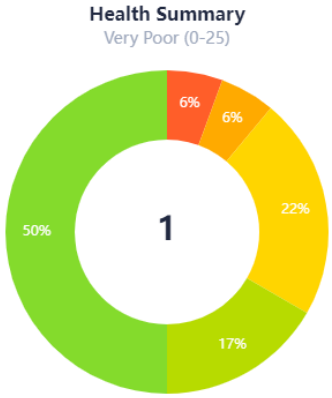


Figure 62, Health Summary Batteries

16.1 Health Index Analysis

All the units had sufficient data to calculate a Health Index (HI). The HI distribution by number of units and percentages is given below in Table 27. The average Health Index of batteries is 76%.

Table 27, Health Index Distribution - Batteries

	Health Index Distribution by Number of Units (18)				
	Very Poor	Poor	Fair	Good	Very Good
Quantities	(<25%)	(25% - <50%)	(50% - <70%)	(70% - < 85%)	(>=85% - 100%)
Units	1	1	4	3	9
Percentage	6%	6%	22%	17%	50%

In the case of these assets, 1 unit is in the Very Poor HI category and another one is Poor. Capacity tests are performed annually at all substation batteries and replacements are planned based on testing results.

Asset Health Index Breakdown

The final calculation of the Health Index represents a weighted average between the age score and the other degradation factor in percentage of 40/60, respectively. An example of battery Health Index Breakdown is found in Figure 63. It is for the battery bank at Sub-38 (21 years old).



Figure 63, Asset Health Index Breakdown Batteries

16.2 Flag For Action (FFA) Plan

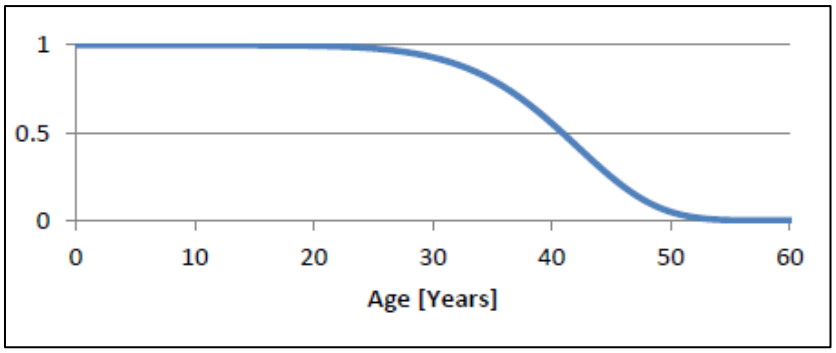
Batteries are maintained in co-ordination with other elements at substations. Capacity tests are performed annually at all substation batteries and replacements are planned based on measurements. It is anticipated that, if necessary, one battery bank will be replaced annually for the next 10 years.

16.3 Data Assessment

There are no data gaps in the analysis of batteries.

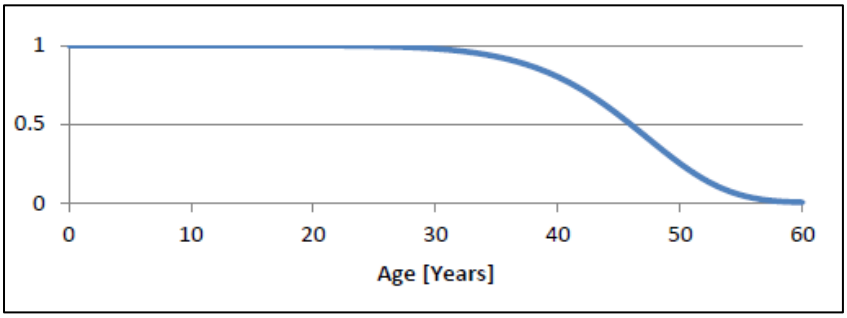
Appendix B: Asset Specific Life Curves

Pad Mounted Transformers (Single and Three-Phase)



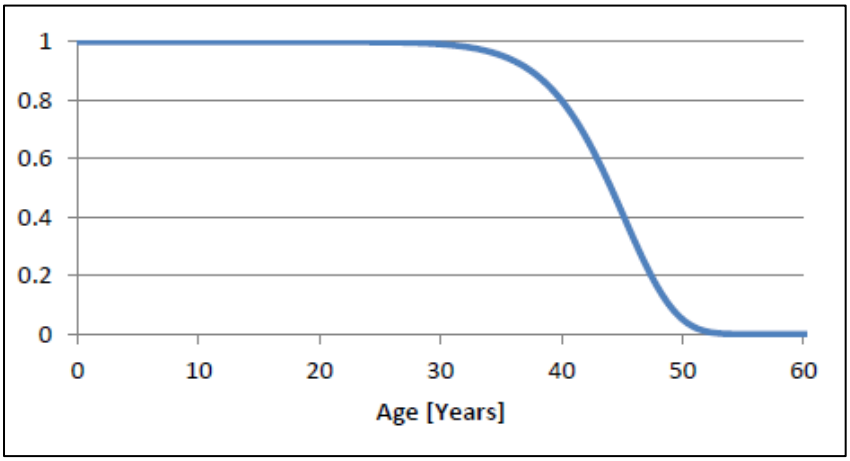
Pad Mounted Transformers

Vault Transformers



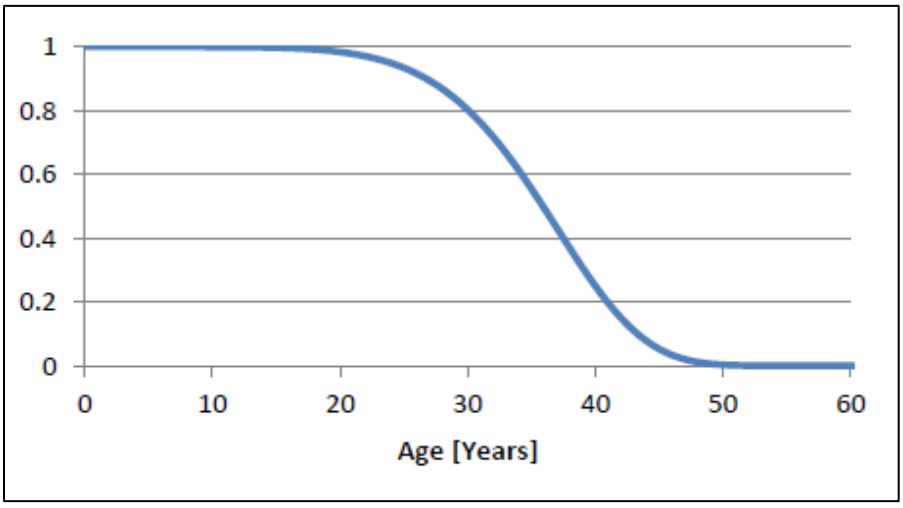
Vault Transformers

Network Transformers

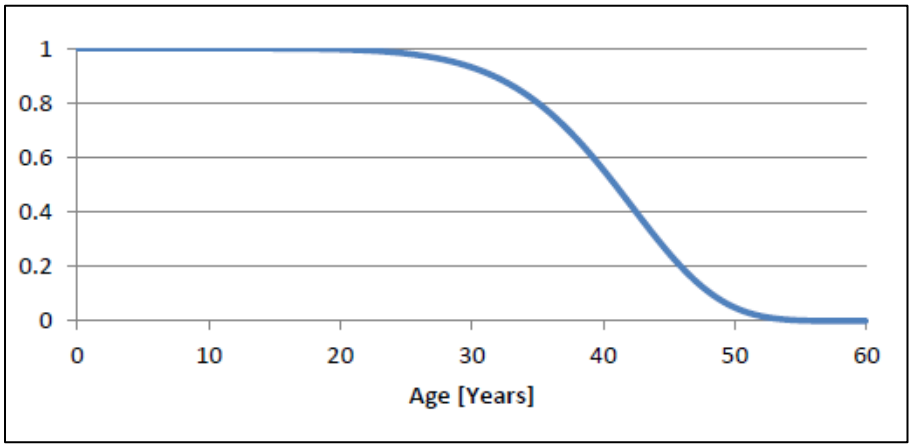


Network Transformers

Distribution Switchgear

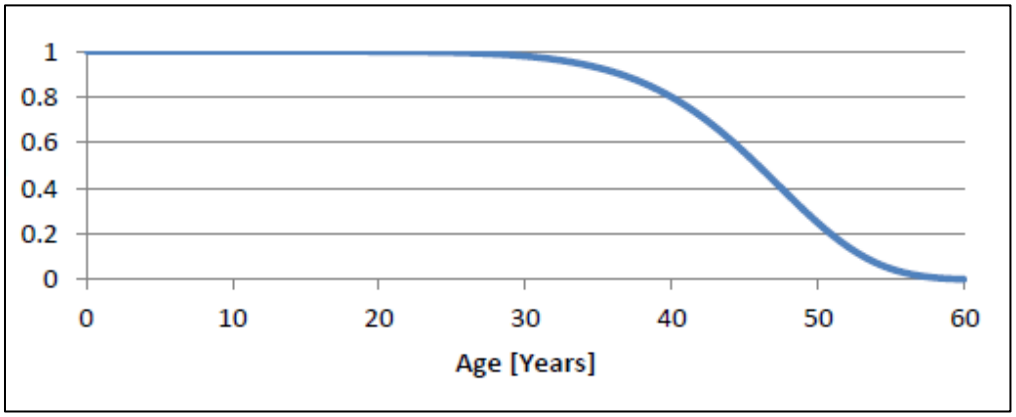


Distribution Switchgears (Air and Solid Dielectric)

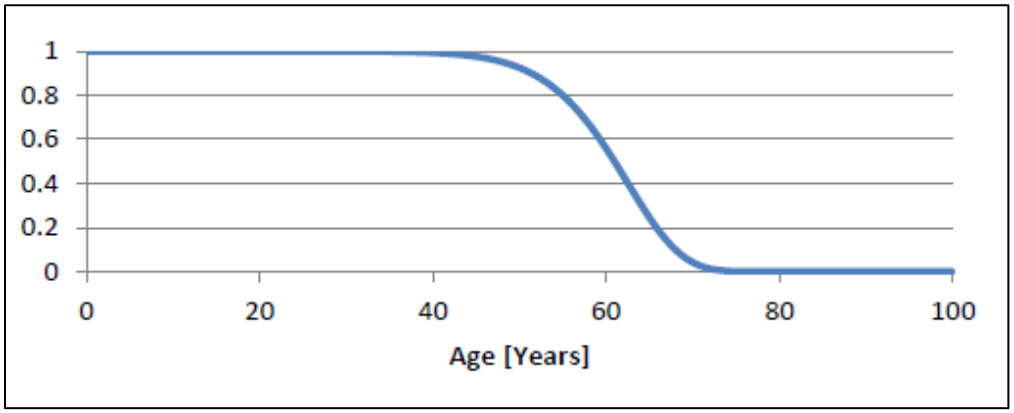


Distribution Switchgears (SF6)

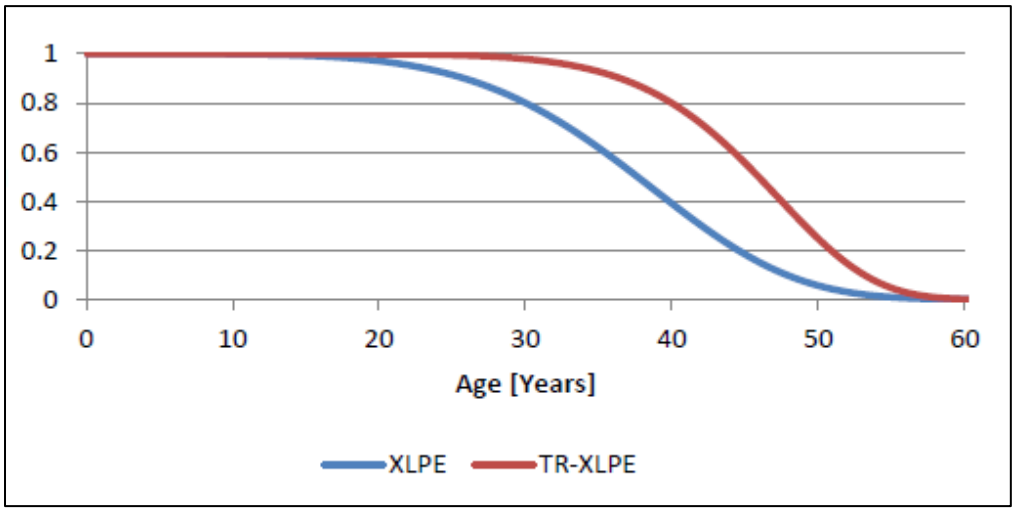
Underground Cables



Underground Cables (EPR)

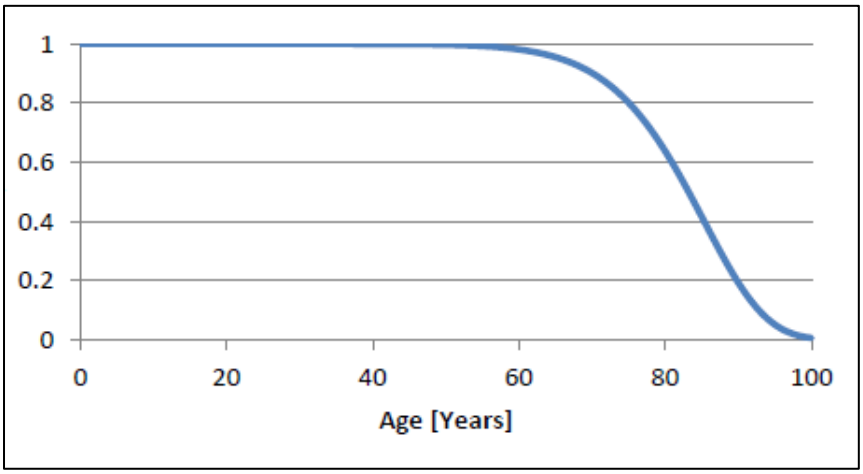


Underground Cables (PILC)



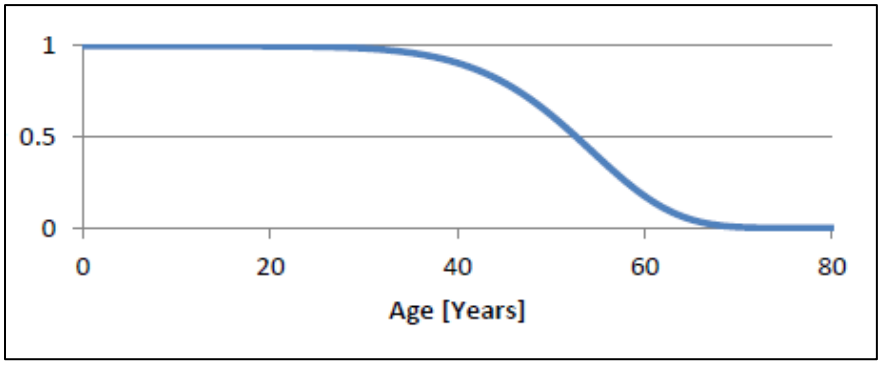
Underground Cables (Polymeric)

Manholes



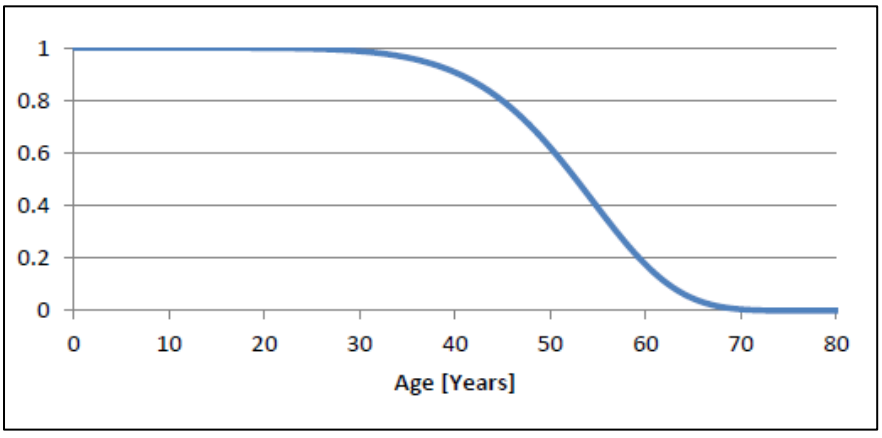
Manholes

Pole Mounted Transformers (Single and Three-Phase)



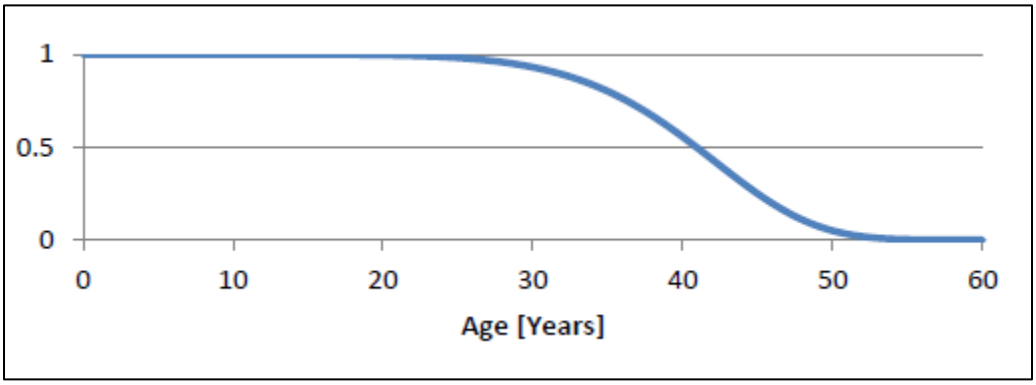
Pole Mounted Transformers

Step-down Transformers



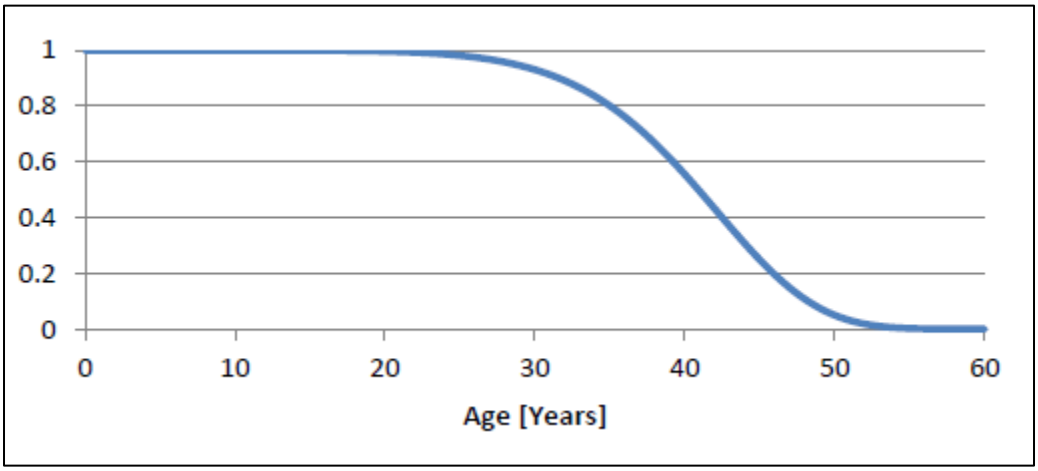
Step-down Transformers

Overhead Switches



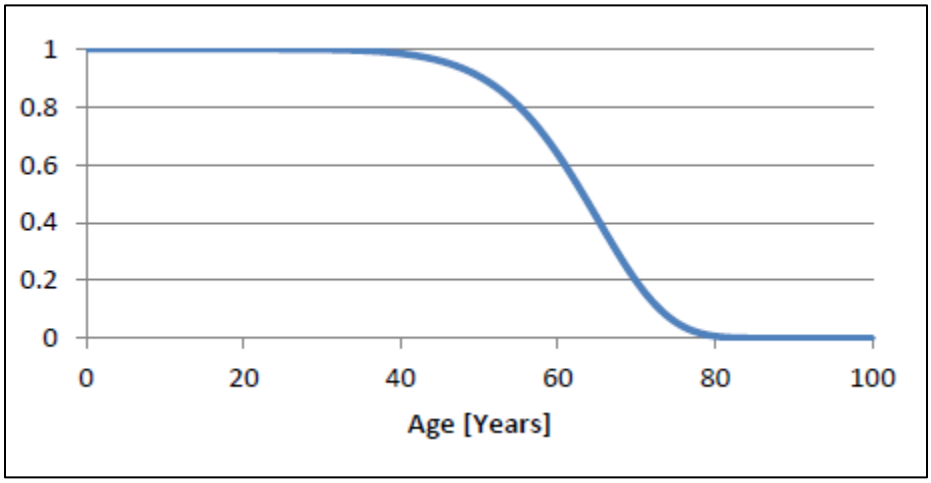
Overhead Switches

Overhead Reclosers

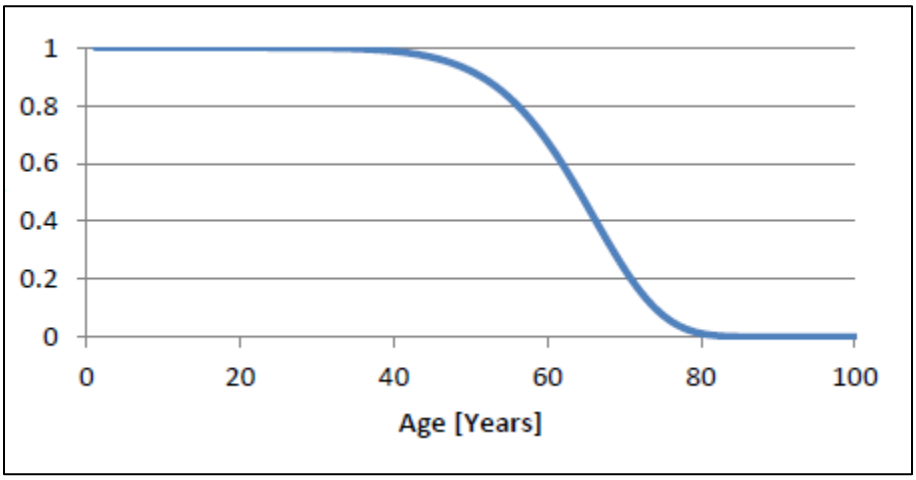


Overhead Reclosers

Poles

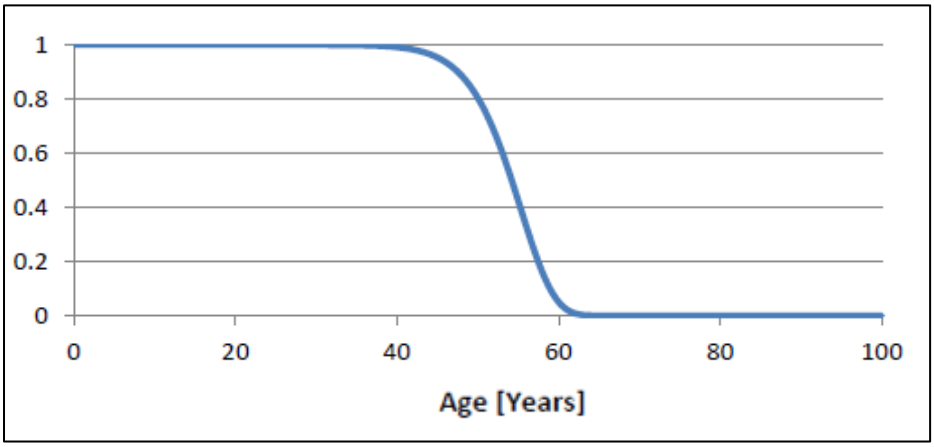


Poles (Wood)



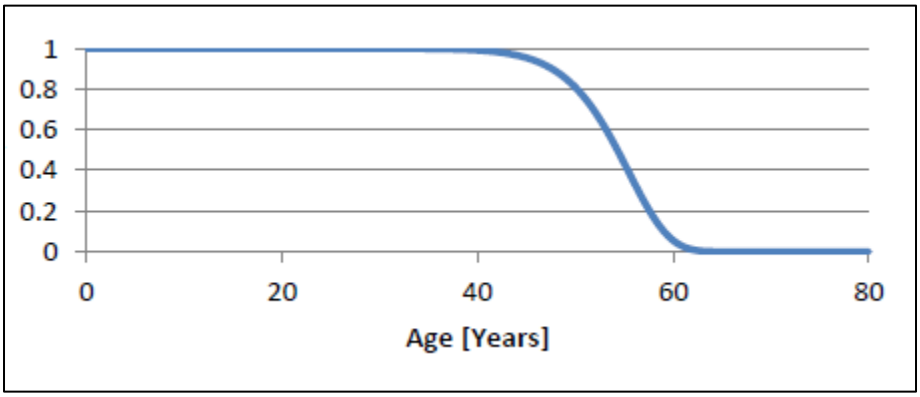
Poles (Concrete)

Substation Transformers

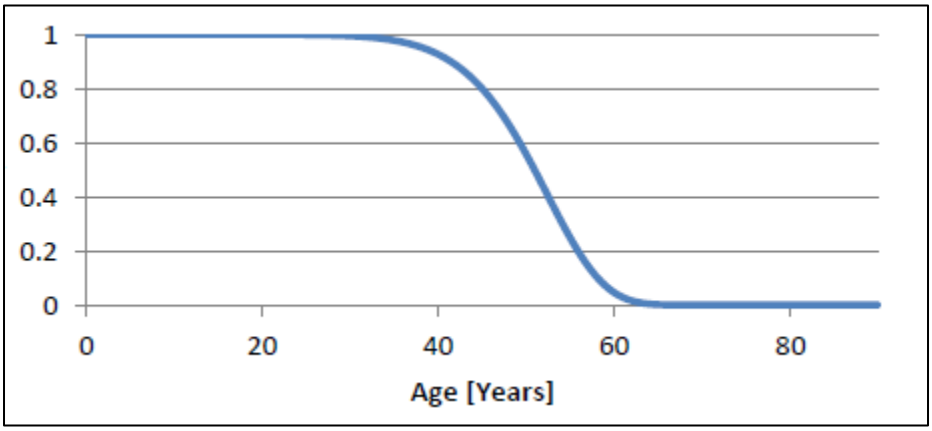


Substation Transformers

Switchgear

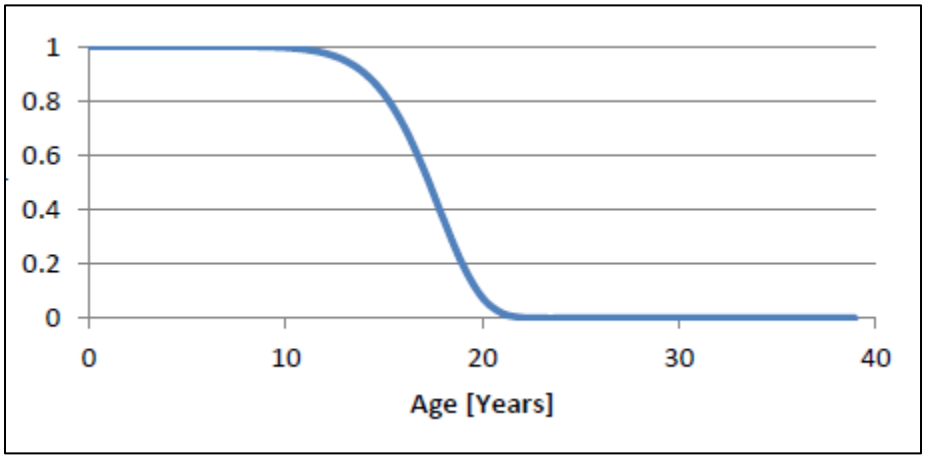


Switchgear (Circuit Breakers)



Switchgear (Reclosers Substation)

Batteries



Batteries

London Hydro

APPENDIX E

Engineering Instruction EI-31: Asset Management and Capital Expenditures Planning: Policy and Processes

Asset Management and Capital Expenditures Planning: Policy and Processes (Asset Management Policy)

EI – 31

Current Version R4 – 07/2026
Review Frequency – 5 years
Next Review Date – 07/2031

Engineering Instruction EI-31

Asset Management and Capital Expenditures Planning: Policy and Processes (Asset Management Policy)

Author/ Revised By	Issue/ Revision Date	Summary of Revision	Reviewed by P.Eng./ Name Designation	Next Review Date
Richard Stainthorpe	R0/Nov 2011	Original Issue	Ken Walsh, P.Eng. Chief Engineer and VP of Operations	--
Richard Stainthorpe	R1/Jul 2015	Minor updates to job titles and work flows	Ken Walsh, P.Eng. Chief Engineer and VP of Operations	--
Richard Stainthorpe	R2/Jan 2016	Updated to Match Chapter 5 Requirements	Ken Walsh, P.Eng. Chief Engineer and VP of Operations	--
Cristina Terek, P.Eng.	R3/Mar 2021	New Analytical Ranking Model added and responsibilities updated	Jac Vanderbaan, P.Eng. Director of Engineering William Milroy, P.Eng. VP Engineering and Operations	Mar 2026
Cristina Terek, P.Eng.	R4/July 2026	Internal role updates	Ismail Sheikh, P.Eng. Director of Systems Engineering Jac Vanderbaan, P.Eng. VP Planning and Operations	July 2031

Overview

This document describes the policies and processes used by London Hydro to manage its assets, in accordance with OEB guidelines, and industry best practices. It defines the decision-making roles and responsibilities that lead to the preparation and review of the Capital Expenditures Plan. It also defines the responsibilities for the annual updates to London Hydro's Asset Sustainment Plans (ASP), the Electrical Distribution System Plan (DSP), the Information System Plan (ISP) and the Vehicle and Equipment Replacement Schedule.

❖ ❖ ❖

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London Hydro

London Hydro

Asset Management and Capital Expenditures Planning: Policy and Procedures (Asset Management Policy)

Policy

London Hydro manages the electrical distribution system within the City of London and is responsible for building, maintaining and operating the system in a safe, efficient and sustainable manner in order to meet the requirements and expectations of its stakeholders, including regulators (e.g., OEB, ESA), customers, employees and the shareholder.

To fulfill this mandate, London Hydro has developed this policy and process for Asset Management and Capital Expenditure Planning and reviews it as required (at least once every five years). This policy also covers General Plant assets that are required to support the electric distribution system. This policy excludes any capital costs that may be incurred as a part of third-party collaboration with other utilities.

Objectives

London Hydro continually seeks innovative methods to meet the following objectives while balancing the competing needs of its stakeholders.

Safety – ensuring that London Hydro's assets are maintained in a safe condition so they never cause injury to employees or the public;

Regulatory – ensuring that London Hydro complies with all legislative requirements;

Environmental – ensuring that the assets are managed in an environmentally responsible manner by meeting and, where practical, exceeding all environmental regulatory requirements;

Capacity – ensuring that the distribution system has sufficient capacity to supply both new and existing customer loads and, where appropriate, connect new generation facilities;

Reliability – ensuring that London Hydro's reliability performance meets or exceeds customer expectations, OEB requirements, and equals or is above the performance average of its LDC peer group;

Customer Focus – ensuring that services are provided in a manner that responds to customer preferences when they are identified and practical;

Losses – ensuring that the distribution system's technical losses are effectively minimized through the introduction of changes in system design or operating practices;

Costs – ensuring that the lifecycle costs of London Hydro's assets are optimized while meeting the above objectives and ensuring that capital expenditures are paced to levelize the impact on customer bills.

London Hydro seeks to foster a culture of continuous improvement in its approach to achieving the above objectives and is committed to developing performance measures to monitor its

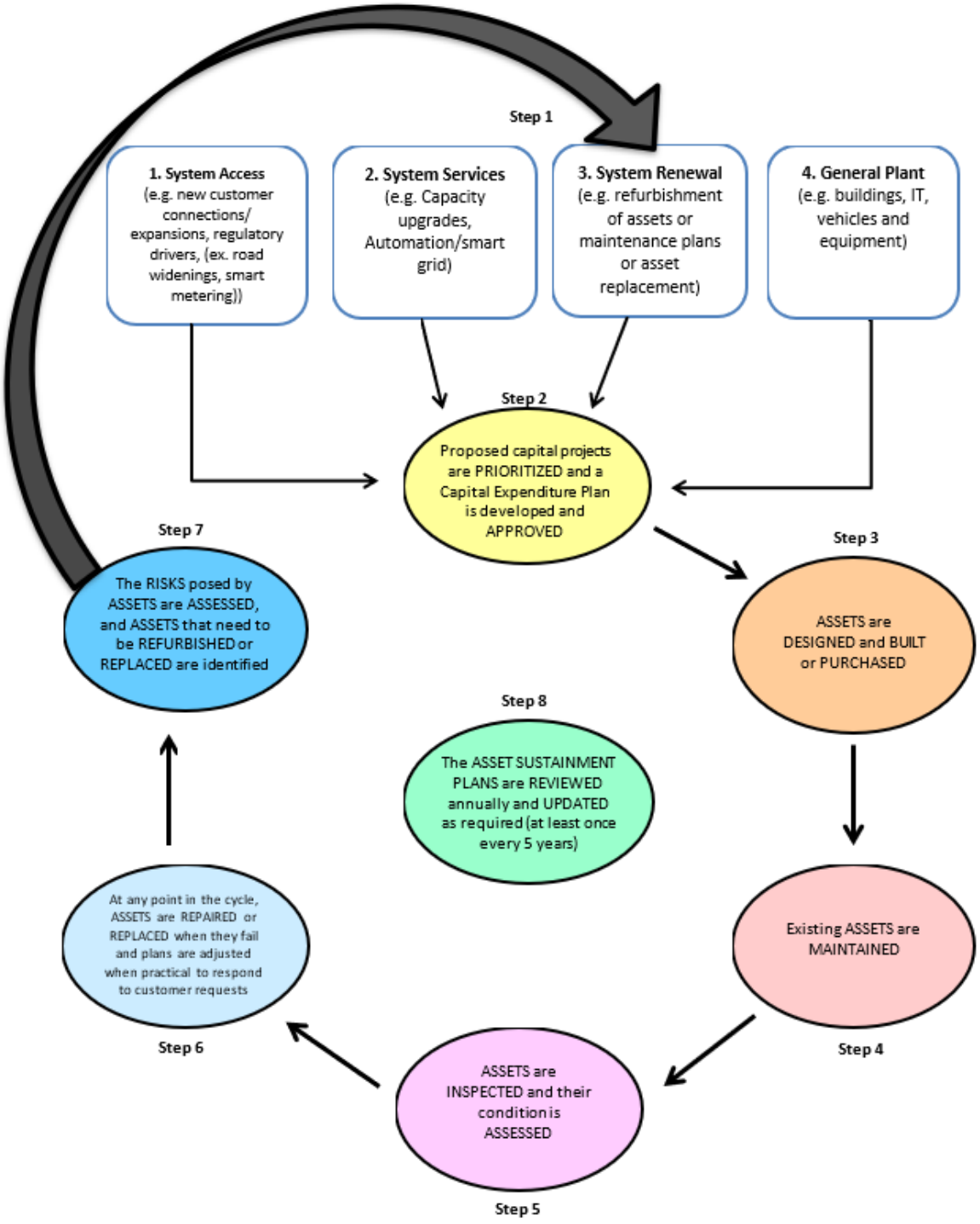
improvement. Currently London Hydro measures, for any given year, the extent to which planned projects are completed and whether they are completed on budget. The OEB Scorecard for Distribution System Plan implementation measures progress by comparing actual capital expenditures to the OEB-approved amounts from the utility's last OEB-approved cost of service or Custom IR application and DSP.

Introduction

This Asset Management and Capital Expenditure Planning: Policy and Processes (Asset Management Policy) describes how London Hydro manages the process of building and maintaining its assets. This document describes how decisions are made to develop the yearly Capital Expenditures Plan, and works in tandem with other documents, including the Asset Sustainment Plans (ASP), the IT Asset Management Framework (ITAMF), the Distribution System Plan (DSP) and the Vehicle and Equipment Replacement Schedule.

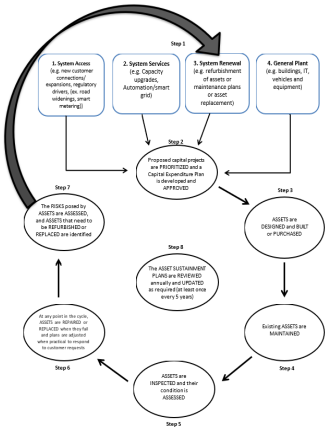
The goal is to meet the objectives described in the Asset Management Policy at the lowest life cycle cost, while balancing the competing needs of all stakeholders. With well-managed processes and plans, we are able to make informed decisions about when to build new assets and, as they age, whether and when to maintain, refurbish or replace them.

The Asset Management Lifecycle



Responsibilities

Step 1



1. System Access (e.g. new customer connections/ expansions, regulatory drivers: road widenings, smart metering)

2. System Service (e.g. capacity upgrades, automation/smart grid)

3. System Renewal (e.g. refurbishment of assets or maintenance plans or asset replacement)

4. General Plant (e.g. buildings, IT, vehicles and equipment)

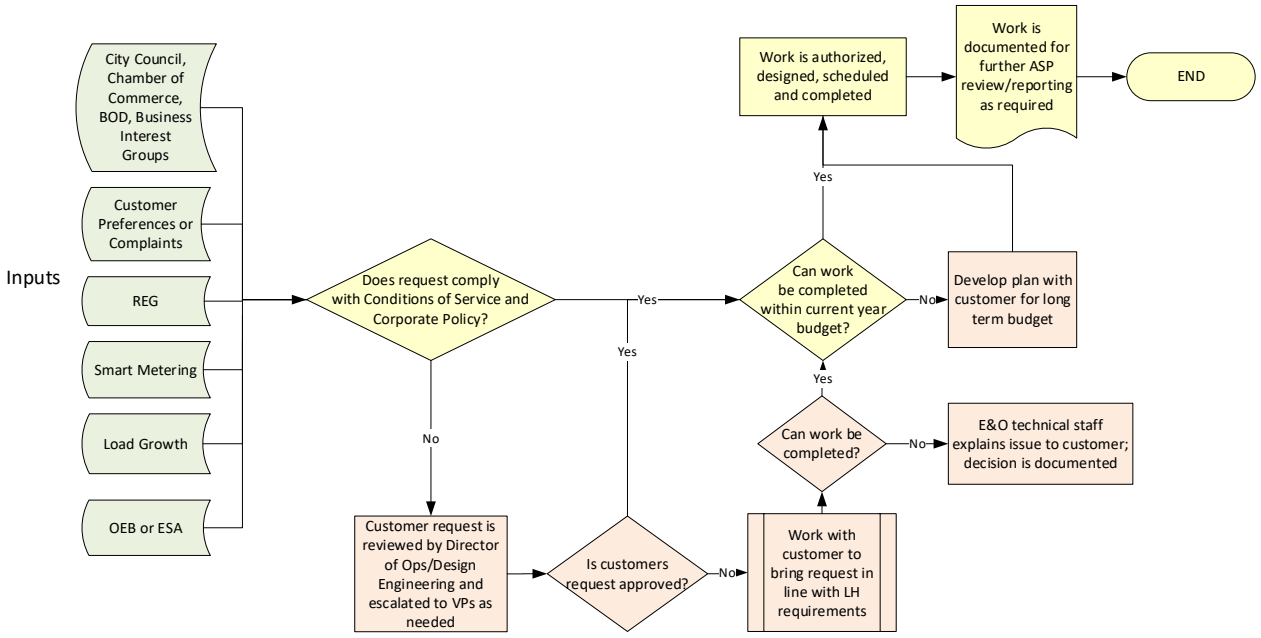
Investment Category	Responsibility
System Access	1. The *CEO* is responsible for ● Meeting with local business and community groups (directly or through delegates) to provide information on London Hydro's capital expenditure initiatives and the significance of those projects on the community and stakeholders; ● Reviewing and approving all policies and attaining Board approval, where necessary; ● Maintaining close ties with the Board of Directors[1] and City Administration to keep abreast of issues in the community in order to ensure that London Hydro is responding to the needs of municipal leaders; and ● Keeping the Board updated on relevant issues pertaining to the distribution system. 2. The *VP Engineering & Construction and VP Operations & Planning* are responsible for ● Establishing and approving policies and overarching guidelines governing the accommodation of customer preferences related to system access including new customer connections, expansions, metering, and other customer-driven requirements; ● Providing direction and making decisions on significant or exceptional customer accommodation matters that require material departure from established design standards, construction practices, and policies; and ● Establishing and approving policies for the construction and financing of system upgrades to accommodate both utility-owned and third party-owned Distributed Energy Resources (DER).

[1] "Board" or "Board of Directors" refers to the London Hydro Board of Directors.

System Access (cont'd)	3. The *Director of Design Engineering* is responsible for • Collecting revisions and clarifications for the Conditions of Service (C of S) document; • Arranging to have the C of S updated to ensure that it addresses the evolving needs of customers and continues to meet the objectives outlined in the Asset Management Policy; • Working with other utilities and the City of London to identify infrastructure work that affects both parties (e.g., road widening) to ensure that designs and budgets are in place to meet mutually agreed upon timelines; • Making technical and operational decisions regarding customer preferences within established standards, policies and practices, and escalating material exceptions or departures to the appropriate Vice President; and • Developing the procedures to ensure that customer requests for new service are responded to and designed within OEB regulated timelines. *4.* The *Director of Operations Engineering is* responsible for • Developing and administering procedures, technical guidelines, and practices to implement System Access policies and support the accommodation of customer preferences within established corporate requirements (e.g., smart metering, etc.); • Analyzing technological trends and budgeting for new growth; and • Making technical and operational decisions regarding customer preferences within established standards, policies and practices, and escalating material exceptions or departures to the appropriate Vice President. 5. The *Director of Systems Engineering* is responsible for • Analyzing economic trends and planning for new growth; and • Developing the procedures to ensure that large customer connection requests requiring Connection Impact Assessments are completed within appropriate timelines. 6. The *Director of Customer Service and Billing* is responsible for • Analyzing customer questions and concerns and recommending capital expenditures to respond to stated customer preferences (e.g., push outage notifications); • Receiving customer complaints and directing them to the appropriate departments for resolution. Customer complaints related to power quality are forwarded to the Manager of Engineering System Planning and Manager of Engineering System Reliability, Manager of Key Accounts or the Manager of Engineering Metering and Technical Services who respond to the complaint; and • Receiving customer complaints from the OEB and ESA, or other stakeholders, and directing them to the appropriate departments for resolution.

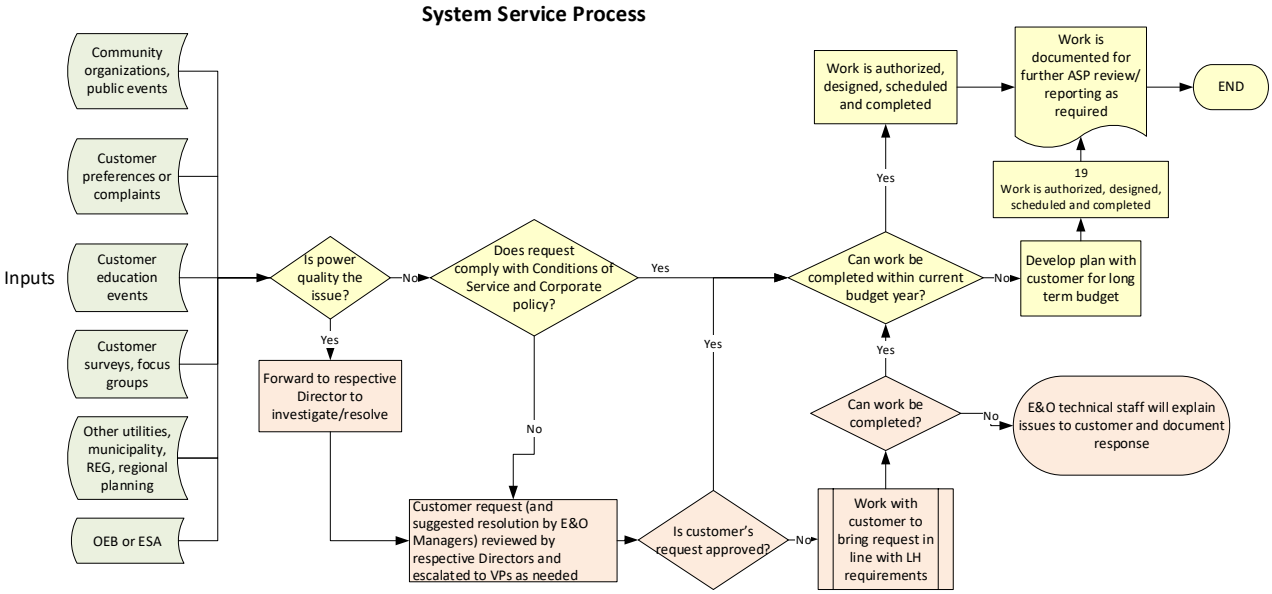
System Access (cont'd)	7. The *Manager of Standards and Generation* is responsible for ● Responding to customer preferences for DER projects and overseeing their administration; and ● Ensuring that all materials and equipment used in the distribution system comply with all codes and standards and that LH is in compliance with all relevant legislation specifically O.Reg 22/04.

System Access Process



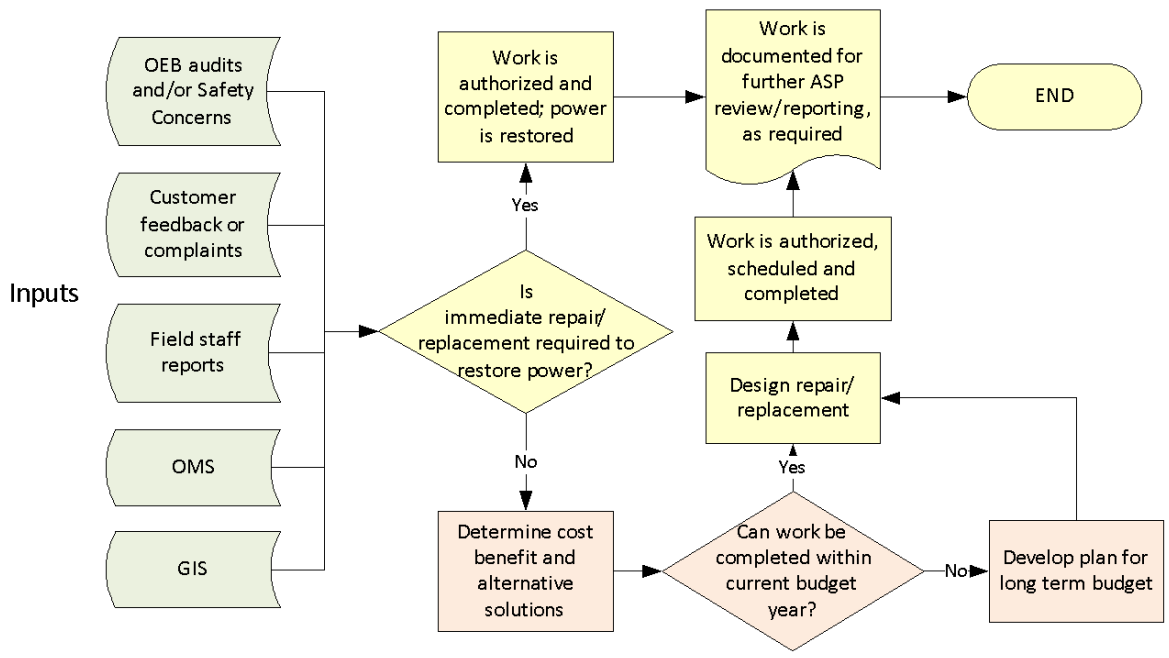
System Service	1. The *VP Engineering & Construction and VP Operations & Planning* are responsible for ● Making decisions when customer preferences contradict our normal design standards and construction practices; ● Developing policies and guidelines related to accommodating customer preferences for system service (e.g., regarding expansions, smart grid automation etc.); and ● Considering customer preferences when determining the inventory required for storm response. 2. The *Directors of Operations Engineering* and *Systems Engineering* are responsible for ● Addressing customer complaints received from the OEB or ESA regarding power quality; and ● Enlisting third party consultants to provide independent recommendations to address customer concerns regarding power quality.

System Service (cont'd)	3. The *Director of Operations Engineering* is responsible for ● Developing and exercising an electrical distribution system emergency restoration plan and for making recommendations on capital expenditures required to respond effectively to catastrophic events (e.g., major ice storm etc.). 4. The *Director of Systems Engineering* is responsible for ● Ensuring that the capacity within the distribution system is adequate to accommodate new customer load and generation and to provide optimum operating flexibility and meets regional planning and DER needs; ● Preparing a planning document to predict future load growth and determine where future transformer station and feeder capacity will be required; ● Determining if London Hydro needs to acquire land for electric distribution system purposes (e.g., new transformer station); and ● Participating in regional planning to determine the impact on existing and future supply points. 5. The *Director of Engineering Services* is responsible for ● Arranging for staff representation at community events and in community service organizations to educate customers on Demand Side Management initiatives and for soliciting suggestions for London Hydro's continuous improvement. 6. The *Director of PR, Corporate Communication and Marketing* is responsible for ● Creating initiatives to educate customers and stakeholders about LDC issues; ● Arranging for a third party to perform an annual Customer Satisfaction Survey; ● Presenting the results of focus groups and Customer Satisfaction Survey to the Executive for consideration in capital expenditure plans; and ● Arranging a variety of methods to determine customer preferences (e.g., for functionality of new website), such as town hall meetings, demonstrations at home shows, and other community events, focus groups, etc.



System Renewal	1. The *Director of PR, Corporate Communication and Marketing* is responsible for • Leading customer outreach initiatives to solicit feedback from small commercial and residential customers regarding preferences related to system renewal and their impact on reliability and cost; and • Forwarding customer feedback to the appropriate Directors. 2. The *Director of Engineering Services* is responsible for • Leading engagement activities with large Commercial and Industrial customers, in coordination with the *Director of Stakeholder Relations*, regarding preferences related to system renewal and their impact on reliability and cost; and • Forwarding customer feedback to the appropriate Directors. 3. The *Director of Operations Engineering* and the *Director of Systems Engineering* are responsible for • Collecting information from field staff throughout the year to identify equipment problems that could pose risks to safety, the environment and reliability; and • Reviewing customer feedback and complaints regarding system renewal projects as part of the decision-making process. 4. The *Director of Systems Engineering* is responsible for • Developing long term budgets to accommodate capital works anticipated by the Asset Sustainment Plan created by the *Senior Engineer Asset Management*; • Using the Asset Sustainment Plan report to identify assets that need to be refurbished or replaced and evaluating alternatives for lifecycle optimization; and • Taking into consideration customer preferences and third-party requirements as they relate to London Hydro's system renewal plans.

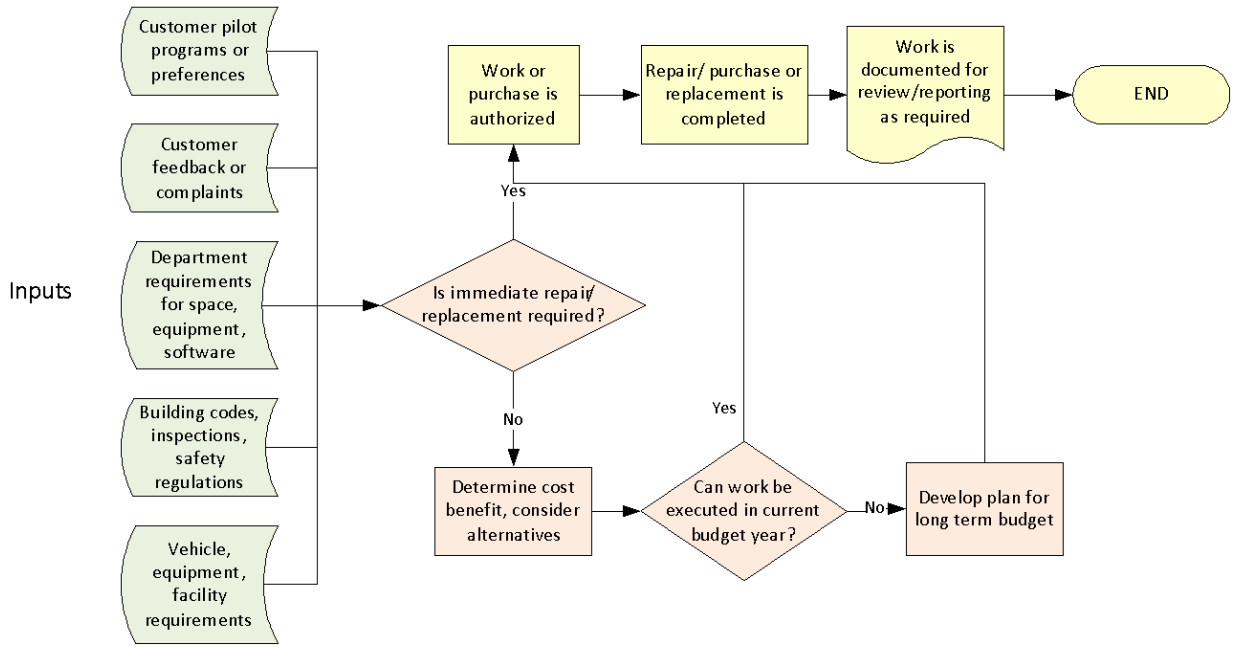
System Renewal Process



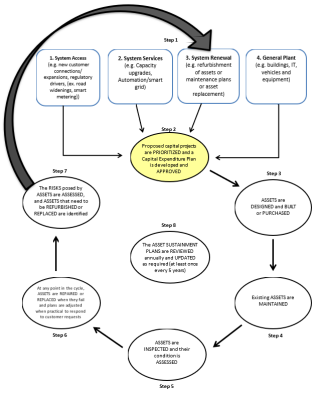
General Plant	1. The *CEO* is responsible for ● Evaluating opportunities to conduct pilot programs to showcase London Hydro (e.g., next generation smart metering, microgrids, DERs, and other leading-edge technologies). *2.* The *Director of Engineering Services is* responsible for ● Ensuring London Hydro's facilities are maintained in accordance with all applicable codes, standards and regulations to ensure the health and safety of employees; and ● Liaising with the various departments to ascertain what they need in terms of space requirements to enable them to function most efficiently. 3. Working with the relevant *Directors* of Information Systems, the *VP of IT and CIO* is responsible for ● Analyzing technological trends and budgeting for new growth; ● Preparing the IT Strategic, Disaster Recovery and Cyber Security Plans annually to determine what new IT assets are required; ● Working with all departments to determine their future IT requirements; and ● Determining which projects will be completed in the following year and how much will be spent on each. 4. The *VP of IT and CIO*, the *Director of Information Systems (Infrastructure & Cyber Security), Director of Enterprise Risk Management, and the Facilities Manager* are responsible for ● Developing and testing disaster recovery plans and making recommendations for capital expenditures as required to mitigate London Hydro's risks to business continuity and to ensure continued service to customers. 5. The *Director of Information Systems (Infrastructure & Cyber Security)* is responsible for ● Determining which IT hardware and systems need to be replaced due to age or obsolescence. 6. The *Director of Customer Service and Billing and the Director of PR, Corporate Communication and Marketing* are responsible for ● Considering customer preferences when designing billing systems and London Hydro's corporate website. 7. The *Director of PR, Corporate Communication and Marketing* is responsible for ● Arranging a variety of methods to determine customer preferences (e.g., for functionality of new website), such as town hall meetings, focus groups, surveys, etc. 8. The *Manager of Customer Electrification* is responsible for ● Updating the annual Vehicle and Equipment Replacement and Refurbishment Schedule and for collecting new vehicle, equipment and capital tool requirements from each London Hydro Department.

General Plant (cont'd)	9. The *Facilities Manager* is responsible for • Identifying the capital improvements and acquisitions required for existing facilities; and • Developing and testing the various disaster recovery plans related to the facilities and making recommendations for capital expenditures as required to mitigate London Hydro's risk to business continuity and to ensure continued service to customers.

General Plant Process



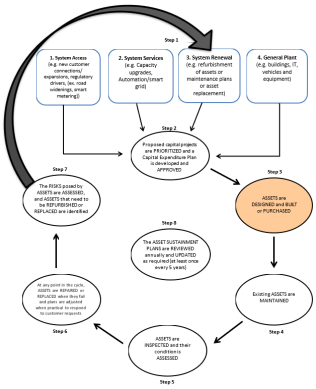
Step 2



Proposed capital projects are PRIORITIZED and a Capital Expenditure Plan is developed and APPROVED

Element	Responsibility
Prioritization and Approval	1. The *CEO* is responsible for ● Ensuring there is a prudent level of capital expenditure that responds to Customer preferences; and ● Obtaining Board approval for annual capital budgets. 2. The *VP Operations & Planning* is responsible for ● In conjunction with the CEO, working with the Board of Directors and Executive Team, determining the pace of short and long term electrical distribution system capital investments to manage the impact on customer bills; and ● Balancing and prioritizing the Engineering and Operations customer and system driven capital projects, including proposed DER investments to be owned by London Hydro. 3. The *VP of IT and CIO* is responsible for ● In conjunction with the CEO, working with the Board of Directors and Executive Team, determining the pace of short and long term IT capital investments to manage the impact on customer bills; and ● Balancing and prioritizing the IT customer and system driven capital projects. 4. The *VP Engineering & Construction and VP Operations & Planning* are responsible for ● Reviewing the proposed capital budget and the project priorities. 5. The *Director of Systems Engineering* is responsible for ● Working with representatives from Engineering and Operations Departments to develop a proposed capital budget that addresses the risks that have been identified with existing assets while balancing the need to fund the building of new assets; and ● Prioritizing projects based on engineering analyses, customer demand and on the Analytical Ranking Model (Appendix D). 6. The *Director of Systems Engineering and the respective Manager of Finance* is responsible for ● Completing the Capital Expenditures Summary to provide the Board and stakeholders with an overview of the Capital Expenditures Plan over a 10-year period.

Step 3



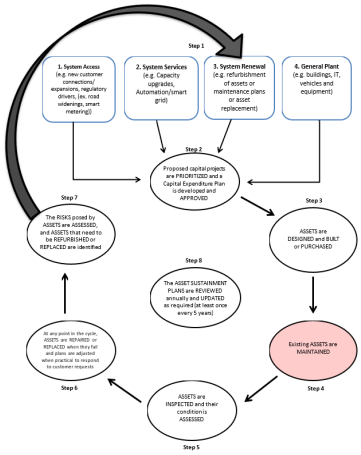
ASSETS are DESIGNED and BUILT or PURCHASED

Element	Responsibility
Engineering Design	1. The *Director of Design Engineering* is responsible for ● Preparing engineering designs for the construction of new assets; ● Keeping design standards up to date and distributing them to all affected parties; ● Maintaining the Conditions of Service up-to-date; ● Ensuring that the most optimal system capacity option is selected (e.g., ensure that Demand Side Management and DER investment alternatives are considered prior to building new capacity); ● Consulting Operations, Reliability, Systems Engineering and Demand Side Management staff to prepare designs that will best meet London Hydro's Asset Management Policy objectives; and ● Ensuring that customer preferences are taken into account when designing new assets. 2. The *Manager of Standards and Generation* is responsible for ● Keeping current with industry standards and regulations for equipment and staying abreast of innovations in equipment design and manufacturing; and ● Working with manufacturers to adapt engineering designs to meet the needs of London Hydro and its customers.
Vehicle and Equipment Assets	3. The *Director of Engineering Services* is responsible for ● Working with users to develop functional requirements for new vehicles and for creating purchasing specifications. If a vehicle will be refurbished (e.g., existing aerial device transferred to a new chassis), this position is responsible for developing the specifications for the work to be done; and ● Considering sustainable options (hybrids, electric) to reduce London Hydro's environmental impact when purchasing new vehicles.
Demand Side Management	4. The *Director of Engineering Services* is responsible for ● Ensuring that staff in the Demand Side Management Department receive ongoing training to keep up to date with regulatory targets and processes related to Demand Side Management objectives; ● Working with the *Director of Design* to explore ways in which Demand Side Management initiatives can be used to reduce the need to invest in system assets; and ● Coordinating with the *Director of Systems Engineering* to ensure that Demand Side Management forecasts (for reduced demand) are used in system planning.

IT	5. The *VP of IT and CIO* is responsible for ● Ensuring that staff in the IT Department receive ongoing training to keep up to date with best practices. 6. The *Director of Information Systems (Enterprise Systems & Architecture)* is responsible for ● Designing or purchasing IT systems and assets used to support day-to-day business and operations activities. 7. The *Director of Information Systems (Infrastructure & Cyber Security)* is responsible for ● Building IT systems and assets used to support day-to-day business and operations activities. 8. The *Director of Customer Service and Billing* is responsible for ● Developing the business requirements of London Hydro's billing system, website, portals, and telephone IVR system to meet regulatory requirements; and ● Ensuring that customer preferences are taken into account when designing new customer-centred IT assets.
Buildings	9. The *Facilities Manager* is responsible for ● Developing the business requirements and specifications to refurbish or purchase new capital assets in the general plant category (e.g., re-roofing buildings, new storage facilities etc.); and ● Ensuring the most efficient energy options are selected for facilities projects and that environmental protection is a factor in decision-making.
Material Resources	10. The *Director of Logistics* is responsible for ● Administering London Hydro's materials management practices to ensure that materials are available when required and can be purchased at the lowest possible cost.
Project Scheduling	11. The *Manager of E&O Finance and Capital Projects* is responsible for ● Working with the Engineering, Operations, Materials Management and Finance Departments to schedule and track projects to ensure they are completed on time and on budget. 12. The *Directors* of Information Systems are responsible for ● Working with affected departments to schedule and track IT projects to ensure they are completed on time and on budget.
Performance Scorecard	13. The *Director of Regulatory Affairs* is responsible for ● Coordinating the completion of the OEB-approved Performance Scorecard annually; and ● Keeping up-to-date on current requirements of the Scorecard to ensure London Hydro remains compliant. 14. The *Manager E&O Finance and Capital Projects* is responsible for ● Reporting on the percentage of electric distribution system capital projects completed at year end as a percentage of those planned; ● Creating Variance Reports to identify gaps for continuous improvement; and ● Reporting on the budgeted vs. actual expenditures.

Labour Resources	15. The *VP Engineering & Construction, VP Operations & Planning* and the *VP of IT and CIO* are responsible for ● Ensuring that a proper balance between the use of internal resources and external contractors is maintained to permit London Hydro to meet its Asset Management Policy objectives; and ● Maintaining an annual succession plan for each major department, in coordination with the Director of People & Culture, to ensure that there is an adequate complement of internal staff to meet future needs. 16. The *Directors of Engineering and Operations* are responsible for ● Managing the construction and refurbishment of assets ○ to meet regulatory obligations for connecting new customers within 5 days (or 10 days depending on the voltage), ○ to provide timely construction services for developers; and ○ to build and maintain distribution assets as efficiently as possible. 17. The *Director of Logistics* is responsible for ● Hiring contractors when necessary to ensure projects are completed on time and on budget. 18. The *Manager of Purchasing* is responsible for ● Ensuring that London Hydro's purchasing policies for quotation and tendering are followed so that new assets are purchased and built in a manner that delivers best overall value, considering cost and other applicable technical, operational, reliability, environmental, and lifecycle requirements.

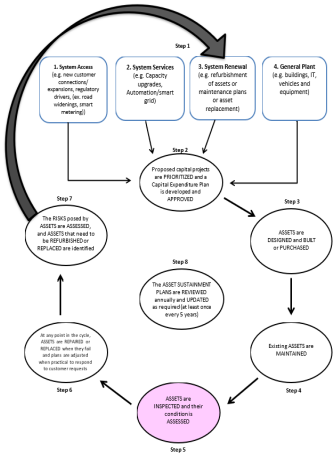
Step 4



Existing ASSETS are MAINTAINED

Element	Responsibility
Preventative Maintenance Plans	1. The *Director of Operations Engineering*, *Director of Systems Engineering* and the *Director of Engineering Services* are responsible for ● Developing preventative maintenance plans for assets under their control; ● Establishing and documenting the safe work practices to ensure that no employee or member of the public is injured or suffers harmful health effects from any of London Hydro's assets; and ● Ensuring that the appropriate staff receive training and keep up-to-date with leading maintenance practices and technologies. 2. The *Director of Information Systems (Infrastructure & Cyber Security)* is responsible for ● Developing preventative maintenance plans for assets and keeping software licences up to date; and ● Ensuring that the appropriate staff receive training and keep up-to-date with leading maintenance practices and technologies.

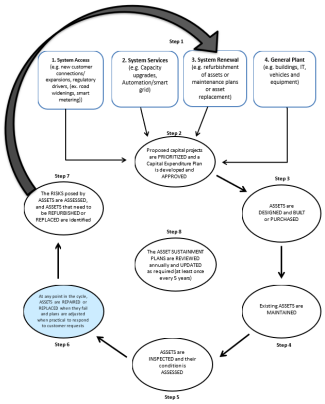
Step 5



ASSETS are INSPECTED and their condition is ASSESSED

Element	Responsibility
Inspections	1. The *Director of Operations Engineering, Director of Systems Engineering, and Director of Lines and Construction,* are responsible for ● Ensuring that London Hydro's Electric Distribution assets are regularly inspected and tested as required by the OEB Distribution Code, ESA Reg 22/04, or more frequently as described in the Asset Sustainment Plan. 2. The *Manager of Engineering Metering and Technical Services* is responsible for ● Ensuring all metering equipment is inspected regularly. 3. The relevant *Directors* of Information Systems are responsible for ● Monitoring the health of servers and other IT infrastructure and business systems. 4. The *Director of Engineering Services* is responsible for ● Ensuring that all regulatory requirements for the inspection of vehicles (CVOR) and rolling stock equipment are met annually; and ● Ensuring that the safety integrity of storage systems is inspected and for making recommendations for capital investments when necessary. 5. The *Facilities Manager* is responsible for ● Ensuring that all buildings and associated capital equipment are inspected annually and for making recommendations for capital improvements as required. 6. The *Joint Health and Safety Committee* is responsible for ● Performing monthly inspections of work areas to identify safety hazards. *7.* Individual *Operations Supervisors and Superintendents* are responsible for ● Scheduling the inspections and analyzing the results to make recommendations about asset maintenance and replacement; and ● Revisiting the field when necessary to audit the accuracy of the data.

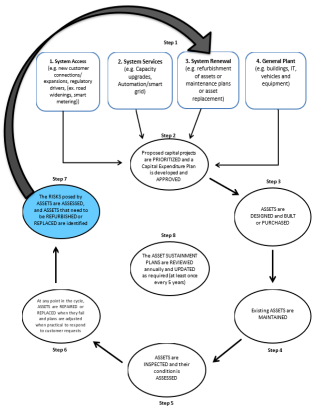
Step 6



At any point in the cycle, ASSETS are REPAIRED or REPLACED when they fail and plans are adjusted when practical to respond to customer requests.

Element	Responsibility
Repair and Replace	1. The *Director of Operations Engineering, Director of Systems Engineering, the Director of Information Systems (Infrastructure & Cyber Security), the Director of Engineering Services, and the Facilities Manager are responsible for* • Developing procedures to respond to equipment failures as quickly as possible at a reasonable cost; • Ensuring that serious deficiencies found during inspections are repaired as soon as possible; • Identifying emergent issues that require unplanned capital refurbishment or replacement or identifying consequential risks that may develop; and • Responding to customer requests, when practical.

Step 7

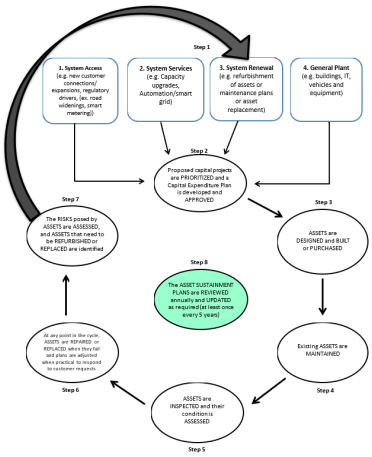


The RISKS posed by ASSETS are ASSESSED, and ASSETS that need to be REFURBISHED or REPLACED are identified

Element	Responsibility
Reliability	1. The *Director of Operations Engineering and the Director of Systems Engineering* are responsible for ● Developing criteria for the refurbishment and/or replacement of assets that pose a risk to customer expectation of service reliability. 2. The *Director of Information Systems (Enterprise Systems & Architecture)* is responsible for ● Developing criteria for the refurbishment and/or replacement of IT assets that pose a risk to customer expectation of service reliability. 3. The *Senior Engineer Asset Management and the Manager of Engineering System Reliability* are responsible for ● Assessing asset inspections and testing results and recommending capital refurbishment and/or replacement plans. 4. The *System Operations Centre Superintendent* is responsible for ● Documenting the cause and duration of every outage in the electric system. 5. The *Manager of Engineering System Reliability* is responsible for ● Analyzing and reporting on London Hydro's reliability and system performance and creating a yearly "Quality of Supply Report," including a review of worst performing feeders; and ● Recommending maintenance, refurbishment or replacement plans to address reliability issues while meeting the requirements of the ASP.
Safety and Environmental	1. The *Director of Operations Engineering, Director of Systems Engineering, Director of Lines and Construction and the Director of Health, Safety and Environment* are responsible for ● Identifying safety and environmental issues related to the performance of London Hydro's distribution assets and ensuring those issues that need attention are addressed.

Safety and Environmental (cont'd)	2. The *Manager of Health Safety and Environment* is responsible for ● Identifying environmental issues related to the performance of London Hydro's distribution assets and general plant and ensuring those issues that need attention are addressed. 3. The *Joint Health and Safety Committee* is responsible for ● Assessing risks in the workplace identified during regular inspections and making recommendations for improvements to mitigate hazards found. *4. Supervisors* and *Superintendents* are responsible for ● Taking appropriate action when employees come forward with issues that pose a threat to safety or the environment. 5. All *employees* are responsible for ● Reporting to their supervisor any perceived safety or environmental hazards related to London Hydro's distribution assets.

Step 8



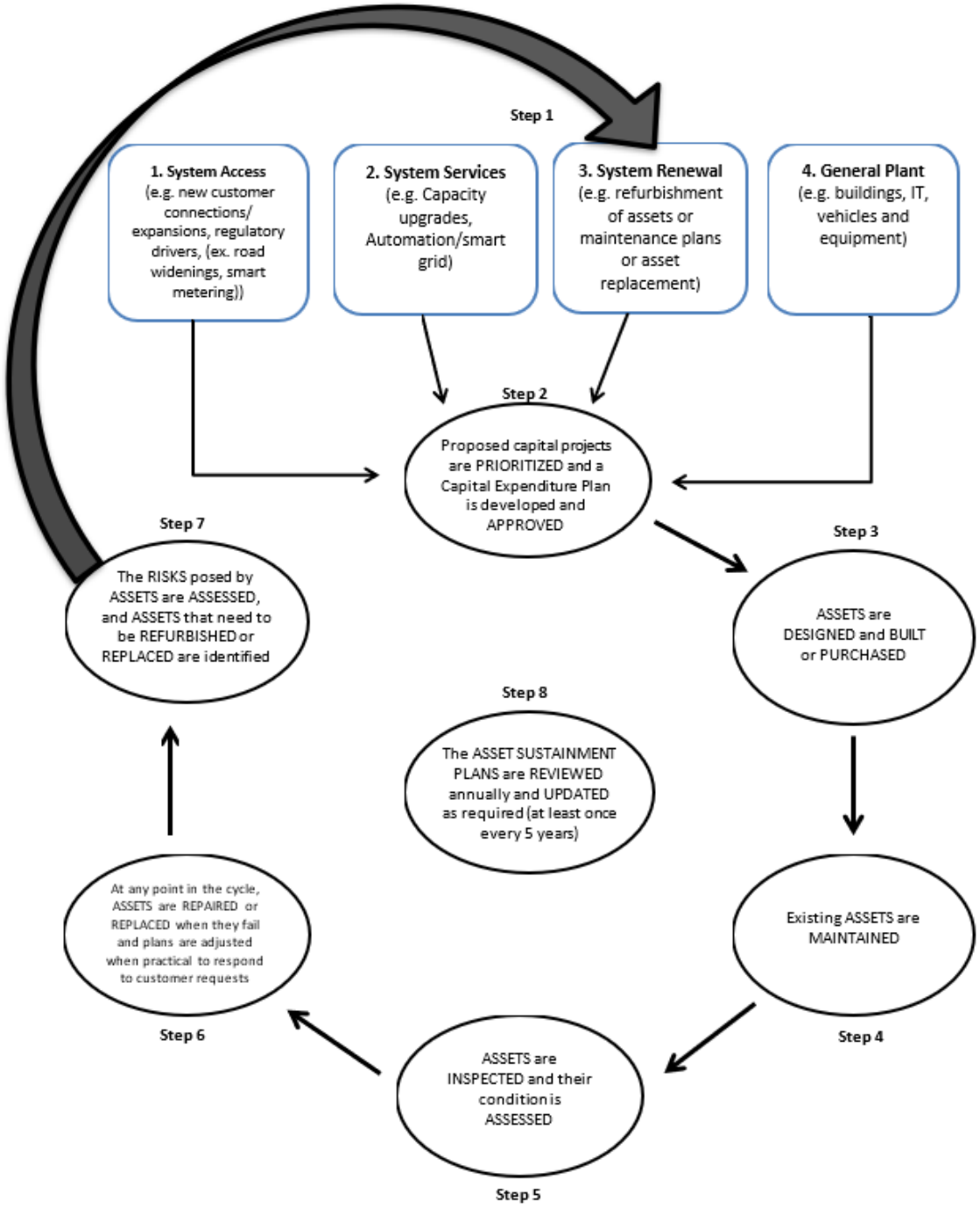
The ASSET SUSTAINMENT PLANS are REVIEWED annually and UPDATED as required (at least once every 5 years)

Element	Responsibility
	1. The *VP Operations & Planning and the VP of IT and CIO* are responsible for • Ensuring London Hydro's Asset Sustainment Plan is reviewed annually and updated as required (at least once every 5 years); • Confirming that they continue to meet London Hydro's strategic objectives; and • Ensuring that all of the processes and procedures described are being followed.

Procedures

The following section describes the procedures that are followed for each step of the asset management process.

Step 1



System Access

1. The CEO meets with local business and community groups, directly or through delegates, to provide information about capital expenditure initiatives (related to both Operations and IT infrastructure) planned by London Hydro and their significance for the community and stakeholders. The CEO also speaks to municipal leaders at the Annual General Meeting of the Shareholder, and they communicate regularly with City Administration to keep abreast of issues in the community. All of these events provide an opportunity to listen to the preferences of stakeholders related to London Hydro's strategic priorities and to solicit suggestions for how London Hydro can contribute to the economic development of the City of London.

   The CEO also reviews and approves all policies and attains Board approval, where necessary, and keeps the Board updated on relevant issues pertaining to the distribution system.

2. The VP Engineering & Construction and VP Operations & Planning develop policies and guidelines, contained in the *Conditions of Service*, for connecting customers to London Hydro's distribution system, including procedures for accommodating customer preferences for system access. In addition, the VP Engineering & Construction and VP Operations & Planning, and/or delegate, meet with developers and with large new customers to determine how London Hydro can integrate them into the distribution system most efficiently and in accordance with the terms and conditions contained in the *Conditions of Service*.

   When customer preferences contradict London Hydro's design standards and construction practices, the VP Engineering & Construction and VP Operations & Planning consider London Hydro's requirements in terms of its *Conditions of Service,* regulatory obligations and its responsibility to the customer base at large when making decisions. In such cases, London Hydro will strive to accommodate customer requests when it is practical, when it does not result in cross-subsidization (increased costs for other customers), and when it does not jeopardize reliability or safety, in accordance with the *Conditions of Service*.

   The VP Engineering & Construction and VP Operations & Planning ensure that grid modernization initiatives are appropriately considered and develop policies for the construction and financing of system upgrades to accommodate both utility-owned and third party owned DER (Distributed Energy Resources) projects, and these are also contained in the *Conditions of Service*. Decisions regarding this type of capital expenditure are made using a business case logic (e.g., the initiative pays for itself or benefits society as a whole), with the end goal being to accommodate all customers without harming the customer base at large, whether through additional costs, reduced reliability or compromised safety.

3. The Director of Design Engineering works with all departments to collect revisions and clarifications for the *Conditions of Service* document and arranges to have it updated at least annually to ensure that it addresses the evolving needs of customers and continues to meet the objectives outlined in the Asset Sustainment Plan. For example, commercial changes are submitted by the Engineering Department, changes in rate structure are submitted by Finance. If gaps or deficiencies are found in the document, those are addressed in the subsequent revision. We also adjust the *Conditions of Service* to remain in compliance with regulatory authorities (e.g., OEB) when they amend or add regulatory requirements.

4. Regarding capital expenditures for system access related to IT infrastructure (e.g., metering), the Director of Operations Engineering follows an established procedure that is based on the principle of ensuring there is a sufficient supply of equipment in stock to meet the needs of our customers without maintaining an excessive oversupply, which can be costly. As part of the decision-making process, the Director assesses new technology to ensure we comply with regulatory requirements and customer preferences.

   At times, customer preferences related to metering contradict London Hydro's standards and general practices. When this occurs, the Director of Operations Engineering will accommodate customer preferences when it is both feasible and safe to do so, although, at times, additional cost to the customer may be incurred. When accommodations cannot be made, final decisions are based on the *Conditions of Service*. When the customer request involves electrical issues or safety, the matter is referred to the Electrical Safety Authority (ESA). When it is not possible to accommodate customer requests, usually because the request contradicts the policies and procedures of the *Conditions of Service*, the Director of Operations Engineering will resolve the issue with the customer.

5. In planning for System Access capital projects, the Manager of Engineering System Planning uses industry standard forecasting methodologies and planning processes that consider City of London residential, commercial and industrial growth predictions, population growth forecasts, and economic forecasts for the area. Analytical methods also incorporate weather normalization, trend analysis and consider government programs that impact Conservation Demand Management and Distributed Generation initiatives. IESO and Hydro One forecasts and models are also considered. Planning processes must adhere to requirements that are specified as part of the Regional Planning Process.

   A system impact analysis is performed for generators over 500kW to ensure power quality, safety, reliability, and operational limits such as voltage limits and fault levels are maintained within acceptable ranges. The impacts of large customers or special loads are also analysed to ensure there are no negative system or customer impacts.

6. One of the most frequent ways we learn about customer preferences is through the customer complaint process. The Director of Customer Service and Billing and the Director of PR, Corporate Communication and Marketing, and the Manager of Key Accounts receive customer complaints and are responsible for either resolving them or directing them to the appropriate department for resolution.

   Directors of the appropriate departments monitor the complaints received and when trends begin to appear, they recommend projects or an action to be taken to address ongoing issues.

7. As the licensed LDC serving the municipality of the City of London, London Hydro has a duty of care to respond to our customers within our service territory by connecting them, and in doing so we also meet regulatory obligations. The Director of Design Engineering develops procedures to ensure that requests for new service are responded to in a timely manner and are connected within OEB regulated timelines. The Director of Design Engineering also works with other utilities, the City of London's Planning Department, other third parties and developers to ensure designs and budgets are in place for infrastructure work that affects all parties (e.g., new subdivisions, commercial/ industrial connections and expansions and line relocations due to road widenings) to meet mutually agreed upon timelines. For all new subdivisions, the Director of Design Engineering, or through delegates,

participates in “Joint Trench Meetings” with all affected third-party utilities to coordinate the work to be done.

The Director of Design Engineering considers customer preferences when planning for work, and when customer preferences cannot be accommodated (e.g., due to problems with timelines or costs), the Director escalates those requests to the VP Engineering & Construction. The VP Engineering & Construction also consults with the VP Operations & Planning when projects may affect future load growth.

8. London Hydro supports customers throughout the Distributed Energy Resource (DER) application, study, and connection process in accordance with the Distribution System Code. Further details regarding requirements and procedures are outlined in Engineering Instruction EI-26 (Managing Micro-Embedded Generators).

   London Hydro’s Standards and Generation team works with DER customers to help them find solutions to challenges that arise throughout the process. While London Hydro’s standards and protection requirements must be met, London Hydro accommodates customers’ preferences for the manner in which they meet those requirements (e.g., which type of central inverter to use at the point of common coupling).

9. When the Director of Customer Service and Billing receives complaints from the OEB, the ESA, or other stakeholders, they contact the appropriate department manager to obtain information and initiate resolution of the issue. Once the issue is resolved, the Director of Customer Service and Billing will follow up and write a formal response indicating the action taken. When the response is received from the OEB or ESA, the Director of Customer Service and Billing follows up on any other actions required or files the acknowledgement of resolution.

System Service

1. The VP Engineering & Construction and VP Operations & Planning develop policies and guidelines, which are contained in the *Conditions of Service*, to accommodate customer preferences for system service. In addition, VP Engineering & Construction and VP Operations & Planning, and/or delegate, meet with developers, commercial customers and third parties to address issues that affect system service and determine if changes can be made to accommodate their requirements within the *Conditions of Service.*

   When customer preferences contradict London Hydro’s design standards and construction practices, the VP Engineering & Construction and VP Operations & Planning consider London Hydro’s requirements in terms of our regulatory obligations, our operational objectives as well as our responsibility to our customers. In such cases, London Hydro will strive to accommodate customers when it is practical, when it does not result in cross-subsidization (increased costs for other customers), and when it does not jeopardize reliability or safety, in accordance with the Conditions of Service.

   Under the direction of the Vice President, Engineering & Construction, and the Vice President, Operations & Planning, London Hydro maintains a strategic inventory program designed to ensure timely and effective response to major storm events while supporting ongoing economic development. This approach minimizes service disruptions and protects customers from unreasonable delays in restoration.

To further strengthen system resilience, London Hydro maintains established relationships with key suppliers to enable rapid emergency resupply in the event of catastrophic damage. In addition, the utility participates in mutual assistance agreements through the Ontario Mutual Assistance Group (OnMAG), allowing for coordinated support across the utility sector when required.

Proactive inventory management practices also account for potential supply chain disruptions and material shortages, ensuring continuity of operations and shielding customers from external market volatility. This integrated approach enhances reliability, supports growth, and reinforces London Hydro's commitment to public service and economic stability.

2. Complaints received from the OEB or ESA that related directly to power quality are forwarded to the Director of Operations Engineering or the Director of Systems Engineering, as appropriate. For customers, the Director(s) will investigate the issue and once the problem is identified, the issue is resolved, if possible. Sometimes the solution can be as simple as modifying a configuration (e.g., of transformer tap changes) and at other times the resolution may involve a capital expenditure.

   When commercial customers have a complaint about power quality, the Director involved will oversee an internal investigation to determine if the problem stems from London Hydro equipment. If it does, the problem is fixed. If the source of the issue cannot be found within London Hydro's system, a third-party consultant is hired (at London Hydro's expense) to determine if the problem stems from the customer's equipment. Once London Hydro has helped the customer identify the source of the problem, the customer takes on the responsibility of pursuing a solution. When it is appropriate, London Hydro consults with legal representation before offering to address complaints. (See Appendix A for Power Quality Complaint – Customer Experience Flowchart)

3. The Director of Operations Engineering is responsible for developing an Emergency Procedures Plan (EPP) and conducting an annual exercise to ensure that all personnel who have responsibilities in the Emergency Procedures Plan are aware of and have the adequate resources to fulfil their respective roles. In addition, the Director is responsible for reviewing the EPP annually. Every three years, the Director is responsible for testing all components of the EPP by liaising with the City of London and participating in the city's emergency exercise. As part of the ongoing improvements to and testing of the Emergency Procedures Plan, capital expenditures may be incurred.

4. The Manager of Engineering System Planning develops system planning criteria for total system, transformer and feeder loading to ensure that adequate system capacity is available to meet the needs of new customer load and generation.

   The Manager of Engineering System Planning also works with the Operations Departments to plan the system so that it provides optimum operating flexibility and system reliability and meets regional planning and DER needs. The plan determines where future transformer stations, feeders and switching equipment will be required.

   Presently London Hydro purchases power through Hydro One owned transformer stations and capacity limits for these stations are provided by Hydro One. London Hydro allows for a sufficient capacity margin to enable the transfer of load during emergency conditions based on the Limited Time Rating overload capabilities of the Hydro One stations.

The London Hydro system is a sophisticated grid with hundreds of feeder tie points and automated devices. London Hydro leverages new technology to help analyse feeder load and automated switching capability. Hexagon's Geographic Information Systems are fully integrated with CYME's system analysis software allowing comprehensive system modelling of faults, load flows and voltage levels. Smart Meter data is also now being leveraged to provide increased system modelling capability.

The system plan also considers the need for system renewal and incorporates the report in decisions related to asset refurbishment as legacy systems that are nearing end of life may not adequately be able to meet the needs of new customer loads.

London Hydro works closely with customers and stakeholders as plans and forecasts are developed for downtown intensification or other major City of London initiatives.

5. Demand Side Management programs can have a direct impact on the distribution system in that they can offset or defer capital capacity expenditures. London Hydro's Demand Side Management Department participates in many community events to educate the public about energy conservation and to let them know about the products and services available through London Hydro's Demand Side Management Department.

   It is the responsibility of the Director of Engineering Services to ensure that London Hydro participates in these outreach events. Participation at these community outreach events provides a valuable opportunity to hear from customers and other stakeholders about their needs and priorities related to energy conservation.

6. Every year, the Director of PR, Corporate Communication and Marketing arranges with a third party to perform an "Electric Utility Customer Satisfaction Survey" to solicit information from customers that will support discussions about improving customer care at every level of the utility. The Director actively participates in developing additional questions that focus on particular London Hydro initiatives or community interests. In addition, the Director works with community agencies to educate the public about electrical safety and conservation.

   When London Hydro plans new customer services, the Director of PR, Corporate Communication and Marketing will conduct outreach activities, including focus groups, to ensure that London Hydro's planned initiatives are aligned with the customers' needs and priorities. The results of all customer outreach activities, including the annual Customer Satisfaction Survey, are presented to the Board for consideration in capital expenditure plans.

System Renewal

1. When capital projects are underway in areas of the city that will cause outages or otherwise affect customers, the Director of PR, Corporate Communication and Marketing is responsible for communicating with affected customers about the nature of the project and duration of any service disruptions that may result. Methods of communication may involve community meetings held at local libraries, mailed notices or even the arrangement of door-to-door visits. Large projects are also posted on London Hydro's website. The Director of PR, Corporate Communication and Marketing forwards customer feedback to the appropriate Directors.

2. The Directors of Operations Engineering and Systems Engineering are responsible for using customer feedback, inspection and testing data to analyze system assets that could pose risks to safety, the environment and reliability. The results of these inspections and audits are collated and included in the Asset Sustainment Plan, and they are used to plan system renewal projects.

3. London Hydro develops an Electric Distribution System Asset Sustainment Plan report (ASP) that provides a comprehensive understanding of the major distribution assets owned by London Hydro, which ensure that the objectives stated in London Hydro's overall asset management policies and procedures are met. The ASP documents the age and condition of London Hydro's major distribution assets so potential performance problems can be anticipated and long-term spending patterns can be predicted as necessary to manage risks within acceptable levels and optimize service reliability at the lowest life cycle cost. The ASP permits London Hydro to make informed decisions about assets as they age, specifically, whether and when to maintain, refurbish or replace them.

   The Director of Systems Engineering works with the Director of Operations Engineering and the Director of Design Engineering to develop long term budgets to accommodate capital works anticipated by the Asset Sustainment Plan report in conjunction with other engineering reports. (e.g., report on 4 kV conversion). In planning for system renewal projects, the Director of Systems Engineering uses the results of the forecasting and planning processes required for system access projects and considers optimal long-term solutions that will best address both the present and future requirements for capacity and reliability and the need to replace or upgrade network assets as identified in the Asset Sustainment Plan report (ASP).

4. The Director of Systems Engineering is responsible for ensuring that the Asset Sustainment Plan report is reviewed annually and for using the Plan to identify assets that need to be refurbished or replaced after considering alternatives for lifecycle optimization. The Director of Design works with third parties (Bell, Rogers and the City of London) to coordinate work on common assets.

   When planning for system renewal, the Director of Design Engineering coordinates work with affected third parties (e.g., Bell and Rogers, with whom London Hydro shares some poles) to ensure work is performed in accordance with third party preferences and regulatory requirements. In some cases, London Hydro takes advantage of opportunities arising from third party projects to complete work or prepare for future work in a way that saves costs.

   The Director of Design Engineering also meets with community groups that express preferences for certain types of electricity infrastructure and will accommodate those requests whenever possible. At times, the requests of customers and other third parties cannot be accommodated and, in such cases, requests may be escalated to the VP Engineering & Construction and VP Operations & Planning. Whenever work is performed in the downtown area, the Director of Design Engineering arranges for notices to be sent to any customers who will be affected by the work as well as the Downtown London Community Association and the City Councillor responsible for that area.

General Plant

1. The CEO is responsible for encouraging opportunities to conduct pilot programs to showcase London Hydro by participating in business, university and community events and by hosting

conferences and symposia to share London Hydro's latest initiatives and thereby invite participation in those initiatives.

2. As part of continuous planning, the VP Engineering & Construction and VP Operations & Planning ensure that monthly inspections and workplace audits are conducted both within the departments and at work sites in the field to ensure that all facilities and work sites are maintained in accordance with all applicable codes, standards and regulations to ensure the health and safety of employees. In addition, the VP Engineering & Construction and VP Operations & Planning request information annually and as needed from each department regarding any changes to space allocation that may be required in order to support the efficient operation of the departments. As an added measure, a formal Space Allocation Study is performed at London Hydro Facilities every few years.

3. To keep up with technological trends so they can budget for new growth and regulatory requirements, the relevant Directors of Information Systems and the VP of IT and CIO attend conferences and other learning sessions (e.g., vendor demonstrations) related to the utility industry, business systems in general and the IT sector. In addition, London Hydro uses research firms to supply information on technology trends across the industry and beyond. London Hydro keeps up to date with system enhancements and the associated costs become part of the capital expenditure plan. Business systems are used by London Hydro to run many business processes accurately and efficiently. London Hydro has also invested in the use of Cloud technology to reduce IT capital costs while making it easier to communicate, collaborate and share high volumes of data within the organization.

   Regarding IT system enhancements and new systems, London Hydro has a strong history of investing in infrastructure and innovation, and our motivation for these investments is centred on our commitment to the continuous pursuit of excellence in reliability and customer care. The VP of IT and CIO works with the relevant Directors of Information Systems to develop an Information System Plan (ISP) that sets out the roadmap for London Hydro's use of technology to enhance its business systems and support all technological aspects of London Hydro operations.

   To ensure business continuity is not jeopardized in the event of a disaster, cyber security incident or other emergency situation, the VP of IT and CIO has developed a Disaster Recovery Plan that will help ensure London Hydro's continued service to customers. London Hydro has engaged a designated cyber-security expert who is responsible for the day-to-day management of data security (e.g., firewalls) for our customers and the business as a whole.

4. As part of this plan, IT infrastructure and business systems are tested regularly and an off-site data centre is maintained that can bring London Hydro's system back to pre-set recovery points. As part of its planning for disaster recovery and cyber security, the IT management team has streamlined the business systems by consolidating them using Cloud technology.

5. The Director of Information Systems (Infrastructure & Cyber Security) is responsible for managing the lifecycle of all hardware components and software licences. London Hydro negotiates 5-year warranties for hardware systems and as a rule, replaces hardware when the warranties expire. By ensuring hardware is under warranty, many inspection and maintenance costs are avoided. At times computer systems that are past warranty are repurposed to become part of the disaster recovery system, which saves on capital

expenditures. Licences for software systems are purchased annually, based on the previous year's requirements together with anticipated growth.

6. Regarding capital spending related to IT, every year, the relevant Directors of Information Systems participate with the VP of IT and CIO on portfolio planning to determine what projects will be completed in the following year and how much should be budgeted for each project. Planning involves working with all departments to determine how IT solutions can help each department meet the strategic priorities of the Board.

   For budgetary purposes, projects fall into one of four categories:

   1. Regulatory & Sustainment – projects completed to meet regulatory obligations
   2. System Enhancements – for existing systems
   3. New Systems
   4. Hardware and Software

7. The Director of Customer Service and Billing monitors all customer complaints and questions regarding IT systems. When those issues have been resolved, the Director of Customer Service and Billing files them by category (e.g., website, bill). When that service is scheduled to be upgraded or renewed, these files are consulted to integrate the customers' suggestions, whenever possible into the functional requirements. At times, the volume of complaints received on a particular topic will drive the change. When the project is undertaken, additional customers will be engaged, through focus groups and/or surveys to ensure their feedback aligns with that of the comments received through the complaint process. The requirements voiced by the customers become some of the functional requirements of the initiative. (See Appendix B: Website Functionality Improvement – Customer Experience Flowchart)

8. The Director of PR, Corporate Communication and Marketing is responsible for working with all departments to arrange a variety of methods to determine customer preferences (e.g., for functionality of new website), such as town hall meetings, participation at home shows, focus groups, surveys, etc.

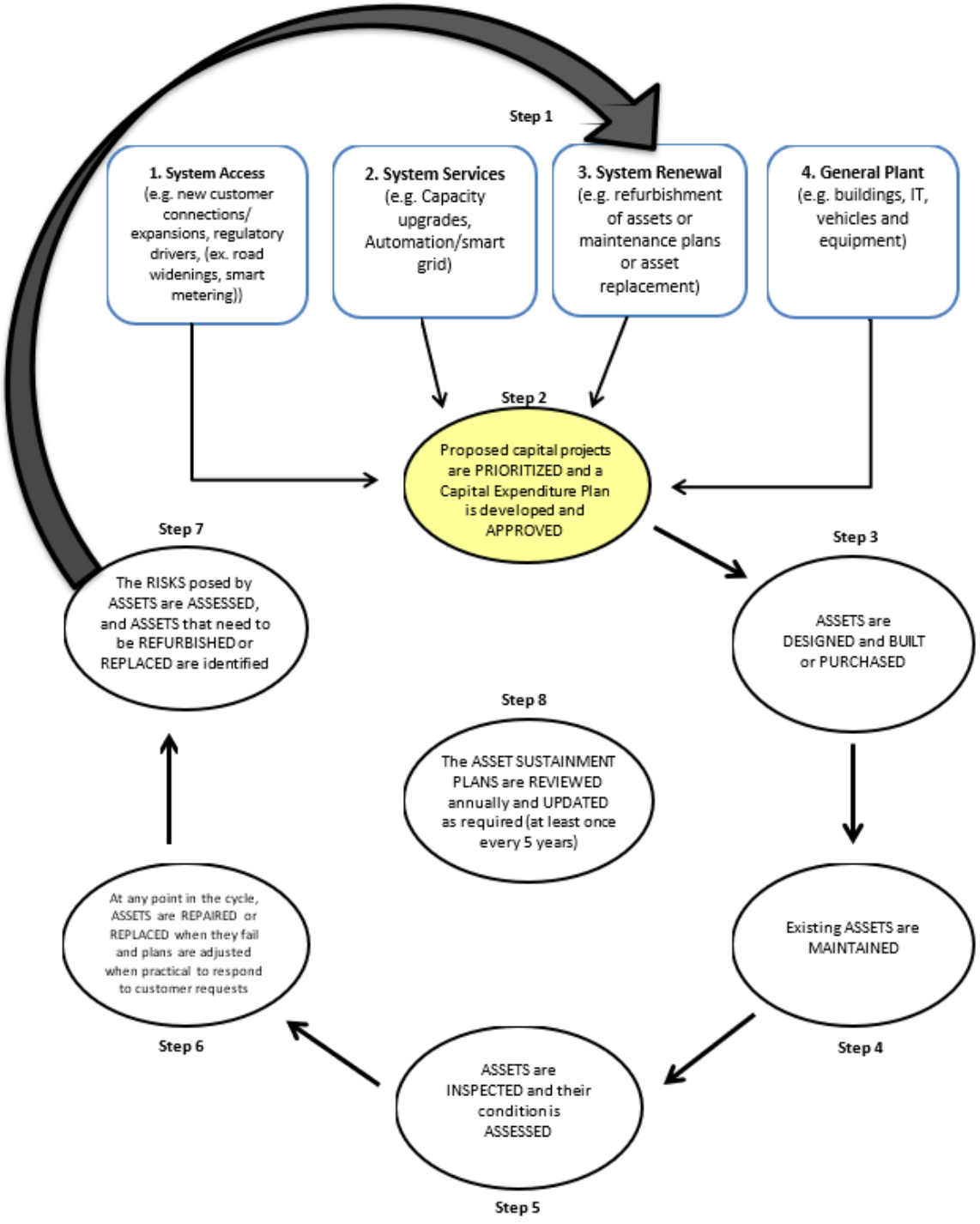
9. The Manager Customer Electrification is responsible for updating the annual Vehicle and Equipment Replacement and Refurbishment Schedule and for collecting new vehicle, equipment and capital tool requirements from each London Hydro Department. To meet this responsibility, the Manager Customer Electrification works with the Fleet Supervisor to collect data on the age, usage, frequency and cost of repairs of all vehicles and equipment and determines which vehicles need replacement or refurbishment. The information contributes to the "5-Year Capital Vehicle Plan" to determine total costs and to identify the vehicles or equipment needing repair or replacement that can be deferred another year. This analysis results in the annual replacement / refurbishment schedule with associated costs.

10. Regarding the security of the London Hydro staff and facilities, the Facilities Manager is responsible for developing and testing the various disaster recovery plans and making recommendations for capital expenditures as required to mitigate London Hydro's risk to business continuity related to facilities and to ensure continued service to customers. In the event of an emergency, as per the SWP Code Section 111C, related to a prolonged electrical outage, it is the Facilities and Security Coordinator's role to ensure the smooth operation of the System Operations Centre in support of those working to restore power and otherwise

deal with the emergency. These responsibilities revolve around ensuring an adequate supply of standby power to key areas and ensuring the safety and security of those working within the System Operations Centre. The specific duties are detailed in London Hydro's "Emergency Procedures Plan."

The Facilities Manager is responsible for identifying the capital improvements required for existing buildings, including those located at the System Operations Centre as well as those located in the field (e.g., substations). Buildings requiring capital improvements are identified during regular inspections.

Step 2


Step 1
1. System Access (e.g. new customer connections/ expansions, regulatory drivers, (ex. road widenings, smart metering))
2. System Services (e.g. Capacity upgrades, Automation/smart grid)
3. System Renewal (e.g. refurbishment of assets or maintenance plans or asset replacement)
4. General Plant (e.g. buildings, IT, vehicles and equipment)
Step 2
Proposed capital projects are PRIORITIZED and a Capital Expenditure Plan is developed and APPROVED
Step 3
ASSETS are DESIGNED and BUILT or PURCHASED
Step 4
Existing ASSETS are MAINTAINED
Step 5
ASSETS are INSPECTED and their condition is ASSESSED
Step 6
At any point in the cycle, ASSETS are REPAIRED or REPLACED when they fail and plans are adjusted when practical to respond to customer requests
Step 7
The RISKS posed by ASSETS are ASSESSED, and ASSETS that need to be REFURBISHED or REPLACED are identified
Step 8
The ASSET SUSTAINMENT PLANS are REVIEWED annually and UPDATED as required (at least once every 5 years)

Capital Expenditures Planning Process

London Hydro's Capital Expenditures Plan, developed on an annual basis, has four categories:

- System Access (e.g., new customer connections/expansions, regulatory drivers, road widenings, smart metering);
- System Service (e.g., capacity upgrades, automation/smart grid);
- System Renewal (e.g., refurbishment or replacement of existing assets); and
- General Plant (e.g., buildings, IT, vehicles and equipment).

The City and Developer works that are driven by external requirements are outside of London Hydro's control. These projects include connecting new services, extending the grid to service new developments, and relocating plant to accommodate City and Provincial works associated with road, water, and sewer improvement programs. The Provincial Acts and associated regulations, codes and requirements stipulate that these are part of the regulated business and must be provided.

Infrastructure related programs are driven by customer value, internal engineering studies, asset condition and operational reports that detail the requirements for expansion, reinforcement and refurbishment.

Proposed capital projects that are part of the infrastructure related programs (i.e. System Service and System Renewal) are submitted by the Director of Systems Engineering and the Director of Operations Engineering. The projects are then prioritized using the Analytical Ranking Model: *Project Related Risk Indexed by Asset Health.* The methodology of the model is presented in Appendix D. The higher the ranking score, the more priority a project will have, enhanced by the blended health index of the asset category(s) it pertains to. The ranking is used to prioritize infrastructure related projects that are not driven by City or developers works. Those projects are included by default as they are driven by a third party.

Once a manageable list of projects has been defined, engineers are assigned to prepare a description and justification for each project. The justification will include any supporting reference material and will discuss any alternatives that have been considered (more maintenance as opposed to replacement, refurbishment instead of replacement, etc.).

1. Once the final list of Engineering and Operations projects is defined, the Capital Budget is presented to the Board for approval. The budget includes an overview and review of London Hydro's current and past system reliability performance, a five-year capital spending forecast and a list of all the supporting reports and documents that are available. In reviewing the Capital Budget, the CEO ensures that it contains a prudent level of capital expenditure that responds to customer preferences.

2. In preparing the budget, the VP Engineering & Construction and VP Operations & Planning will consider *pro forma* financial statements, long term municipal forecasts, and engineering forecasts to determine what impact the capital spending would have on the Corporation's financial status. Using this information, the VP Engineering & Construction and VP Operations & Planning work with the CFO and CEO to determine the pace of short and long

term capital investments (including electrical distribution system, customer and system driven capital projects and DER investments), with a view to levelizing the impact on customer bills.

A budget estimate is prepared for each project as well as a monthly cost and timing estimate, and the VP Engineering & Construction and VP Operations & Planning present the draft list of work to the Executive Committee for consideration. Other projects from the IT department, Facilities, Fleet, etc. are also brought forward and a final list of capital projects is established to meet London Hydro's asset management and financial objectives.

3. Regarding capital spending related to IT, every year, the relevant Directors of Information Systems participate with the VP of IT and CIO on portfolio planning to determine what projects will be completed in the following year and how much each project will cost. In portfolio planning, the IT requests from individual departments are balanced with each other and the strategic priorities set out by the Board for the corporation.

4. The VP Engineering & Construction and VP Operations & Planning consider the recommendations made by the Director of Design Engineering, the Director of Systems Engineering and the Director of Operations Engineering and weigh those against the budget parameters.

5. Every year the Director of Design Engineering and the Director of Systems Engineering meet with representatives from relevant Engineering and Operations Departments to discuss proposed projects for the upcoming year to develop a list of specific capital projects for the following year's budget.

   The capital budget planning team, including Directors and Managers, works together to balance the need to refurbish or replace existing assets that have been identified in the Asset Sustainment Plan report with the need to fund the building of new assets.

   The proposed capital budget is submitted to the VP Engineering & Construction and VP Operations & Planning, who work with other VPs and the CEO to balance the Engineering and Operations capital budget proposal with other corporate needs and then obtains Board approval.

6. After reviewing the details of all capital projects to determine their justification and budget requirements, the Manager E&O Finance and Capital Projects completes the Capital Expenditures Summary. This Summary includes all Capital Budget requests and the overall cost summary and forecasts future projects over a five-year period. It is submitted annually to the Executive as an overview of the Capital Expenditures Plan.

   A number of factors are considered in determining a particular year's capital program, and they can be summarized into the following evaluation criteria, which, in turn, are considered either primary or secondary drivers. The proposed budget is reviewed by the Executive Committee and revised as necessary before being provided to the Board for approval.

Primary Drivers

Reliability analysis provides an indication of how well a system is performing. The statistics provide a relative evaluation in that they look at service levels in comparison to the total customer base. Step 7 of the Procedures discusses how London Hydro tracks and manages system reliability, and at London Hydro the capital program is designed to maintain reliability at a level expected by our customers. Year over year, customers surveyed have expressed strong satisfaction with London Hydro's reliability; therefore, we need to invest the amount necessary to maintain that level of service.

Safety is the highest-level criteria and covers both people (staff and public) and equipment. Considerations for safety include

- Compliance with codes and regulations;
- Possibility of destructive failure jeopardizing equipment, personnel or the public; and
- Antiquated equipment and/or installations that make them unsafe to operate or maintain.

These situations, while not frequent, occur because the equipment has aged beyond its useful life or because circumstances, such as overloading or environmental conditions, have adversely altered the life cycle.

The **Environmental Benefits** of a project factor in decision making both for operational enhancements (e.g., finding alternatives to working with lead) and capital expenditures (e.g., selecting hybrid or electric vehicles).

Capacity – London Hydro facilitates economic development by ensuring the infrastructure is in place to accommodate the City's economic growth**.**

Efficiency – London Hydro invests in projects that will improve efficiency in its system operation. The cost-effectiveness of alternatives is evaluated in decision-making.

Customer Value - Certain projects are undertaken primarily to add value to the customers' experience after extensive consultation with user groups (e.g., online functionality through the website).

Secondary Drivers

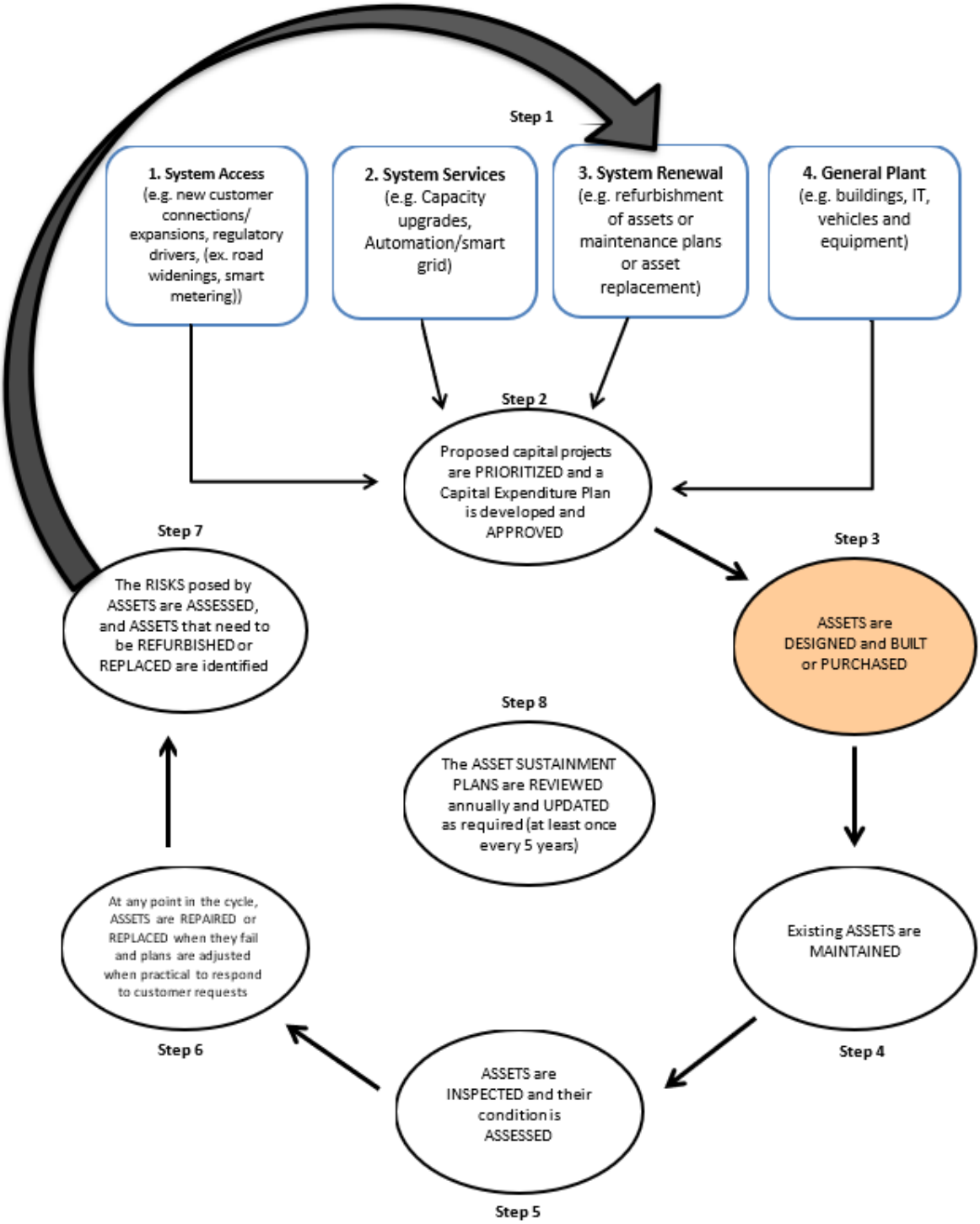
Cyber-security and Privacy are factors in decision-making for capital projects, where applicable (that is, London Hydro will select the operational asset that supports better cyber-security or privacy). At times, cyber-security is the primary driver for the project (e.g., when purchasing firewalls).

Co-ordination and Interoperability are considered for all projects affecting third parties. In certain cases when third parties are engaged in their own projects that present an opportunity for London Hydro to install plant for future operational requirements, coordination and interoperability become primary drivers for the project.

In addition, London Hydro continues to use the following historical drivers because by using them, comparisons can be made year after year. Each year as the Capital Budget is planned, every project is assigned a class code to identify its main (historical) driver:

- SAF = Safety
- REL = Reliability
- COL = City of London
- DEV = Developer
- RNF = Capacity Reinforcement
- SRV = Enhancing service (automation, telemetry)

Step 3


Step 1
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Construction of Assets

Engineering Design

1. London Hydro has a comprehensive set of Engineering Design Standards certified by professional engineers that form the basis of the design of our distribution system. The Director of Design Engineering keeps the design standards up-to-date and ensures that when changes are made, copies are sent to all the registered holders of the Design Standards binder and that the unique digital Standards document is updated. In order to ensure a consistent methodology is used for the introduction or revision of standards at London Hydro, we have developed a "Procedure for the Implementation of New and Revised Standards." All engineering staff adhere to this procedure to ensure that important changes are vetted by and communicated to all stakeholders.

   London Hydro has a number of Engineering Instructions that outline the correct procedures for a number of processes, such as

   - Approving plans, designs and specifications;
   - Integrating electrical civil works into City projects;
   - Sharing costs with the City and other utilities for joint projects;
   - Relocating electrical plant for third parties; and
   - Approving equipment acquisitions.

   The various Directors ensure that all Engineering Instructions are kept up-to-date and are circulated to all stakeholders.

   London Hydro has developed a *Conditions of Service* document that, in addition to addressing the OEB's requirements, describes in considerable detail the policies and procedures for connecting and sharing costs with new customers. Having these guidelines documented ensures that policies and procedures are applied consistently.

   The Director of Design Engineering ensures that key staff in the design department receive ongoing training and periodically attend industry conferences and seminars to keep up-to-date with best practices. When new assets are designed, various design options are considered and factors that affect reliability (increased automation for example), operational flexibility (such as redundancy and alternate feeds) and future capabilities (such as Smart Grid) are balanced with cost to select the best option. The Director of Design Engineering solicits input from Operations, Standards, Reliability and Systems Engineering staff as well as from those involved in Demand Side Management programs to facilitate their joint agreement on new design features that will best meet London Hydro's Asset Management Policy objectives.

   For rebuild work that is initiated by London Hydro, the Director of Design Engineering works closely with affected customers. This includes notice letters for rebuilds, outages are communicated through 48-hour notices, maintenance is published on the website; also, restoration activities are communicated to customers through social media and councillor

notices. The Director of Design works with the Director of PR, Corporate Communication and Marketing to arrange the customer outreach events.

The Director of Design occasionally uses the services of external Engineering Design firms to assist with workloads. The use of external resources also permits the Director to benchmark London Hydro's design methods and efficiency and to keep London Hydro up to date with best design practices. London Hydro uses design specialists for all of its civil engineering work since the volume of this type of work does not warrant having staff designated for this purpose. When work is to be performed on customer-owned equipment, the Director of Design hires consultants to coordinate the work.

2. London Hydro's Manager of Standards and Generation is responsible for the Standards Department who ensures that every piece of equipment meets the highest standards for safety and that each piece of equipment is both safe and effective. In this task the Standards Department must keep current with industry standards and regulations for equipment and also stay abreast of innovations in equipment design and manufacturing.

   The Standards Department works closely with the Manager of Engineering System Reliability to identify equipment problems as early as possible and to implement mitigation measures that may be required.

   Staff in the Standards Department regularly attend equipment trade shows and conferences, participate in industry committees and subscribe to trade publications to keep up-to-date with new equipment trends and standards.

   London Hydro has developed a formal Equipment Approval Process (Engineering Instruction EI-23) to comply with the Electric Safety Authority's requirement to use only approved equipment in electric distribution systems. The Approval Process defines how London Hydro uses certified tests, approvals by professional engineers, trial periods and good utility practices to ensure that equipment does not pose a safety hazard to employees or the public. The Standards Department ensures that the Equipment Approval Process is followed whenever new equipment is introduced to London Hydro. By following all these processes, London Hydro ensures that the equipment and designs it uses provide the best long term value for customers.

Vehicle and Equipment Assets

3. The Manager Customer Electrification is responsible for working with users to develop functional requirements for new vehicles and for creating purchasing specifications. If a vehicle will be refurbished (e.g., existing aerial device transferred to a new chassis), the Manager Customer Electrification is responsible for developing the specifications for the work to be done and works with the Fleet Supervisor to accomplish this task. Once a vehicle is identified and budgeted for replacement or refurbishment, user requirements are evaluated alongside corporate standards, anticipated lifecycle repair costs, and industry best practices to ensure the selected vehicle is functional, cost-effective, and delivered within budget. The Manager Customer Electrification works with the Manager of Purchasing to ensure that all purchasing and tendering policies and protocols are followed in the purchasing of vehicle and equipment assets.

   The Manager Customer Electrification considers sustainable options (hybrids, electric) when purchasing vehicles to reduce London Hydro's environmental impact.

Demand Side Management

4. The Director of Systems Engineering consults with the Director of Engineering Services to ensure that the impact of Demand Side Management initiatives and renewable energy projects are considered when forecasting for capacity. In doing so, the Director of Systems Engineering also considers plans for reserve capacity in the event distributed generation is not available. The Director of Design Engineering considers Demand Side Management and renewable energy projects in distribution system designs.

   As new technologies and programs are introduced to conserve electricity, training is required to ensure the Demand Side Management team is able to educate the public on resultant Demand Side Management initiatives. The Director of Engineering Services is responsible for ensuring that staff in the Demand Side Management Department receive all necessary training.

Information Technology (IT)

5. Part of London Hydro's strategic plan is to build internal IT expertise to ensure a team is in place that can manage and maintain the day-to-day functioning of all business systems. As new IT infrastructure and systems are built or purchased, training is required to ensure staff are able to keep up with the new technology. The VP of IT and CIO is responsible for ensuring that staff in the IT Department receive all necessary training.

6. The Director of Information Systems (Enterprise Systems & Architecture) designs the overall plan of London Hydro's IT infrastructure and its functionality, ensuring that the technologies and systems used integrate seamlessly. Within the overall infrastructure, the Director investigates systems and assets that will support day-to-day business and operations activities and collaborates with end users to design the functional requirements of each system. The RFP process is employed to ensure specific technologies used can be integrated into our system.

7. For projects related to IT systems used to support business operations, including both hardware and software, London Hydro's Directors of Information Systems are responsible for coordinating the completion of projects within given deadlines and budgets. The respective Directors assign a Project Manager or Project Lead to each project and ensure that appropriate support and resources are available to facilitate completion on schedule and within budget.

8. The Director of Customer Service and Billing develops the business requirements of IT programs and systems that are used directly by customers, including the website, portals, billing system and IVR system, ensuring that they meet both regulatory requirements and customer preferences. Information about customer preferences is gathered in a number of ways.

   After new services are launched to respond to customer preferences, the Director of Customer Service and Billing works with the Director of PR, Corporate Communication and Marketing to collect feedback from interested parties to gauge the success of the service and to determine ways in which the service can be improved.

Buildings / Facilities

9. The Facilities Manager develops the functional requirements and specifications to refurbish or purchase new capital assets in the general plant category (e.g., re-roofing buildings, new storage facilities etc.). A database is kept that documents the purchase date of major general plant assets, their specifications and their expected lifespan with a view to planning for replacement. When such new capital assets are required, the Facilities Manager works with affected departments and the Manager of Purchasing to prepare an RFP and select the third party who will perform the work at the lowest possible cost.

   The Facilities Manager is also responsible for all equipment that is attached to buildings (e.g., garage doors, hoists, cranes, boilers, furnaces, fall arrest devices etc.), and works with all affected departments to determine requirements and to obtain the equipment through the RFP process or from Supplier Alliances, when possible.

Material Resources

10. The Director of Logistics is responsible for Infrastructure Purchasing and the Materials Management Department. Working with the Manager of Standards and Generation, the objective is to purchase, at the lowest cost, specified materials needed to fulfill needs for regular maintenance, capital projects, customer driven projects, as well as, unforeseen storms or other unplanned events. A secondary objective is to maintain an optimal inventory level that ensures resiliency in supply, which allows London Hydro to maintain utmost system reliability and removes barriers to fast customer connections, such as new housing developments and commercial growth.

    London Hydro maintains relationships with multiple vendors and often purchases in bulk orders with constant competitive tension through a revolving RFP process for much of the

large value/volume purchases such as cables and transformers etc. This allows for volume purchasing with multiple shipments while maintaining a robust supply base. This also maintains administrative efficiency and lower inventory carrying costs while ensuring supply continuity.

This process encompasses a "Just in Case" strategy where, due to a constantly disrupted supply chain, a flexible strategy is necessary to maintain system reliability and resiliency. This strategy warrants a higher volume of inventory that can be managed higher or lower given the current economic and political realities of a global supply chain.

Project Scheduling

11. London Hydro has a dedicated full-time Manager E&O Finance and Capital Projects in the Logistics team who is responsible for coordinating with Planning, Engineering, Operations, Materials Management and Finance to schedule and track non-IT projects to ensure they are completed on time and on budget.

    The Manager meets regularly, tracks and manages the schedule and budgets that are approved by the Executive team. All work orders and budgets are constantly managed, and any deviations from schedule or budget are captured in variance analyses and reported to stakeholders on a monthly basis at the Planning Meeting, as well as monthly budget meetings with the VP Engineering & Construction and the VP Operations & Planning.

    Engineering Instruction EI-21, "Engineering and Operations Capital Program Project Cost Control Requirements," describes in more detail the procedures in place for identifying and reporting on project cost overruns or under-spending and the procedure for obtaining approval for scope changes or new projects that are not in the Board approved capital budget.

12. For projects related to Information Technology, both hardware and software, London Hydro's Directors of Information Systems coordinate the completion of projects within given deadlines and budgets. The respective Directors are responsible for assigning a Project Manager or Project Lead to each project and ensuring that appropriate support and resources are available to facilitate project completion on schedule and within budget.

Performance Scorecard

13. The OEB gathers benchmarking information from each utility on performance outcomes related to Customer Focus, Operational Effectiveness, Public Policy Responsiveness and Financial Performance. In accordance with Regulatory Reporting Requirements (RRR), the Director of Regulatory Affairs is responsible for gathering the information required for the OEB-approved Performance Scorecard and submitting that information to the OEB, both on a quarterly basis and annually. The Director of Regulatory Affairs is also responsible for keeping up-to-date on the most current requirements of the Scorecard to ensure London Hydro remains compliant with OEB standards and regulations.

14. The Manager E&O Finance and Capital Projects contributes to annual reporting of performance outcomes by reporting on the Capital planned vs actual jobs completed as a

measure of the progress of the Distribution System Plan implementation. To keep track of the status of capital projects, the Manager E&O Finance and Capital Projects prepares a monthly Capital Variance report that captures the percentage of the budget spent on each Engineering-Driven project, year to date and identifies projects that are over or under budgeted amounts as well as rationale for those variances. Rationale related to customer demand and preferences is listed as it relates to City road works and developer new service projects. Gaps in London Hydro processes that lead to the variances may also identify steps to address those gaps as part of continuous improvement planning.

Labour Resources

15. It is London Hydro's philosophy that a proper balance between cost and customer service is best achieved by using a combination of internal staff and external contractors. When staff and contractors work together or observe each other's work, both can learn from the other to develop best practices. However, relying too much on external contractors can result in the loss of internal expertise and can leave us overly dependent on third parties for critical response during storms or emergency events. Although internal staff can generally respond more quickly to customer requests for new service, the presence of external contractors in the workplace can serve as a useful benchmark for marketplace standards and efficiencies and ensure continued delivery of value to stakeholders.

    The VP Engineering & Construction, the VP Operations & Planning, the VP of IT and CIO and the VP Customer and Employee Experience, in coordination with the Director of People & Culture, are responsible for developing a succession plan each year for each major department and submitting an internal staffing plan with the Operational Budgets to ensure that an adequate complement of technical staff, apprentices and trades people is available to meet the objectives of London Hydro's Asset Management Policy and IT strategy. As a result, London Hydro's hiring practices will continue to ensure we have enough qualified and trained staff on hand to meet all of our stakeholders' electric distribution system needs.

16. The Director of Design Engineering is responsible for ensuring that a proper balance is maintained between the use of internal resources and external contractors to permit London Hydro

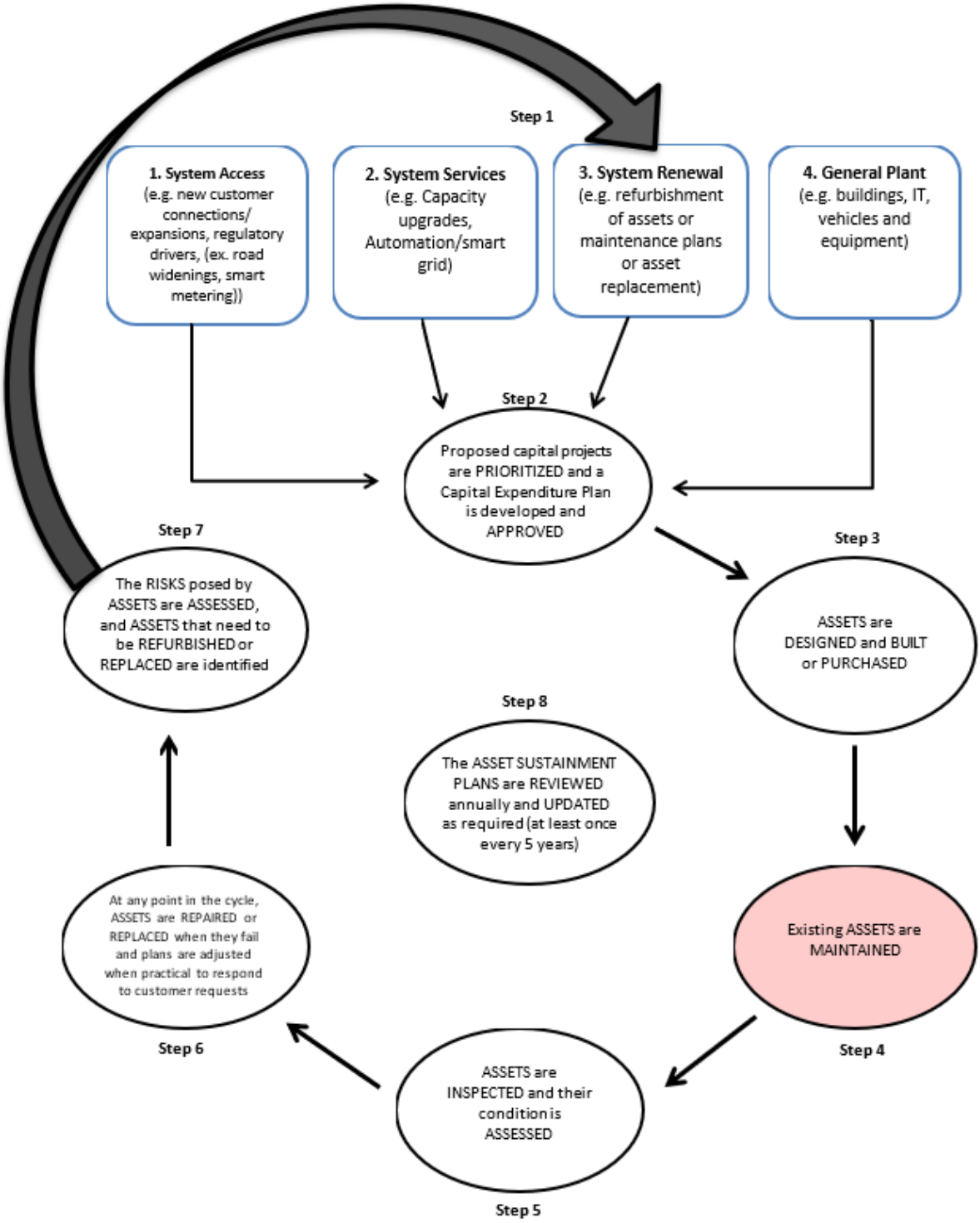
    - to meet its regulatory obligations for connecting new customers within 5 days (or 10 depending on the voltage);
    - to provide timely construction services for developers and third parties; and
    - to build and maintain distribution assets as efficiently as possible.

17. In coordination with operations management, the Manager E&O Finance and Capital Projects reviews the project volume, timelines and internal resources allocations and recommends hiring contract resources to meet customer demand and to complete scheduled projects on time and on budget.

18. The Manager of Purchasing is responsible for ensuring that the purchasing policies and appropriate tendering practices are followed so that new assets are purchased and built at the lowest cost possible. The Manager of Purchasing approves all Purchase Orders and the

Purchasing Department works with all departments to oversee the process for all contracts valued at over $25,000 ensuring that purchasing policies and procedures are adhered to. The Purchasing Department also reviews projects smaller than this limit to ensure that tender processes are not circumvented if the project grows in scale and cost. On a regular basis, the Manager of Purchasing reviews these policies and procedures to ensure that they continue to meet London Hydro's requirements and all regulatory obligations.

Step 4


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Maintenance of Assets

1. The Asset Sustainment Plan report describes the current maintenance and testing activities performed on all of London Hydro's major assets and also describes how the work is recorded and how decisions are made regarding when assets need to be refurbished or replaced. The relevant Directors work with their Managers to develop preventative maintenance plans to optimize asset lifecycles. They also ensure that the appropriate staff receive training and participate in industry committees, equipment shows, conferences and seminars as required to keep up-to-date with leading maintenance practices and technologies.

   Currently, when maintenance and repair activities are recorded, they are tracked and monitored in a database that can be accessed in GIS, making the information readily accessible and easily transportable when assets are moved or retired.

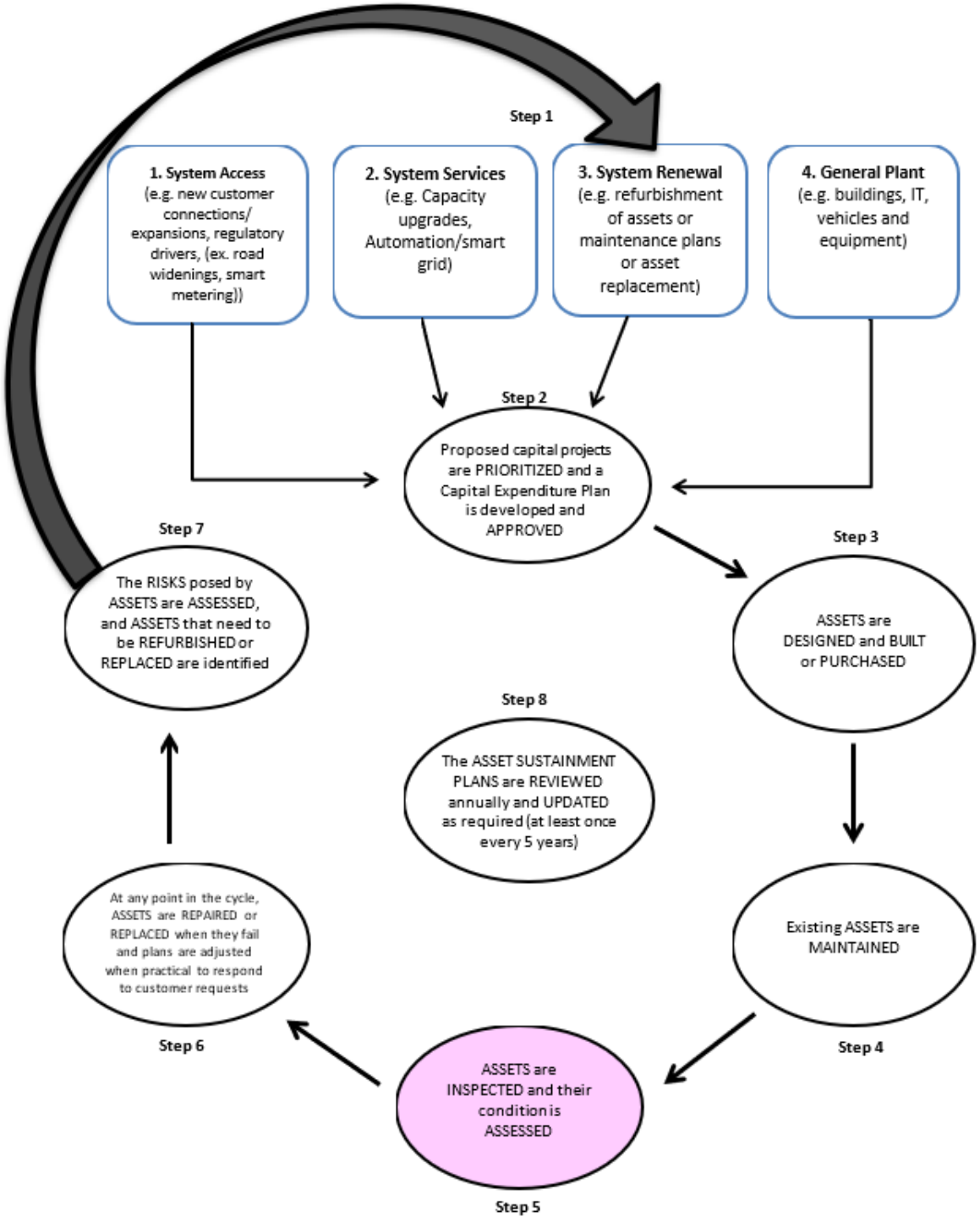
   The Directors of Engineering and Operations work with the Joint Health and Safety Committee (JH&SC), Managers, Supervisors and staff in individual departments to establish and document the policies and procedures related to live line work, Work Permits, outage planning, etc. to ensure that the maintenance and construction of London Hydro's electrical assets can be completed in a safe manner so no employee or member of the public is injured or suffers harmful health effects from any of our assets. These policies and procedures are documented in London Hydro's 'Safe Work Practices' manual.

   Regarding Vehicles, the Manager Customer Electrification works with the Fleet Supervisor who prepares the Preventative Maintenance Schedule for vehicles, and monitors mileage, hours and dates to properly maintain vehicles and equipment according to Commercial Vehicle Operator's Registration (CVOR) and manufacturers' requirements.

2. The Director of Information Systems (Infrastructure & Cyber Security) manages the day-to-day functioning of the corporation's hardware and software and it is this position that is responsible for ensuring that equipment and software are appropriately maintained and that designated personnel receive the necessary training to ensure a proportion of this can be completed in-house.

   Computers and other IT hardware are purchased with three to five-year warranties, and maintenance on these assets is generally completed either by London Hydro trained personnel or by the hardware/warranty provider (if in-house resources are not appropriately trained). To mitigate the effects of hardware failures, London Hydro has monitoring systems that notifies key personnel when a hardware failure is imminent.

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Inspection and Condition Assessment

1. The Director of Lines and Construction and the Director of Systems Engineering ensure that London Hydro's assets are inspected and tested as required by the OEB Distribution Code, ESA Reg 22/04, or more frequently as described in the 'Electric Distribution System Asset Sustainment Plan'. Individual Operations Supervisors are given areas of the city or lists of equipment that need to be inspected each year.

   London Hydro staff record the condition of assets during their inspections and the information is entered into GIS. Supervisors ensure that serious deficiencies are repaired as soon as possible and revisit the field when necessary to audit the accuracy of the data. Assets such as poles, maintenance holes and vaults, and transformers are inspected regularly by operations staff and third parties beyond the detail and timeframes stipulated by the OEB, and the results are tracked and reported.

2. Regarding meters, London Hydro is an accredited, Measurement Canada approved Electric Meter Facility that has been approved for the "removal, rework, sampling, final testing and inspection" of meters as well as the verification of electricity metering installations. London Hydro is therefore able to perform these services both in-house and for other utilities throughout Canada. Meters are inspected to ensure they are operating properly and transmitting accurate information. All meters are outfitted with alarms and notifications that alert staff of any measurement discrepancies or indicate power system disturbances or abnormalities.

3. Regarding IT, the Director of Information Systems (Infrastructure & Cyber Security) is responsible for monitoring the health of London Hydro's IT servers and uses a third party to virtualize our infrastructure in the "Cloud," which enables us to deliver service and data access to our customers at any time from any location. We monitor performance, lifecycle, warranties, licences and maintenance and support contracts to ensure our systems perform to our requirements and to those of our customers and address London Hydro's IT needs. London Hydro's IT infrastructure automatically alerts us to any potential or actual failures in the system.

4. The Health and Safety Management System outlines the inspection frequencies and responsibilities for preventative maintenance (PM) of equipment, tools, vehicles, and facilities. This includes large equipment, trailers, vehicles, and CVOR vehicles maintained under the Fleet department, as well as small equipment such as ladders, confined space guards, and fall arrest systems maintained by department Supervisors. The Fleet Supervisor is ultimately responsible for monitoring and maintaining London Hydro's vehicle PM program, with Operation department Supervisors responsible for ensuring compliance with inspection requirements for tools and equipment within their areas. Any deficiencies or defective equipment identified through inspection are addressed in accordance with London Hydro's documented safe work practices and applicable legislation. Regarding vehicles, the Manager of Customer Electrification is responsible for ensuring that all regulatory requirements for the inspection of vehicles (CVOR) and rolling stock equipment are met annually. Department Supervisors are responsible for daily vehicle inspections, including CVOR inspections, and reporting any defects to Fleet, and any defects are repaired or quarantined until they can be repaired in-house or by the dealer. A vehicle database is kept

up to date, which details the schedule of preventative maintenance (PM) for each vehicle to ensure required vehicle and equipment PM and inspections are completed.

Regarding the daily inspection of vehicles, each operations driver is required to perform a vehicle circle check daily according to the procedures outlined in the Highway Traffic Act and London Hydro's Safe Work Practice (Section 205).

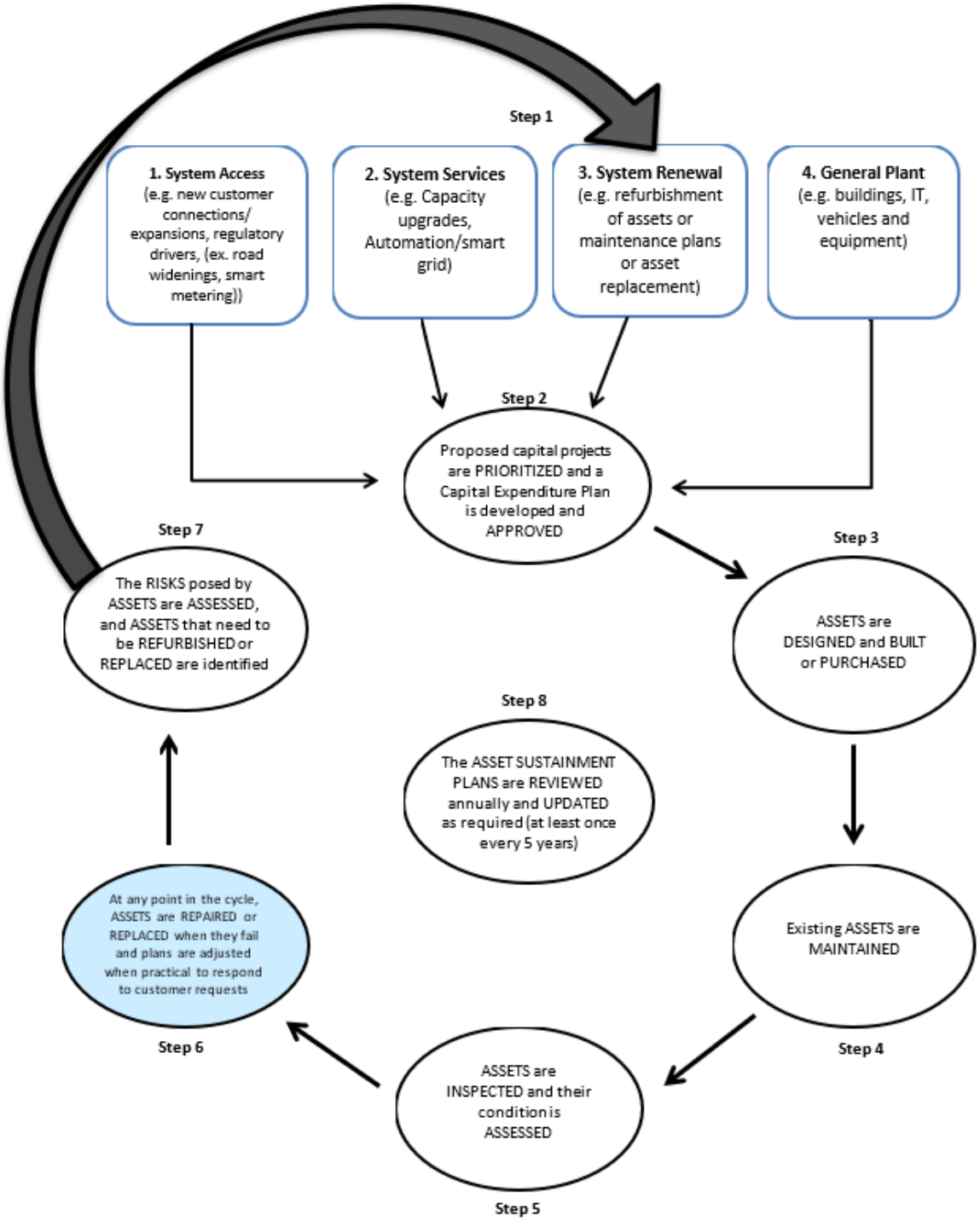
5. The Facilities Manager is responsible for the inspection of all buildings and equipment attached to buildings and meets or exceeds the inspection frequency requirements set out by government regulators and manufacturers (including hoists, cranes, for example). Building inspections are performed within a two-year inspection cycle and capital equipment follows an annual cycle. The inspection of this capital equipment is audited annually by the Joint Health & Safety Committee. The majority of inspections are performed by third party experts and it is the responsibility of the Facilities Manager to arrange for these inspections. Details of all inspections are documented in the report entitled, "Annual Inspection Reports and Certifications." In addition, a database is kept that documents the purchase date of major general plant assets, their specifications and their expected lifespan with a view to planning for replacement. For example, if a roof is expected to last for 25 years, planning or consideration for its replacement will begin in year 20 (unless regular inspections identify the necessity to replace it sooner).
6. In compliance with the Occupational Health and Safety Act, the JH&SC performs monthly workplace inspections and is responsible for inspecting at least one workplace area each month, and each area must be inspected at least once a year. If any hazards are found, the Committee will issue written notification to the Supervisor responsible for the area, who will follow up to resolve the issue.
7. The Supervisors responsible for each area use the information from the inspection audits to determine what work needs to be completed immediately, what work can be scheduled in a timely manner, what work can be deferred until the next inspection or is not required at all, and when the scope of work required needs further Engineering study. All deficiencies that require further study from the Engineering Department are forwarded to the Director of Design. When repairs are made, those who performed the work and the date the work was completed are entered into the database.

   The Manager of E&O Finance and Capital Projects generates a monthly report to track the progress of all of London Hydro's inspection and preventive maintenance programs. Each month the 'Electric System Inspection & Maintenance Audit Report' shows what percentage of each year's scheduled work has been completed to date and tracks in detail the number and status of all the deficiencies found during inspection. If deficiencies are carried over from one year to the next, this too is tracked to ensure that all problems found during inspections are eventually remedied.

   Field staff equipped with tablet computers or mobile devices collect inspection information which is then uploaded into the GIS system for updating. Individual inspection reports are created for every municipal substation, every pad mounted, network and vault transformer and every underground switching enclosure or load center. Pole inspection records have also migrated to digital records but reports for the overhead system are created only when deficiencies are found. The use of the Incident Deficiency Reporting app that the Operations

staff have on their mobile phone facilitates the collection of more detailed information on poles and other equipment.

Step 6


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1. When assets fail, Supervisors work with their staff to determine the cause of the failure and make judgements about whether the failure is routine or requires further investigation. If, during the repair, serious deficiencies or emergent issues are discovered that could affect other similar assets, Supervisors will bring this information to the attention of the Manager of Standards and Generation, the Manager of Engineering System Reliability, and the Manager of Engineering System Planning, who will involve the Engineering Departments and other resources, as required, to develop an action plan. To respond to failed assets, the Manager of Standards and Generation, the Manager of Engineering System Reliability, and the Manager of System Planning will initiate an investigation, often using third party subject matter experts, to analyze the root cause of the failure and determine the corrective action required.

   The Manager of Engineering System Reliability analyzes all of London Hydro's outages on a regular basis and makes note of how long it typically takes to make repairs. If improvements can be made in repair times by modifying response methods or procedures, these suggestions are brought to the attention of the Directors of Operations Engineering and Systems Engineering who convene meetings and revise procedures in the Safe Work Practices Manual as required to ensure that the appropriate practices are in place to keep outages as short as possible.

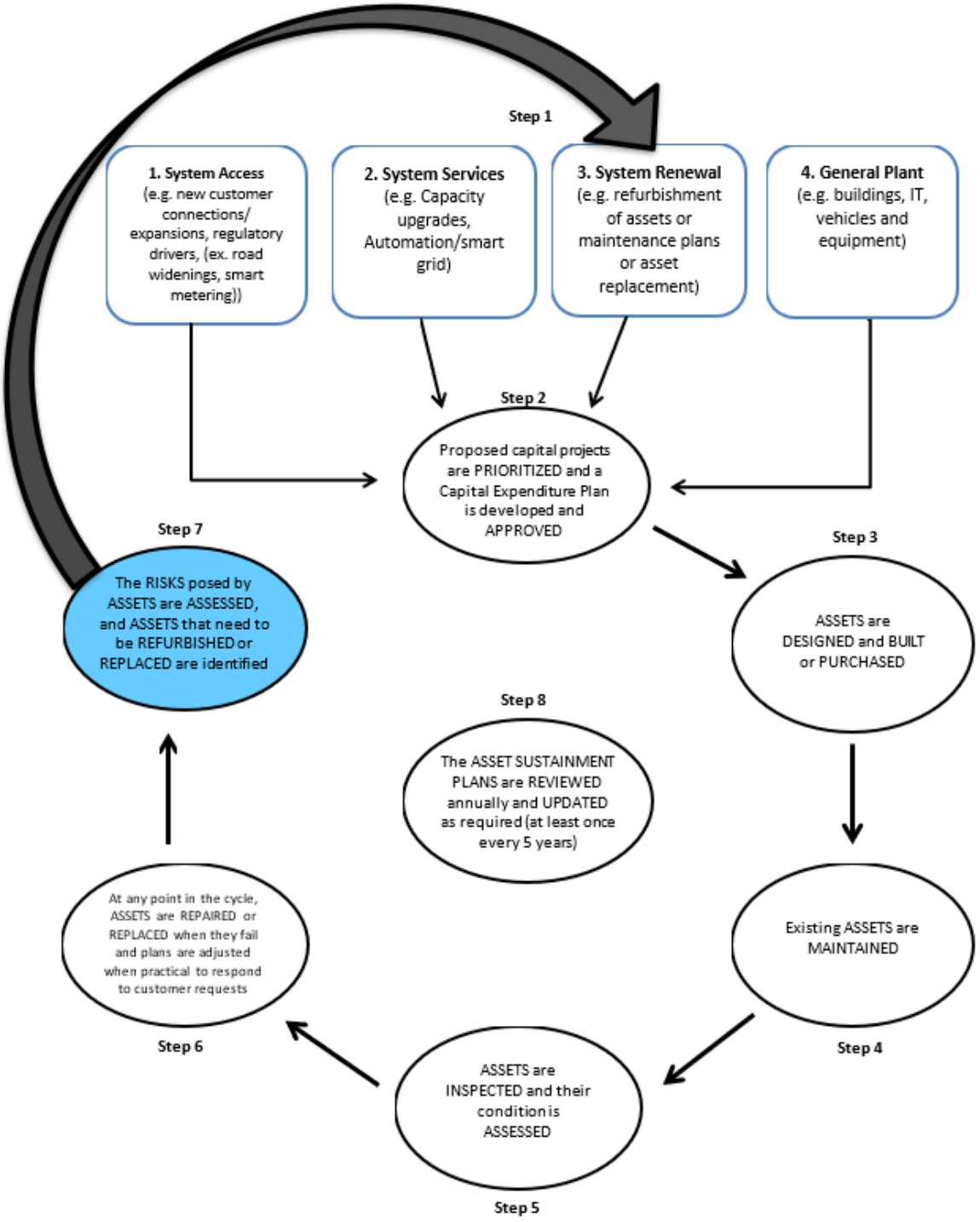
   IT critical systems are designed with redundancy in mind and minimum time replacement, so back-up systems are in place when primary systems fail. For non-critical systems, spare parts are available for IT staff to deploy when required. The Director of Information Systems (Infrastructure & Cyber Security) responds to business system failures immediately first by identifying the reason for the failure and by organizing its remedy, organizing replacements under warranty, when possible. Replacement of systems that fail outside of warranty protection become capital expenses.

   For specialized infrastructure and equipment related to Operations Technology, the Manager of Grid Operations and Technology serves as the primary point of contact for incident response and remediation. Because this technology directly impacts physical grid operations and production environments, response protocols prioritize physical safety, operational continuity, and grid stability. Remediation and parts replacement are coordinated directly with operational staff to minimize disruption. In cases where grid equipment requires proprietary OEM (Original Equipment Manufacturer) servicing or specialized legacy parts, the Manager of Grid Operations and Technology, alongside the Protection & Controls (P&C) department, maintain dedicated vendor support agreements and targeted spare-part inventories. Should a failure present a potential network or cybersecurity risk, the Manager of Grid Operations and Technology will immediately coordinate triage and containment with the Cybersecurity team.

   Occasionally, assets related to the general plant are repaired or replaced as a result of a customer request. In particular, substation buildings, which are located in neighbourhoods throughout the city, have been the subject of customer requests for improved fencing and reduced noise. These concerns are forwarded to the Facilities Manager who is responsible for responding to them and these responses may involve capital expenditures (e.g., replacing a

fence or building a noise wall). (See Appendix C: Complaint about Maintenance Issue – Customer Experience Flowchart)

Step 7


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Managing System Reliability

1. The Directors of Systems Engineering and Operations Engineering are responsible for developing criteria for the refurbishment and/or replacement of assets that pose a risk to customer satisfaction. One way in which the directors plan for the refurbishment or replacement of major assets is by using the new Analytical Ranking Model developed in-house to analyze and rank capital projects. The model looks at five objectives that are regarded as risk factors in various proportions: Reliability, Safety, Environment, Capacity and Efficiency. The average Health Index of various asset categories is incorporated in the model. When evaluating subdivisions in terms of their priority for cable rehabilitation and transformer replacement, multiple factors including safety, performance, operability, outage, risk, and environment are considered. The analysis is primarily based on the cable condition assessment and field testing. It also looks at the impact of faults on subdivisions, the safety risks posed to employees and to the public due to outdated equipment, the potential effects on the environment from leaking transformers, etc. These methods aim for improved system operating conditions and reliability, and from an economic point of view, they optimize spending to address the most imminent scenarios that can lead to reduced performance. Other methods used to determine the need to replace or refurbish major assets include infrared testing on underground and overhead systems, and oil sampling of transformers at substations.

   London Hydro's goal is to be able to represent our reliability performance on maps to the customer level to enable us to identify those customers who experienced the worst reliability over any given period of time. We can then target specific action plans to improve the reliability for individual customers even if London Hydro's overall system reliability is on target. The GIS also allows us to represent all outage cause types geographically and to segregate them by their impact on both individual customers and overall reliability. This information, together with customer feedback, will refine our ability to target asset management spending as efficiently as possible.

2. London Hydro has also improved reliability through its use of IT Cloud-based systems. By synchronizing SAP to our web portal, we have increased the reliability of information received by our customers while also making our on-line service offerings more useful (Time of Use functionality). The Director of Information Systems (Enterprise Systems & Architecture) is responsible for developing the criteria upon which to base decisions about whether to replace or repurposed assets that may cause a risk to reliability.

3. The Director of Design Engineering and Director of Systems Engineering are responsible for using RCM techniques to where and when our maintenance and refurbishment or replacement activities should be targeted. Targeting maintenance and rebuild plans where they will do the most good is the best way to ensure they are efficient and cost effective.

   The Manager of Engineering System Reliability also creates a yearly 'Quality of Supply Report' to summarize the reliability performance (SAIDI and SAIFI) and the factors contributing to those results. Action plans are recommended when appropriate and it is an ongoing objective to prevent the same feeder from appearing repeatedly in the top 10 list. To select the worst performing feeders, London Hydro weighs the feeder performance with the

number of customers affected on that feeder to ensure that even feeders with few customers but many outages get the attention needed despite having little impact on overall system reliability.

4. The System Operations Centre Superintendent updates a database to record the cause and duration of every outage in the electric system. Momentary outages are also recorded. This tracking system is complemented by our SCADA system which also logs all breaker operations. The information generated is forwarded to the Manager of Engineering System Reliability, who uses the information to rank assets that need to be replaced immediately.

5. Reporting to the Manager of Engineering System Reliability, the Reliability Engineering Technologist analyzes all of London Hydro's outages and creates a weekly and monthly "Reliability Summary Report." They also prepare a "Monthly Reliability Performance Overview" that summarizes outages that are considered significant for at least one of the following three factors:
   - the incident posed a threat to safety (i.e., ESA was notified);
   - the incident resulted in an action plan; or
   - the incident had a significant impact on our system.

   Meetings are held with Operations and Engineering staff to discuss performance issues and to develop action plans when required. Failure trends are thereby analyzed and reported on and this information forms one of the resources for the Asset Sustainment Plan.

Assessing Risks to Safety and the Environment

1. The Asset Sustainment Plan report describes how risks to safety, reliability and the environment are assessed for each major asset and how this information is used to develop maintenance, refurbishment and replacement plans.

   Throughout the year, as field staff routinely identify equipment problems that could pose risks to safety or the environment, Operations Supervisors bring these matters to the attention of the respective Managers who in turn inform their respective Directors, who involve the appropriate departments to ensure immediate issues get resolved and non-urgent issues get included for consideration in the following year's budget.

   As a regular feature of safety meetings, Supervisors are responsible for reviewing pertinent sections of the Safe Work Practices Manual with their staff. The purpose of this review is not only to ensure that employees know London Hydro's standard procedures, but also to encourage them to develop better procedures and to identify assets that are either deteriorating or that could pose risks to safety or reliability. As part of its Health and Safety Management System annual audit, the JH&SC confirms that these Safe Work Practice reviews are conducted.

2. In addition, London Hydro has implemented an Environmental Management System (EMS) that serves as a standardized and objective process for evaluating London Hydro's interaction with and impact on the environment. Specifically, the purpose of the EMS is to identify all the activities performed at and by London Hydro that may have an impact on the

environment and to evaluate those impacts with a view to managing, reducing and eliminating them, where possible. When failures occur related to distribution assets and general plant that may have an impact on the environment, an Environmental Occurrence Report is completed and forwarded to the Manager of Health, Safety and Environment who tracks the issues and makes recommendations to mitigate any environmental impact.

3. The responsibility of London Hydro's Joint Health and Safety Committee is to

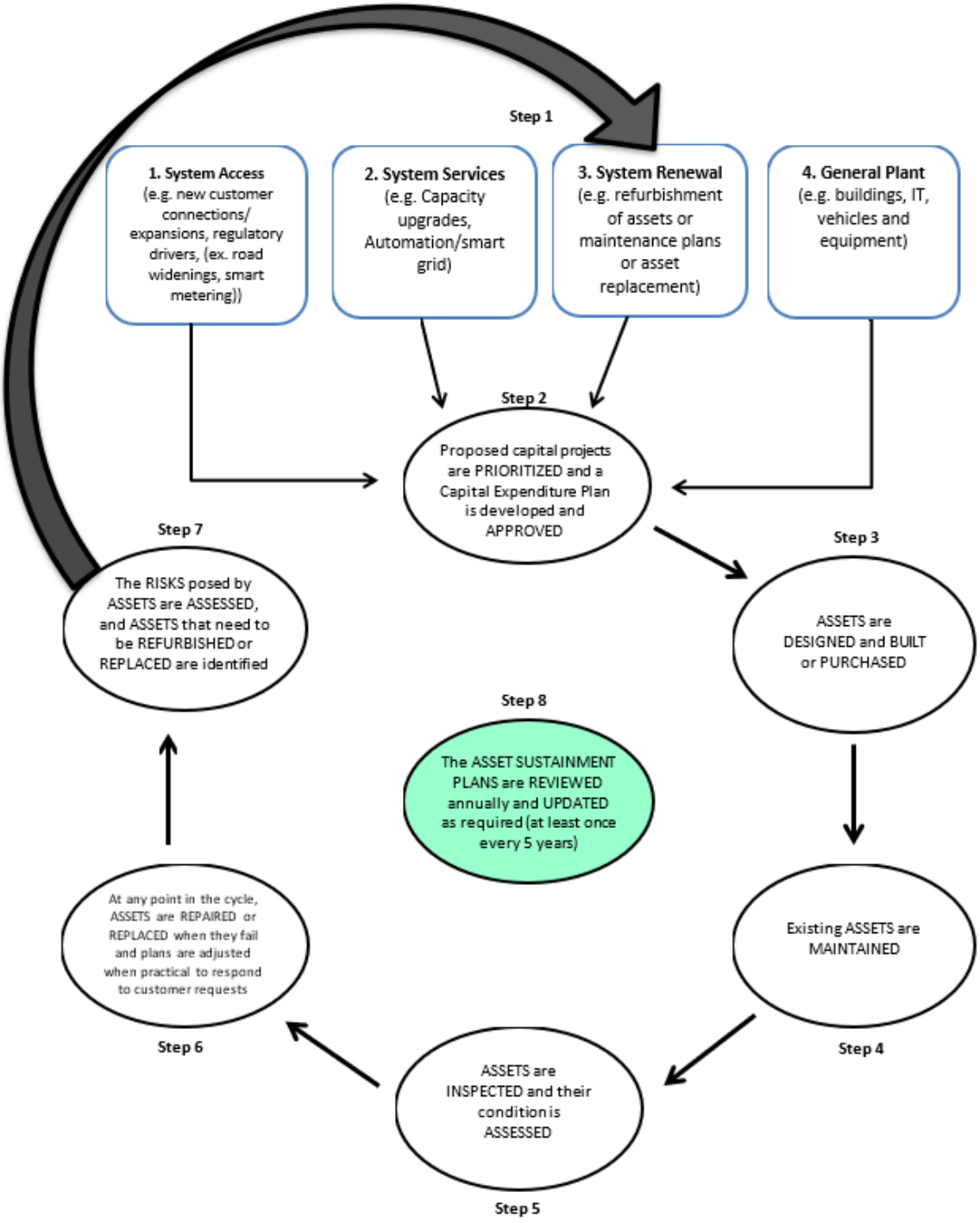
   · Identify unhealthy or unsafe situations at the workplace;
   · Recommend corrective action; and
   · Promote health and safety at London Hydro.

   Two of the methods used to identify hazards includes performing monthly workplace inspections and semi-annual field audits.

4. Supervisors are responsible for taking appropriate action when employees come forward with issues related to assets that pose a threat to the safety of employees, or to the public, or to the environment.

5. All employees are responsible for reporting to their supervisor any perceived safety or environmental hazards related to London Hydro's distribution assets. In accordance with the Occupational Health and Safety Act, all employees are responsible for reporting to their supervisor
   - any known missing or defective equipment or protective device that may be dangerous to any worker [section 28(1)(c)];
   - any known workplace hazard [section 28(1)(d)]; and
   - any known contravention of the Act or regulations [section 28(1)(d)].

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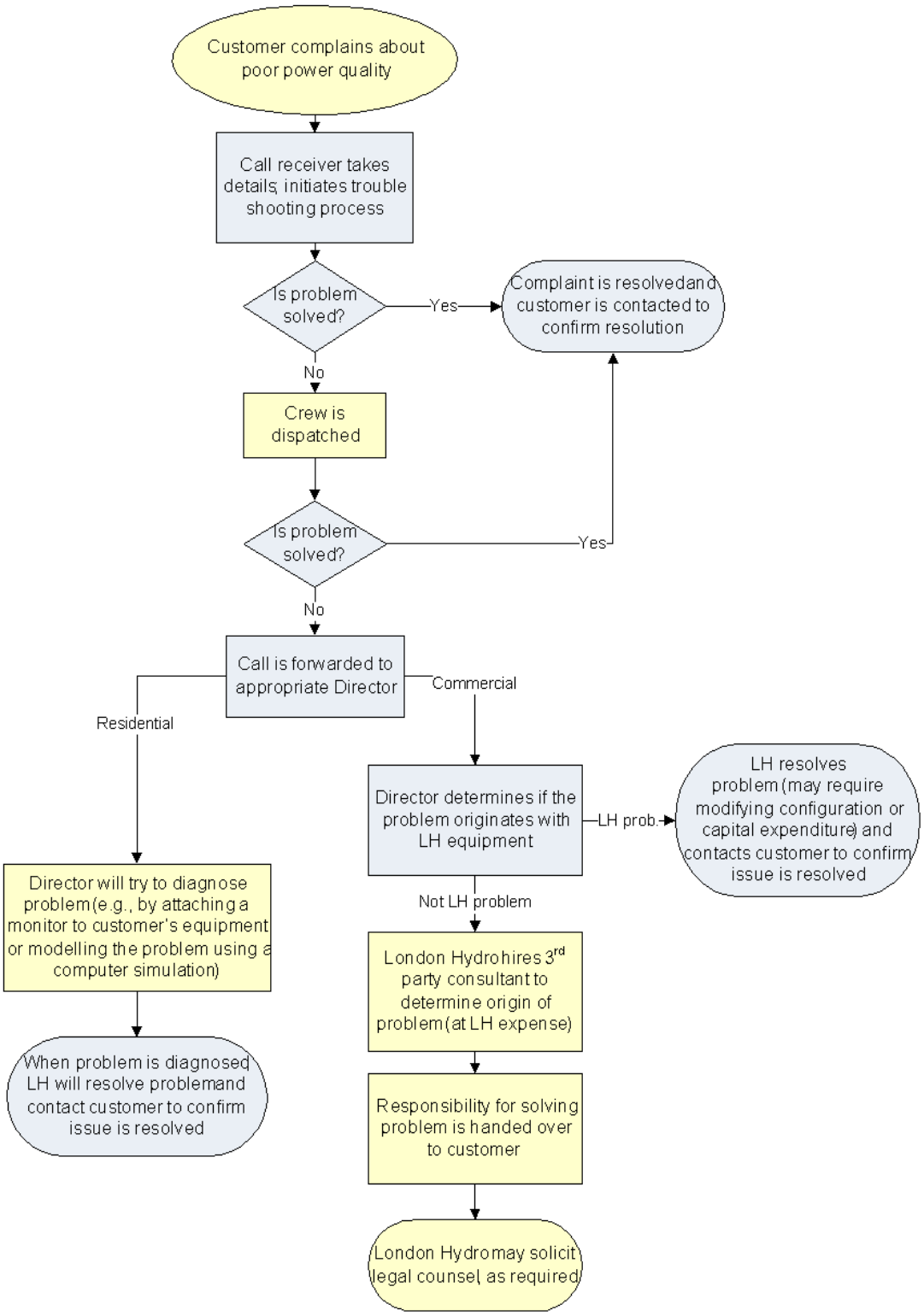
Asset Management Review

1. The VP Operations & Planning and the VP of IT and CIO ensure that the Asset Sustainment Plans are reviewed annually and updated as required (at least once every 5 years), and confirm that they continue to meet London Hydro's Strategic Objectives and that all of the processes and procedures described in them are followed.

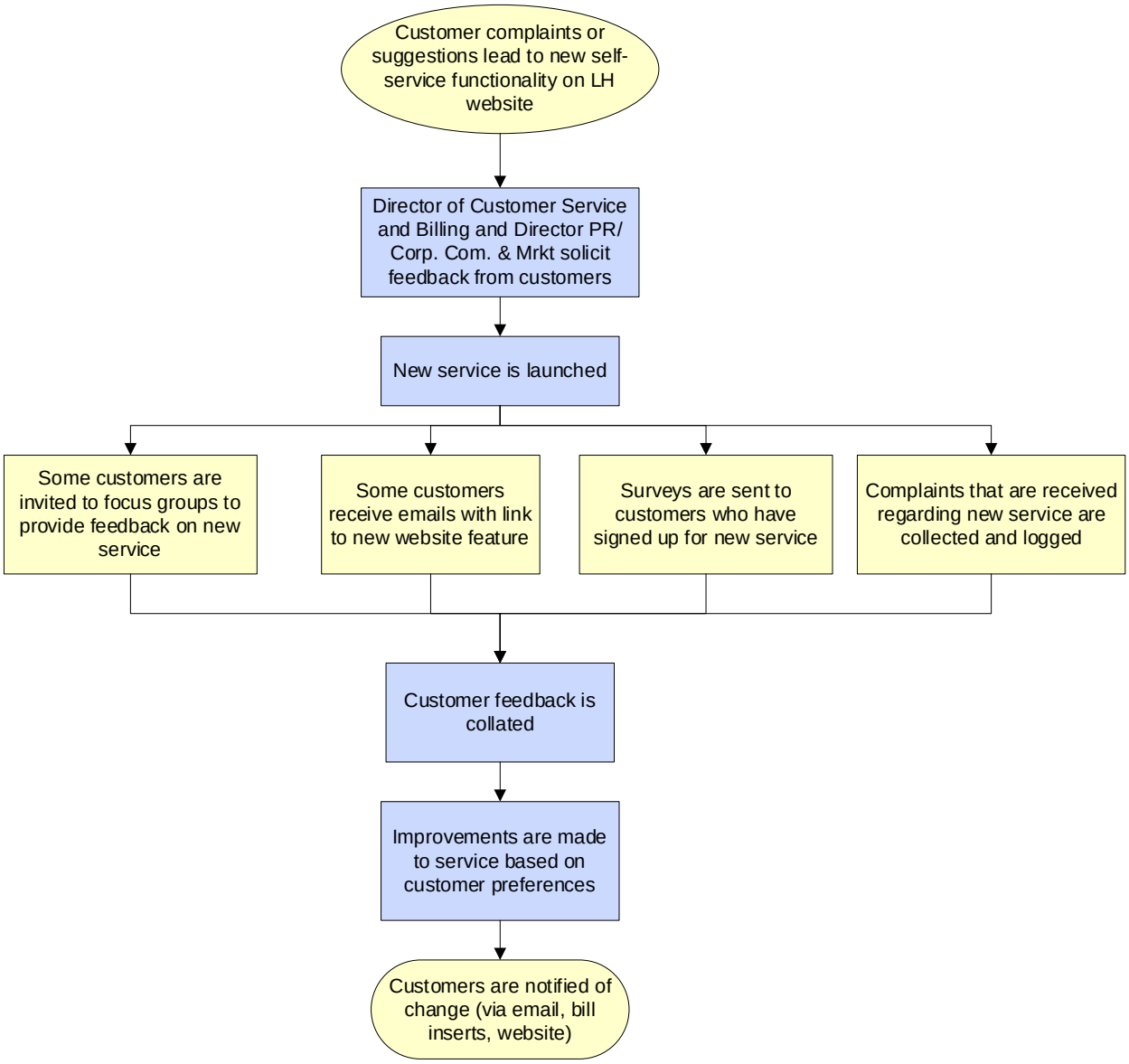
   The Asset Sustainment Plan report is distributed to all Engineering and Operations management staff after each review to ensure that information relating to the age and condition and the associated assessment of risk for each asset is transparently communicated throughout the organization.

Appendices

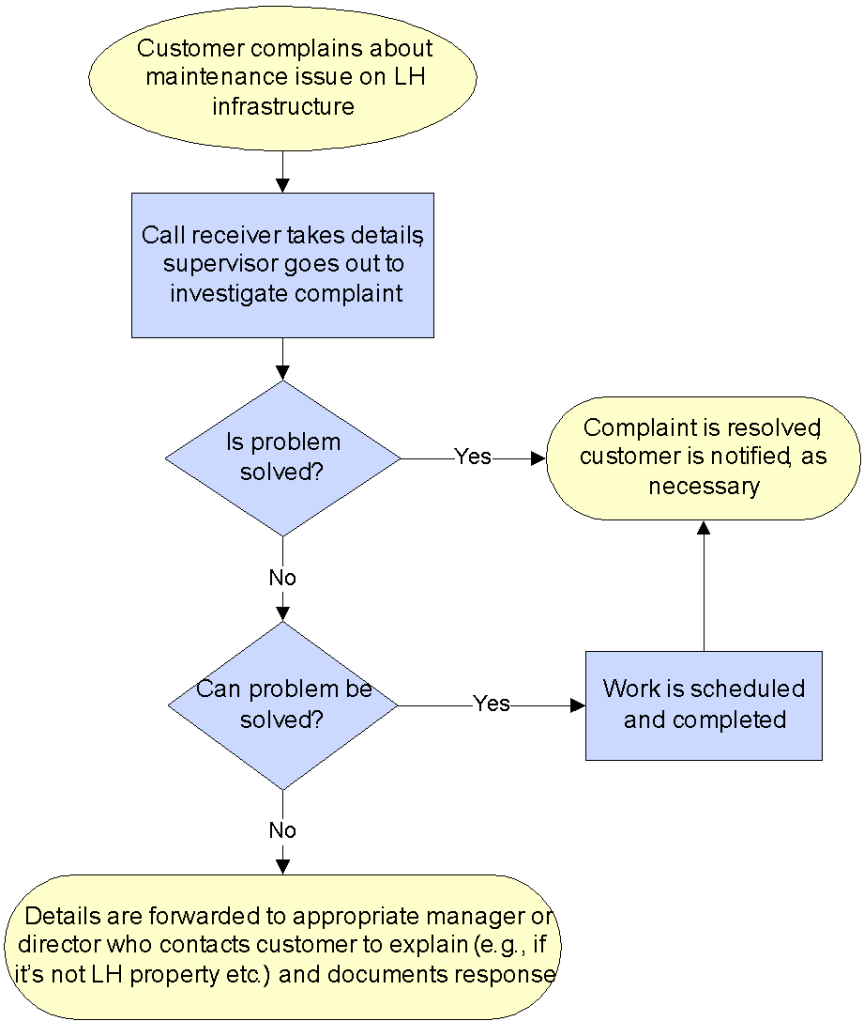
Appendix A: Power Quality Complaint – Customer Experience (System Service)



Appendix B: Website Functionality Improvement – Customer Experience



Appendix C: Maintenance Issue* Complaint – Customer Experience



* Examples of a non-urgent maintenance issue would be lawn needs cutting at substation; paint is peeling on transformer etc.

Appendix D: Analytical Ranking Model

Project Related Risk Indexed by Asset Health
An Analytical Ranking Model for
Infrastructure Capital Projects

Many years ago, London Hydro's engineers created the first analytical Reliability and Safety Correlation model to prioritize investments focused on improving system reliability and safety. The narrow focus on those two factors became limiting as corporate objectives expanded, prompting the need for a more advanced methodology. Project prioritization must also consider asset health, with System Renewal supporting the timely refurbishment or replacement of aging assets to sustain service quality, and System Service addressing capacity, reliability, and broader grid modernization needs.

This paper describes a new, more enhanced model that permits an objective comparison of infrastructure related capital projects based on a multitude of objectives. In addition, the average Health Index of each asset class is incorporated in the calculations such that the projects gain more priority the more the asset class shows degradation. When defining new capital programs, five improvement objectives are accounted for due to the significance of their associated risks: *Reliability, Safety, Environment, Capacity and Efficiency.*

The challenge that is being faced is achieving the right mix of improving *Reliability* and increasing *Safety*, while being aware of adverse effects on the *Environment* from outdated, prone-to-failure infrastructure, as well as added benefits to the distribution system, such as *Capacity* and *Efficiency* gains. To that extent, a percentage can be attributed to each of the objectives as risk factors to the overall system operation. Their defined contribution is depicted in the graph below and it was determined through consultation with customers, the shareholder and London Hydro staff.

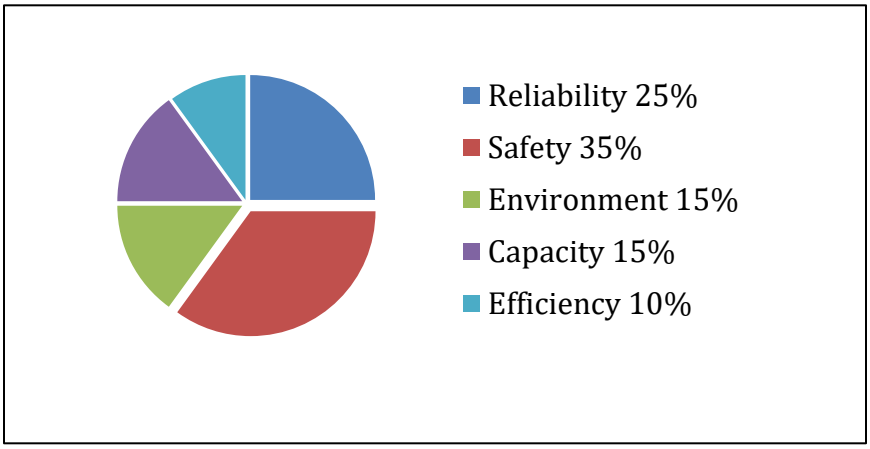


Figure 1, Asset Management Improvement Objectives Mix

London Hydro completes an Asset Condition Assessment every five years. In this assessment we analyze and evaluate the asset classes London Hydro owns, operates and maintains, which include electrical as well as civil infrastructure (i.e. poles, structures). The Asset Condition Assessment report focuses on quantifying the age and condition of each asset and calculating a Health Index that reflects how close the respective asset is to its end of life. A 100% score means that the asset has full lifetime remaining, while a lower percentage score indicates how much of the asset lifetime is left on average.

London Hydro's Capital Expenditures Plan has, for decades, grouped the engineering capital projects into sections. These sections are listed below (Table 1) and they represent all groups of projects under the four OEB categories: System Access, System Renewal, System Service and General Plant:

Table 1, Sections of Capital Projects (less General Plant)

A – Substation Rebuilds	E – Projects Resulting from Developer Works
B – Subdivision Rebuilds	F – Network
C – Main Feeders	G – Overhead Line Works
D – Projects Resulting from City Works	H – Automation
AA – Transformer Station	CC – Renewable Energy Capacity

As a distributor, London Hydro has an obligation to maintain sufficient supply capacity to connect customers and accommodate forecast growth. Accordingly, projects required to address material supply capacity constraints identified through Regional Planning or London Hydro's local system planning processes – such as the construction of a new municipal transformer station or substation – are excluded from the normal project ranking process. These investments are driven by the need to maintain adequate capacity to fulfill connection obligations and cannot reasonably be deferred based solely on their relative ranking against other infrastructure needs.

Similarly, City and Developer Works are excluded from the ranking process because they are driven by external requirements and must be undertaken by London Hydro as required. These projects include connecting new customers, extending the distribution system to serve new developments, and relocating distribution assets to accommodate municipal or provincial road, water, sewer, and other infrastructure programs. Applicable legislation, regulations, codes, and other regulatory requirements establish these activities as part of London Hydro's regulated distribution responsibilities.

Accordingly, the project ranking methodology presented herein is applied to infrastructure investments for which London Hydro has discretion to prioritize the relative timing and level of investment. This includes the projects within Sections A, B, C, F, G, and H.

The prioritization process follows a multi-step approach.

Firstly, an Average Health Index is calculated for each asset category (i.e. transformers, switchgear, poles, etc.) based on the individual Health Indices of each asset. This produces a quantifiable evaluation of the general condition of each asset category. Since projects in each section involve multiple categories of assets, a matrix is constructed identifying the specific group of asset categories that is affected by projects in that section. For example, the Substation Rebuilds section projects are driven by the condition of three main asset categories: the Station Transformers, the Station Switchgear and the Batteries. Furthermore, the representation of each asset category is weighted section by section accordingly, using engineering judgement of affiliated risks. In this case, the Station Transformers condition poses a higher risk to the operation of a substation than does the Switchgear or the Batteries. An appropriate weighting division is:

Substation Transformers: 0.6 Station Switchgear: 0.3 Batteries: 0.1

With the represented asset categories identified and the appropriate weighting system in place, a Weighted Blended Health Index (WBHI) is calculated for each project section. An illustration of the computed WBHI is provided in Table 3.

The assignment of the WBHI by section permits projects in different sections to compete in priority due to the condition of the asset categories involved. Thus, the average asset Health Index can be further incorporated into the algorithm of prioritizing projects according to the five improvement objectives formulated earlier.

Each project is next being evaluated in terms of risk factors, and a score of 1 to 10 is assigned under each of the five objectives. A comprehensive list of guidelines was established so that the score assignment is done in the most objective way, thus preventing certain projects to gain bias over the others. The guidelines for the score assignment are presented in Table 4. The score assignment is reviewed by a team of engineering and operations experts to ensure a consistent and un-biased result.

An example of a project (B2) is considered for illustration in the Subdivision Rebuild section. The project involves the replacement of underground primary cables and transformers at the end of life. Below is a summary of how scores are assigned according to the guidelines:

Reliability – A large improvement in reliability would be provided by eliminating the risk of cable failures which supply power to large numbers of residential customers and can lead to lengthy interruptions to very many people from one outage; therefore, a score of 6 was given under this improvement objective

Safety – Some subdivisions still deploy a limited number of live-front transformers which can pose a risk of live contact so a small score of 2 was assigned in this case

Environment – No environmental impact is avoided by this project so the score for this improvement objective is 1

Capacity – Capacity can slightly be improved when larger size conductors are used to allow for customer load growth due to electrification, therefore granting a score of 4 under this objective

Efficiency – Efficiency is also moderately improved when newer style dual load-break switches are utilized in transformers for operational flexibility so a score of 4 is also assigned to this objective

Table 2, Project Scores

	Reliability	Safety	Environment	Capacity	Efficiency
Objective %	25%	35%	15%	15%	10%
Scores (B2)	6	2	1	4	4

Once the scores are assigned to each project, the percentage contribution of each objective is used to tally the total scores by project. The Weighted Blended Health Index of the project section is then used as a divisor to obtain the highest ranking for the project that has the highest score and the lowest average Health Index. Figure 2 shows the overall ranking for all the capital projects that were ranked following this methodology from the highest to the lowest.

Table 3, Health Index by Asset Category and Project Sections

Health Index (%) by Asset Category (Asset Condition Assessment)		1 Poles	2 Station Transformers	3 Station Switchgear	4 Batteries	5 Pole-mounted Transformers	6 Step-down Transformers	7 Pad-mounted Transformers	8 Network Transformers	9 Network Protectors	10 Vault Transformers	11 Distribution Switchgear	12 Overhead Switches	13 Overhead Reclosers	14 Civil Structures	15 Underground Cables		Weighted Blended Health Index (WBHI)
		HI-1	HI-2	HI-3	HI-4	HI-5	HI-6	HI-7	HI-8	HI-9	HI-10	HI-11	HI-12	HI-13	HI-14	HI-15		
Sections																		
A	**Substation Rebuilds**		HI-2	HI-3	HI-4													WBHI - A (%)
	weighting		*w*	*w*	*w*													
B	**Subdivision Rebuilds**							HI-7			HI-10	HI-11				HI-15		WBHI - B (%)
	weighting							*w*			*w*	*w*				*w*		
C	**Main Feeders - Overhead**	HI-1				HI-5							HI-12					WBHI - C/OH (%)
	weighting	*w*				*w*							*w*					
	Main Feeders - Underground														*HI-14*	*HI-15*	Σ(HI% x w)	WBHI - C/UG (%)
	weighting														*w*	*w*		
F	**Network**								HI-8	HI-9					HI-14	HI-15		WBHI - F (%)
	weighting								*w*	*w*					*w*	*w*		
G	**Overhead Line Works**	HI-1				HI-5	HI-6						HI-12					WBHI - G (%)
	weighting	*w*				*w*	*w*						*w*					
H	**Automation**												HI-12	HI-13				WBHI - H (%)
	weighting												*w*	*w*				

Table 4, Guidelines for Score Assignment

Scores	Impact ranges	Reliability	Safety	Environment	Capacity	Efficiency
8-10	**Extreme impact**	**outage risk system wide (TS out/sections of the city)**	**fire, burns, hot spills, electric arc**	**high to extreme volume/toxicity and/or continuous occurrence and/or prompt action has no effect**	**added capacity to system (e.g., new feeder)**	**restoration or system operation or increased efficiency are always directly improved by the project**
5-7	**Large impact**	**outage risk feeder(s) related/thousands of customers**	**potential fire, burns, hot spills, electric arc**	**moderate volume/toxicity and/or occasional occurrence and/or action will prevent further impact**	**released overloaded existing supply**	**restoration or system operation or increased efficiency are indirectly improved by the project**
2-4	**Moderate impact**	**outage risk sub-system (riser)/hundreds of customers**	**perceived safety threat due to exposure**	**low volume/toxicity and/or seldom occurrence and/or prompt action will reverse impact**	**increased options of supply/redundancy**	**project may benefit restoration or system operation or increased efficiency**
1	**Low impact**	**outage risk local (1-2 Tx) / several customers**	**minimum to no safety risk**	**no impact, unlikelihood of occurrence, prevent action exists**	**no additional capacity**	**no improved system efficiency**

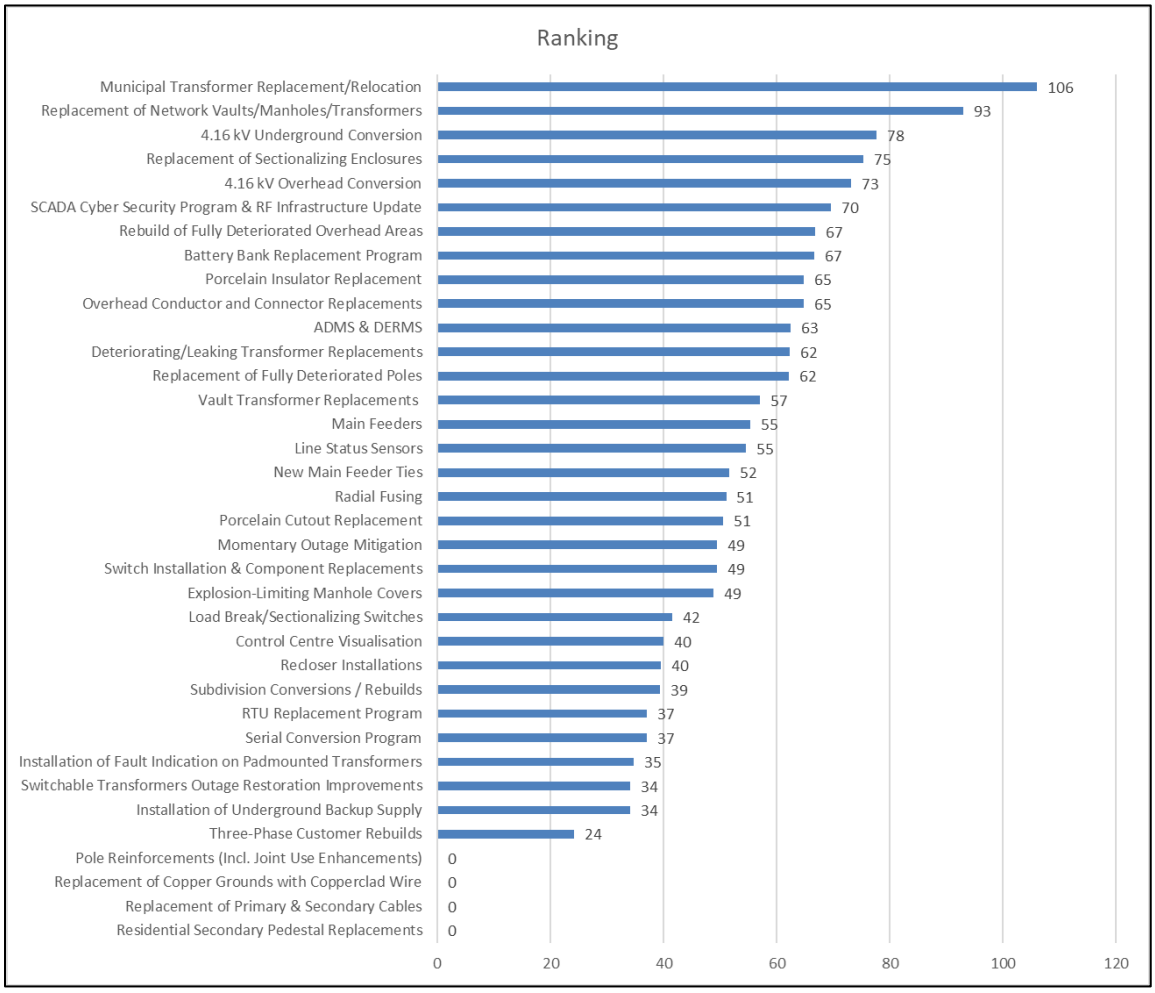


Figure 2, Project Overall Ranking

It should be noted that projects with a score of "0" were intentionally omitted from the ranking process, as they are governed exclusively by essential safety obligations that supersede all other criteria.

This analytical ranking model was developed to aid in the prioritization of capital projects. It uses an objective methodology of determining simultaneously which assets pose the highest failure risk due to degradation, and which projects support the five established objectives to a higher degree. The prioritization should be illustrative of the priorities London Hydro should be taking on behalf of customers.

London Hydro

APPENDIX F

IT Asset Management Framework (ITAM)

London Hydro

IT Asset Management Framework

August 2026

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1 IT ASSET MANAGEMENT FRAMEWORK

London Hydro acknowledges that its ITAM maturity is currently in a developing state. London Hydro is currently formalizing lifecycle planning practices to support a consistent and transparent approach to IT sustainment and risk mitigation. This IT Asset Management (ITAM) Framework outlines London Hydro's path.

1.1 PURPOSE AND SCOPE

The purpose of this IT Asset Management (ITAM) Framework is to outline how London Hydro manages the lifecycle of its IT and digital assets. The framework supports risk-based and evidence-based investment decisions by linking IT lifecycle needs to service reliability, cybersecurity, regulatory compliance, and cost predictability.

As the electricity distribution business becomes increasingly dependent on digital systems and data, London Hydro's IT assets are required to remain secure, supportable, and fit for purpose. This framework provides a structured basis to identify lifecycle triggers, prioritize mitigation actions, and plan capital and OM&A requirements in a manner that is proportionate to the size and maturity of the organization.

As shown on Figure 1, London Hydro manages IT assets through a defined lifecycle that includes planning, developing or acquiring, integrating, maintaining or upgrading, and retiring assets. This lifecycle approach helps ensure that IT assets remain secure, supportable, and fit for purpose over time. It also provides a consistent basis to identify lifecycle needs, assess risk, and determine when assets should be refreshed, upgraded, or retired.



Figure 1. IT Asset Lifecycle Management

This ITAM Framework applies to IT and digital assets under the governance of London Hydro's IT function, including:

- Core infrastructure: data center compute, storage, and corporate network equipment.
- Software and applications: enterprise platforms (e.g., SAP, JD Edwards), operational systems (e.g., OMS, GIS), cloud-based services (SaaS/IaaS), and AMI and meter data management applications managed by IT.
- End-user computing: workstations, mobile devices, and field technology.
- Cybersecurity assets: security monitoring, identity and access, perimeter and endpoint protections.
- IT/OT interface assets: infrastructure and security layers that enable secure integration between corporate IT and operational environments.

The framework does not include physical grid assets, physical metering devices, or pure OT field/edge devices (e.g., SCADA sensors and telemetry end devices), which are managed under separate operational asset and control frameworks.

The ITAM aligns with the five-year regulatory planning window, while acknowledging that IT asset lifecycles vary significantly - ranging from 3-5 years for end-user hardware to 10+ years for major enterprise platforms.

1.2 Corporate Alignment

IT asset management is driven by the following corporate pillars:

- **Building for the Future**

  IT assets provide the essential data backbone for grid modernization, the implementation of Advanced Distribution Management Systems (ADMS), and the integration of Distributed Energy Resources (DERs).

- **Pursuing Operational Excellence**

  ITAM operationalizes the corporate mandate to strengthen risk management and cybersecurity. It ensures digital assets are secure, available, and optimized to reduce manual intervention.

- **Creating and Communicating Value**

  London Hydro's IT investment approach takes a "Cloud Value" strategy. Cloud assets are adopted only when they offer a superior Total Cost of Ownership or capabilities that are unavailable on-premise.

1.3 IT Assets overview

London Hydro's IT assets provide the digital foundation for utility operations, supporting the Company's workforce, service providers, and core business functions. The portfolio includes physical hardware (e.g., servers and endpoints), software (commercial and custom-based applications), and cybersecurity.

IT Asset Management Framework

For planning and governance purposes, London Hydro organizes its major systems in its IT landscape into four functional domains to support lifecycle planning, risk identification, and portfolio prioritization (shown in Figure 2).

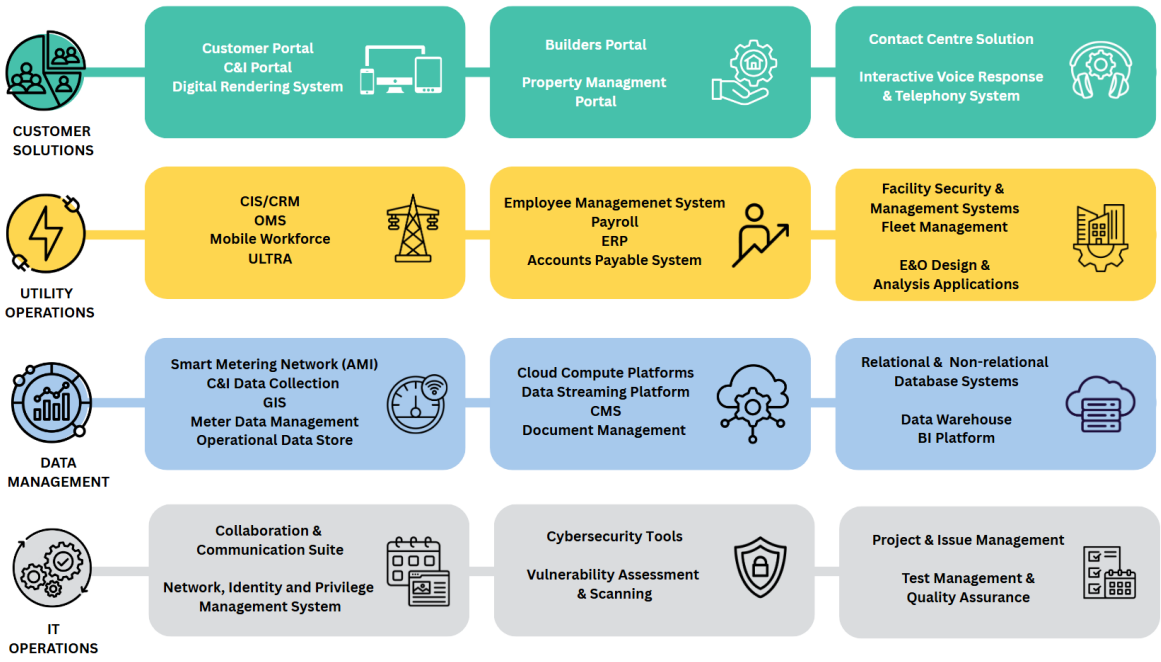


Figure 2. IT Landscape

Customer Applications provide the digital interface for customer engagement, offering self-service capabilities and communication channels. This features targeted portals for customers, property managers, and builders, as well as the Green Button platform for standardized data exchange. Integrated contact center solutions and interactive voice response (IVR) systems further support seamless customer service interactions.

Utility Operations houses the core transactional systems essential for daily utility management, including the "Meter-to-Cash" cycle and workforce administration. Key applications include the CIS/CRM for billing, ERP for financial and supply chain management, outage management system (OMS) and mobile workforce coordination. It also supports human capital functions through systems for payroll, time and attendance, and employee lifecycle management.

Data Management serves as the foundational data layer. This domain is responsible for the ingestion, storage, and visualization of grid and corporate data. It includes the Smart Metering Network (AMI) and Meter Data Management (MDM) systems for collecting meter data, geographic information system (GIS) and data warehousing platforms (relational, non-relational, and cloud compute) that drive business intelligence, customer engagement solutions and analytics.

IT Operations Focused on the security and stability of the technology environment. This domain includes tools for managing the IT lifecycle, support desk and defending the enterprise.

It encompasses platforms for Security Information and Event Management (SIEM), vulnerability scanning, and identity management, as well as suites for workforce collaboration, project management, and quality assurance to ensure efficient and secure delivery of IT services and related support.

1.4 IT Asset Management Approach

London Hydro applies a fit-for-purpose ITAM approach that reflects the shorter lifecycles and different risk characteristics of IT assets compared to traditional grid infrastructure. The framework is designed to be practical and scalable, with progressive improvement over the planning horizon.

The ITAM framework is designed to achieve four objectives:

1. **Reliability**: maintain availability of utility-critical systems to minimize operational disruption and customer impacts.
2. **Cost predictability**: apply defined lifecycle refresh practices to reduce unmanaged obsolescence and smooth expenditure requirements where feasible.
3. **Compliance and supportability**: maintain assets in a vendor-supported state and reduce exposure to unpatchable vulnerabilities.
4. **Prudence**: demonstrate that expenditures are linked to defined lifecycle triggers, service needs, or risk mitigation.

To achieve these objectives, London Hydro structures its ITAM around four core components: Lifecycle Strategy, Governance, Investment Categorization, and Continuous Improvement.

Table 1: ITAM Framework Components

ITAM Framework component	Description
Lifecycle Strategy	IT Assets are managed through five stages: Plan (Business Case), Acquire (Procurement), Integration (Configuration/Testing), Operate/Maintain (Patching/Monitoring), and Dispose (Secure Decommissioning)
Governance and Oversight	IT asset decisions are integrated into the corporate governance structure: • Board of Directors/Risk Committee: reviews top enterprise risks (including IT) and approves the high-level ERM framework. • Executive Leadership Team: acts as the steering body for major IT capital investments, reviews business cases and ensures alignment with corporate strategy. • IT Management: Responsible for the daily execution and operations.

Investment Portfolio Categorization	IT investments are classified into three distinct portfolios: • Sustainment and Compliance – non-discretionary investments required to maintain current operations and security. • System Enhancements – discretionary investments that improve efficiency or capabilities. • Strategic – discretionary investments that fundamentally change business models
Continuous Improvement	London Hydro treats IT asset management as an ongoing cycle of monitoring, evaluation, and improvement. Performance, risks, costs, lifecycle outcomes, and changing business requirements are regularly reviewed to identify opportunities to improve IT asset performance and management practices. Lessons learned and performance measures inform adjustments to policies, investment priorities, and lifecycle strategies, with ITAM practices continually evolving to support business needs and manage risk.

1.5 1.5 PLANNING CONSIDERATIONS

IT investment planning is guided by four strategic considerations:

1. **Customer Focus**

   Customer-facing IT investments are prioritized where they improve service accessibility and usability, enable self-service transactions, and support timely outage communications, consistent with customer service expectations and efficient service delivery. Planned investments focus on the "Digital Customer Layer" to reduce transaction friction and enable "Customer Co-Creation" of digital tools.

2. **Operational Efficiency**

   London Hydro prioritizes investments that improve business efficiency and performance, reduce manual effort, strengthen work management, support field and workforce productivity, and lower operational burden through standardization, automation and consolidation. This includes investments that improve dispatch, field execution, inspections, and reporting workflows, as well as data quality, integration across systems, the reduction of “technical debt”, and sustainment complexity over time. Technical debt refers to the future cost incurred when faster or simpler solutions are chosen over more robust approaches, often leading to additional rework and higher costs over time. Deployment choices (including cloud versus on-premise) are made based on demonstrated lifecycle value, security requirements, resilience, integration complexity, and total cost over the planning horizon.

3. **Regulatory Requirements and Compliance**

   Compliance represents a non-discretionary baseline. Investments are prioritized to address material compliance obligations and to manage cybersecurity risk consistent with applicable OEB requirements and internal risk tolerance.

4. **Grid Modernization**

   As the grid digitizes, IT assets become integral to operations. IT investments focus on IT/OT convergence, ensuring the secure transport of data from smart meters and sensors to control systems. This includes preparing the data governance, data architecture and integration layer required for ADMS and AMI implementation.

2 IT ASSETS

London Hydro's IT asset portfolio includes hardware (infrastructure and endpoints), software (operational, enterprise and customer engagement applications), and cybersecurity platforms. For IT asset planning and control, London Hydro manages these assets as asset pools with applicable standards, lifecycle triggers, and renewal practices that are aligned to operational criticality, vendor supportability, cybersecurity requirements, and total cost of ownership.

This section summarizes London Hydro's asset strategies and standards for the key IT asset classes used to support utility operations and customer service.

2.1 IT HARDWARE STRATEGY AND STANDARDS

London Hydro's hardware strategy is to maintain a standardized and secure infrastructure that is supportable over the planning horizon and capable of meeting grid and business availability requirements, while minimizing avoidable lifecycle costs.

Hardware investments are driven by two non-discretionary triggers:

a) Vendor supportability – ensuring hardware remains within vendor support windows to receive critical security patches.
b) Capacity and performance – ensuring infrastructure can handle the increasing volume of grid and smart meter data.

2.1.1 Asset Categories

London Hydro segments its IT hardware portfolio into distinct asset pools to support lifecycle planning and risk management.

Table 2: Hardware Asset Types

Hardware Asset Pools	Description	Purpose
Core network	Connectivity assets, including routers, switches, wireless infrastructure, and security appliances that link offices, substations, and field environments.	The connectivity backbone across corporate, operational, and field environments. It is treated as high criticality because failures can disrupt communications, cybersecurity controls, and access to core business systems.
Compute and storage	Server, virtualization, and storage infrastructure that hosts applications, data platforms, and related services.	The hosting and storage foundation for business and operational applications. London Hydro's approach reflects a balance between on-premise infrastructure and cloud services based on supportability, resilience, security, and lifecycle value.

End user computing	Workstations, laptops, ruggedized field devices, mobile phones, and related peripherals used by office and field staff.	To equip employees and field crews with standardized, secure devices required for service delivery. This pool is managed to balance usability and productivity with cybersecurity, supportability, and consistent device lifecycle management.

2.1.2 Standards Description

London Hydro applies standard approaches and lifecycle management practices for hardware assets from acquisition through decommissioning to reduce operational complexity, manage OM&A, and maintain a consistent cyber posture for systems supporting customer service and grid operations. These practices are reviewed periodically and are informed by vendor specifications (including support windows), incident experience, and industry good practice.

Hardware standards are based on the following principles:

1. **Standardization and homogeneity**

   London Hydro maintains a set of enterprise-grade hardware standards and configurations for each asset pool (network/security, compute/storage, and end-user computing). Standardization reduces spare part variety, improves recoverability, and enhances consistency in patching, monitoring, and configuration management. Non-standard deployments are managed as exceptions and are limited to cases where required for interoperability, cybersecurity, or supply-chain risk mitigation.

2. **Criticality and resiliency design**

   Hardware resiliency requirements are scaled to operational criticality:

   - Corporate, grid and customer-critical services are designed to avoid single points of failure, such that a single component failure does not result in a service interruption.
   - Other non-critical services are designed for standard availability with defined recovery procedures, balancing service expectations and cost.

3. **Cybersecurity and supportability requirements**

   Hardware and software standards require that assets remain in a vendor-supported state and provide capabilities necessary to implement modern security controls (e.g., secure configuration, encryption support, and segmentation). This approach supports London Hydro's obligation to maintain prudent protection of customer and operational data and to manage cyber risk consistent with evolving sector expectations and applicable requirements.

2.1.3 Performance and Risks

As grid and customer processes become increasingly digital, the principal drivers of investment in hardware are maintaining vendor supportability and ensuring sufficient capacity and resilience

for critical services. In planning hardware investments, London Hydro considers not only current requirements, but also expected business, data, and system needs at the time the asset approaches end of life.

The primary risk themes are:

- **Obsolescence and end-of-support exposure**: assets operating outside vendor support cannot receive patches or manufacturer support, increasing the likelihood and consequence of cyber vulnerabilities and prolonged outages.
- **Capacity and performance constraints**: growth in data volumes, users, and application requirements can increase compute, storage, and network demand and compress recovery windows. Accordingly, hardware planning considers expected future capacity requirements over the service life of the asset, rather than only current demand.
- **Procurement timing and replacement planning**: replacements are generally planned in advance of end-of-support to support orderly implementation, avoid unnecessary operational risk, and allow sufficient time for procurement, configuration, and deployment.

2.1.4 Lifecycle Management

London Hydro applies a risk-based refresh approach. Assets are replaced based on operational risk and vendor supportability.

Target service life bands (subject to vendor supportability and risk):

- **End-user devices**: generally 3 years.
- **Servers, storage, and active network/security infrastructure**: generally 5 years, or aligned to vendor support windows, with longer retention only where supported and demonstrably low risk.

Where practical, London Hydro structures refresh needs into annual programs to reduce expenditure volatility and maintain more predictable lifecycle funding requirements.

Retired assets are securely sanitized prior to disposal and removed from the asset register to maintain accurate asset information for planning and compliance

2.2 IT Software Strategy and Standards

London Hydro manages a portfolio of enterprise and operational software applications that enable core customer, financial, and grid-related business processes. These applications must remain supported, secure, and integrated to sustain safe operations, protect customer information, and provide accurate billing and settlement.

Software investment decisions are driven by business criticality, cybersecurity and data security, vendor support windows, maintainability, and total cost of ownership. London Hydro seeks to limit avoidable technical debt and unnecessary customization costs, while maintaining stable and supportable meter-to-cash and operational processes.

2.2.1 Software Categories

London Hydro classifies applications by operational criticality to determine support requirements, upgrade prioritization, and investment focus.

Table 3: Software Category Definition

Software Category	Description	Applications example
Mission Critical	Systems where failure materially impacts public safety, grid operation, revenue enablement and reporting. The applications are assigned the highest service expectations and prioritized for sustainment and supportability.	ERP CIS OMS Metering Infrastructure Contact Center
Business Critical	Systems that support essential corporate functions with defined recovery objectives, but that do not typically present immediate system safety or revenue risk during short outages.	GIS HRIS Time and Attendance ULTRA
Departmental Applications	Systems that support specialized business functions or domain-specific operational needs within particular teams or user groups. These applications are maintained where they provide necessary functionality, analytical capability, or operational support that is not otherwise provided through enterprise platforms.	CYME GeoTab Spidacalc

Applications may be implemented on-premise, cloud-hosted, or SaaS. London Hydro evaluates on-premise versus cloud options using criteria including business criticality, data and cybersecurity considerations, vendor maintenance windows, operational flexibility (e.g., maintenance scheduling), ability to scale up or down, disaster recovery, monitoring of utilization, and total cost of ownership.

2.2.2 Standards and Practices

London Hydro applies architectural and operational standards to limit application sprawl and ensure interoperability:

- **Commercial-Off-The-Shelf (COTS) preference with controlled configuration**

  London Hydro prioritizes proven commercial solutions to retain vendor supportability and reduce sustainment burden. Custom development is reserved for targeted integrations or limited functionality where it is demonstrably lower TCO than extensive vendor customization.

- **Integration and data discipline**

  London Hydro progresses toward an API-oriented integration approach and clear system-of-record definitions to limit data replication and reduce upgrade fragility.

- **Identity and access management**

  Access is governed by role-based controls and centralized identity management to support timely provisioning/deprovisioning and consistent security enforcement.

2.2.3 Performance and Risks

London Hydro's software portfolio continues to evolve as major platforms are modernized and legacy capabilities are progressively addressed.

Some systems (including OMS and mobile workforce related tools) have known functional and integration limitations that constrain efficiency, and in some cases, increase operational workarounds. These limitations are addressed through planned sustainment and modernization initiatives within the utility's forward investment plan.

The principal risk themes for London Hydro's software environment are summarized below:

- **Vendor supportability and end-of-support exposure**

  Software outside vendor-supported lifecycle windows increases cyber and continuity risk due to reduced patch availability and limited vendor incident support. For critical systems, this risk is elevated because failure or compromise can directly affect customer billing, grid operations, or regulatory compliance.

- **Vendor lock-in and cost escalation (including foreign exchange exposure)**

  Software, cloud and related technology service arrangements can expose London Hydro to unilateral price increases and currency risk, contract renewal risk, and foreign exchange exposure, particularly where services are priced in U.S. dollars. London Hydro mitigates this risk through a Cloud Value approach, ongoing review of licensing models, and periodic rationalization of redundant or overlapping applications and services.

- **Integration fragility and technical debt**

  Complex, tightly coupled, or overly customized integrations increase upgrade risk and can create recurring costs when vendor upgrades require rework across multiple

applications. London Hydro mitigates this through integration practices that support clearer system-of-record accountability, maintainable interfaces, and reduced dependency on point-to-point customizations where feasible.

- **Specialized skill requirements and talent scarcity**

  Critical systems require specialized skills that may not be economical to maintain fully in-house. London Hydro addresses this through a hybrid support model, combining internal core capability with specialized vendor or partner support where required.

2.2.4 Lifecycle Management

London Hydro manages software lifecycles through a risk- and supportability-driven approach that prioritizes critical systems, maintains vendor support, and limits avoidable customization. Software upgrades are planned and executed based on defined triggers that reflect prudence, risk, value, system interdependencies, resourcing and budget constraints.

Lifecycle actions (upgrade, replacement, or retirement) are typically triggered by:

1. **End of support**: vendors sunset support, discontinue maintenance, or no longer provide a practical support path, creating increased cyber, operational, and service continuity risk for crucial systems.
2. **Lifecycle dependencies across the technology system**: software platforms may depend on underlying operating systems, databases, middleware, infrastructure, or related applications that are also approaching end of life or support. In these cases, London Hydro assesses the broader system to determine whether coordinated upgrades or replacements are required.
3. **Regulatory requirements**: changes to regulatory requirements that require system modifications to remain compliant and functional.
4. **Security vulnerability management**: critical security patches are applied on a risk-based priority basis, while functional upgrades are scheduled and bundled to reduce operational disruption.
5. **Performance, resilience, or scalability limitations**: current software cannot maintain acceptable performance or service expectations without material operational workarounds.

London Hydro also considers internal delivery capacity, external resource availability, operational change burden, and budget constraints when sequencing lifecycle replacements. Where practical, lifecycle work is phased in over time and related changes are coordinated to support manageable implementation, reduce disruption, and smooth expenditure requirements.

London Hydro conducts periodic software portfolio reviews to identify redundant, underutilized, or low-value applications. Where applications do not align to business needs or can be consolidated, they are candidates for retirement. This approach supports prudent management of licensing costs and reduces long-term support burden.

London Hydro schedules planned upgrades to minimize service disruption, align with operational windows, and maintain cyber posture. For critical systems, upgrades are subject to

heightened testing and change control given the consequence of failure and the need for continuity of customer and grid operations.

2.3 IT CYBERSECURITY STANDARDS

London Hydro manages cybersecurity as a distinct IT asset class. Cybersecurity tools and platforms (including identity controls, endpoint protection, network security, and monitoring) are provisioned, maintained, and renewed to protect grid operations and customer information. London Hydro aligns its cyber program to the Ontario Cybersecurity Framework (OCSF), and reports annually to the OEB on cyber readiness and control implementation. London Hydro is considered a High Risk utility.

2.3.1 Security Asset Categories

London Hydro manages cybersecurity assets in the following asset pools to support the protection, monitoring, and recovery needs of its IT environment. These asset pools are organized for lifecycle and investment planning purposes and are mapped to the OCSF outcomes of Identify, Protect, Detect, Respond, and Recover.

Table 4: Cybersecurity Asset Category Definitions

Cybersecurity Asset Category	Description
Identity and Access Security	Tools and controls that ensure only authorized people can access London Hydro's systems and data, and that access is limited to what each person needs to do their job. This asset pool includes strong sign-in controls (e.g., multi-factor authentication), role-based access, and enhanced safeguards for high-risk administrator (privileged) accounts
Endpoint and Server Protection	Tools that protect computers, laptops, mobile devices, and servers from malware, ransomware, and unauthorized changes. These controls help prevent, detect, and contain cyber threats on devices used by office staff and field crews, and support secure configuration so systems operate in a known, controlled state.
Perimeter Security and Segmentation	Tools that protect and manage the boundaries of London Hydro's networks, including connections to the internet, remote users, and third parties. This separates environments so an issue in one area cannot easily spread to another. This includes firewalls, secure remote access, and controls that maintain appropriate separation between

	corporate IT and operational environments, with only controlled interfaces between them.
Security Monitoring and Logging	Tools that collect and retain security-relevant activity records (logs) from systems and networks and use them to identify unusual or malicious activity. This asset pool supports timely detection and response by correlating events (e.g., repeated failed logins, abnormal data access) and tracking incidents through defined workflows.
Vulnerability and Patch Management Enablement	Tools and processes that identify known security weaknesses in systems and confirm that security patches and fixes are applied on time, based on risk. This includes scanning, validation, and compliance reporting to demonstrate that critical vulnerabilities are being addressed and that systems remain supportable and secure.
Data Protection and Privacy Controls	Tools that protect the confidentiality and integrity of data, including customer and operational information, both “at rest” (stored) and “in transit” (moving between systems). This includes encryption and controlled data handling; where warranted, it also includes controls that help prevent unauthorized sharing or leakage of sensitive information (e.g., data loss prevention capability).
Third-Party and Supply Chain Security	Controls that manage cybersecurity risks associated with vendors and service providers, including how they are granted access and how that access is monitored. This includes contractual cybersecurity requirements, secure vendor access pathways, and oversight mechanisms to reduce the risk that third-party connections introduce vulnerabilities into London Hydro’s environment.

2.3.2 Standards and Practices

London Hydro applies risk-based cybersecurity standards and operational practices that support its broader cyber risk management program, which is aligned with the Cybersecurity Risk Management Strategy, enterprise risk management, OEB requirements, and the Ontario Cyber Security Framework.

Key practices include:

- **Governance and Oversight**

  Cybersecurity is governed as an enterprise risk. London Hydro maintains governance, reporting, and evidence practices that support management and Board oversight, risk

ownership, escalation and acceptance, and readiness for OEB reporting and independent assessment.

- **Risk, Assurance, and Continuous Improvement**

  London Hydro uses a combination of ongoing risk and control assessment activities, periodic technical testing, and independent assessments obtained in accordance with OEB requirements. Findings and recommendations are used to prioritize remediation activities, support roadmap planning, and inform the sequencing of cybersecurity investments.

- **Secure-by-design delivery**

  Security and privacy requirements are incorporated into project and system delivery through proportionate risk, threat, and privacy assessment activities, scaled to the criticality and sensitivity of the service, system, or information involved.

- **Defence-in-depth controls**

  London Hydro applies layered controls that emphasize identity-centric access management, endpoint and workload protection, segmented connectivity between corporate and operational environments, and centralized logging and monitoring to support timely detection, response, and resilience.

- **Asset, Vulnerability, and Secure Configuration Management**

  London Hydro applies risk-based practices to maintain asset visibility, classify assets, prioritize vulnerabilities, establish secure configuration baselines, and track remediation through defined service levels and exception handling.

- **Awareness, Training, and Incident Readiness**

  London Hydro supports its controlled environment through cybersecurity and privacy awareness activities, role-based training, incident response planning, and exercises that strengthen operational readiness and support compliance with regulatory reporting obligations.

2.3.3 2.3.3 Performance and Risks

London Hydro measures cybersecurity performance primarily through OCSF reporting, independent assurance, and selected operational indicators used to monitor the effectiveness of core controls over time. This includes ongoing assessment of control maturity, remediation progress, and the operational effectiveness of key capabilities such as asset inventory, vulnerability management, identity and access controls, network segmentation, and centralized security monitoring.

Recent independent assessment work indicates that London Hydro has a solid operational cybersecurity foundation, with many control areas assessed as established or progressing appropriately. Remaining gaps are concentrated less in the absence of core security technologies and more in the continued maturation of governance, enterprise risk integration,

documentation, accountability, and repeatable control processes. Most remaining gaps were identified as medium priority, with targeted areas for continued improvement.

Key risk themes include:

- **Cyber risk governance and maturity**, where continued work is needed to strengthen reporting, oversight, metrics, and alignment with enterprise risk management.
- **Supply chain and third-party risk**, where assessment, monitoring, and contractual security requirements for vendors and service providers require further formalization.
- **Risk assessment and treatment**, where likelihood, impact, prioritization, and risk tolerance processes require greater consistency and documentation across the enterprise.
- **Critical service dependency visibility**, where mapping of dependencies, external systems, and recovery requirements should continue to mature to support resilience and recovery planning.
- **Response and recovery improvement**, where lessons learned, metrics, and improvement processes should continue to be formalized to strengthen cyber resilience over time.

These risk themes inform London Hydro's ongoing cybersecurity sustainment and improvement activities during the planning period and support prudent investment in governance, control monitoring, remediation, resilience, and roadmap-based maturity improvement. This work is managed within a broader cyber risk lifecycle that emphasizes risk ownership, escalation and treatment, evidence-based reporting, and alignment with Enterprise Risk Management (ERM) and OEB expectations.

2.3.4 Lifecycle Management

London Hydro manages cybersecurity assets using risk- and supportability-driven lifecycle planning. Cyber controls generally have shorter effective lifecycles than other IT assets due to evolving threats and vendor support windows.

Lifecycle actions are triggered by:

(i) vendor end-of-support/end-of-life,
(ii) material vulnerabilities,
(iii) control gaps identified through OCSF reporting and assurance activities, and
(iv) performance/throughput requirements (e.g., encrypted traffic inspection and log volume growth).

London Hydro plans timely renewal of perimeter and core security platforms to maintain supportability. Cybersecurity equipment is managed on an approximately five-year lifecycle considering end-of-sale/end-of-support and patching requirements, with retired security devices and storage media being securely decommissioned and sanitized prior to disposal.

3 IT INVESTMENT PLANNING FRAMEWORK

3.1 IT PORTFOLIO PLANNING PROCESS

London Hydro formerly planned its IT investments using a functional modeled and has moved to a centralized, risk-based portfolio management framework. This evolution strengthens the alignment between IT expenditures, corporate strategic goals, and ratepayer value. The process is integrated with the corporate business planning cycle to ensure that IT budgets are driven by validated business requirements, asset lifecycle needs, and regulatory obligations.

The IT portfolio capital program is developed through a sequence of activities:

1. Needs identification (bottom-up)

Business owners and IT identify requirements arising from:

- asset health and lifecycle status (e.g., end-of-support),
- business demand and operational pain points, and
- regulatory and compliance scans (including cybersecurity requirements).

2. Screening and documentation

Initiatives are documented in project sheets or summary business cases, assigned to Sustainment and Compliance/System Enhancement/Strategic portfolios, and characterized as discretionary or non-discretionary.

3. Prioritization within constraints (top-down)

London Hydro prioritizes initiatives within the available funding envelope by first addressing non-discretionary "Run" items, specifically those where deferral would create unacceptable risks to billing accuracy, cybersecurity, or grid reliability. Discretionary System Enhancements and Strategic initiatives are evaluated based on their ability to deliver tangible business benefits or customer value.

4. Executive and Board approval

The proposed IT portfolio is reviewed and endorsed through management governance and approved by the Board as part of the annual corporate budget. Following approval, material initiatives proceed through the applicable Project Governance Framework, including periodic review of scope, schedule, budget, risks, and continued alignment with the approved business case.

For key initiatives, particularly Strategic projects and significant System Enhancements, London Hydro applies an options evaluation to confirm that the recommended path is the most prudent and efficient approach.

Each material business case includes a “status quo/do nothing” baseline to quantify the implications of deferral, including operational risk, cybersecurity exposure, supportability (end-of-support), service impacts, and cost escalation (e.g., increasing vendor support and workarounds). Where the baseline does not create an unacceptable risk to safety, reliability, compliance, or cybersecurity, London Hydro will generally defer or re-phase the investment.

Where the baseline is not acceptable, London Hydro evaluates, at a minimum:

- **Do minimum** (sustain/patch): Extend life through limited upgrades, configuration changes, or constrained support arrangements.
- **Replace like-for-like**: Refresh with a modern equivalent to restore supportability and reduce failure risk.
- **Enhance/transform**: Implement a solution that adds capability, strengthens controls, or materially changes delivery.

Additional decision considerations (as applicable):

- **Build vs. buy**: Commercial options are evaluated against internal development only where it is practical, supportable, and demonstrably lower total lifecycle cost and risk.
- **Cloud vs. on-premise**: Deployment selection is based on demonstrated value, security and resilience requirements, integration implications, and lifecycle cost (including ongoing consumption/egress considerations).

3.2 IT Risk Management Framework

London Hydro manages IT risk as part of its broader ERM program and associated Enterprise Risk Assessment (ERA) process, recognizing that failures of critical IT systems can adversely affect customer service, operational continuity, and the utility's ability to meet regulatory obligations. Consistent with a developing IT asset management capability, London Hydro's approach is pragmatic and risk-based, with a focus on establishing a consistent baseline for identifying and addressing material IT risks across the portfolio.

For the purposes of IT investment planning, London Hydro's principal IT risk themes include:

- cybersecurity and privacy,
- availability and recoverability of business- and grid-supporting systems,
- end-of-life/end-of-support exposure, and
- delivery and support risk for material IT projects, including the availability of the internal and external capabilities required to implement and support the selected solution.

Risk considerations are incorporated into project scoping and prioritization and are a key driver of non-discretionary (Sustainment & Compliance) initiatives, such as replacement of end-of-life infrastructure where continued operation would create unacceptable service, security, or supportability risk.

Significant IT risks are escalated through the established ERA process and existing management oversight, with management responsible for day-to-day risk assessment and treatment, Executive review of significant enterprise risks, and Board oversight where warranted, to ensure that portfolio decisions reflect enterprise operational risk considerations.

3.3 Project Governance

London Hydro employs a project governance framework in which the level of governance and documentation is commensurate with a project's cost, complexity, and risk profile. This

approach is intended to protect ratepayer funds through appropriate oversight of higher-risk initiatives, while avoiding unnecessary administrative burden for routine sustainment and lifecycle replacement work.

The framework has been strengthened based on lessons learned, including a shift away from reliance on system integrator-led governance toward an internally-led PMO model with stronger business participation and independent assurance, where warranted.

Projects are classified into two governance tiers:

- **Tier 1 (Strategic)** includes high-cost, multi-year initiatives with significant operational and delivery risk (e.g., future ADMS). These projects are overseen by a formal Executive Steering Committee comprised of the C-Level and Vice Presidents, are subject to stage-gate reviews and PMO tracking, and may include external quality assurance or independent checks
- **Tier 2 (Sustainment & Compliance, System Enhancements)** includes routine hardware refreshes, lifecycle replacements, and software enhancements. These projects are governed through functional management and IT leadership, managed using standard tracking tools, and monitored primarily through schedule and budget variance controls within the approved annual funding envelope, with escalation on an exception basis.

IT projects follow a common lifecycle with stage gates designed to release funding as confidence in the solution increases:

1. Initiation and high-level business case (Gate 1 approval to proceed to planning);
2. Planning and design, including requirements, vendor selection, and refinement of cost estimates (Gate 2 financial approval and final capital release, with approvals aligned to delegation of authority thresholds);
3. Execution and monitoring, including change control for scope and budget changes beyond defined tolerances; and
4. Closure and realization, including operational handover, financial close and capitalization, and post-implementation review for major initiatives to confirm delivery of benefits identified in the business case.

Roles and responsibilities are defined to support accountable delivery and “Business-Led, IT-Delivered” alignment:

- **The Executive Sponsor** is accountable for benefits realization and securing required approvals;
- **The Steering Committee** provides direction, resolves escalated issues, and approves major changes;
- **The Project Manager** manages day-to-day execution, schedule, and risk; and
- **Business Subject Matter Experts** develop business use cases, validate requirements, and provide the evidence base supporting investment decisions.

3.4 IT Human Capital

London Hydro's IT human capital strategy ensures the prudent stewardship of technology assets by balancing the importance of institutional knowledge with fiscal efficiency. The strategy addresses the rapid obsolescence of technical skills and competition for talent, while maintaining stable operating costs.

The IT department operates under three functional Directors reporting to the Chief Information Officer:

- **Information Systems**: Manages critical infrastructure (data centers, networks) and houses the independent Cybersecurity & Risk function.
- **Enterprise Business Systems**: Responsible for the stability and currency of core software assets, including CIS and ERP.
- **Application Development (including Shared Services)**: Manages customer-facing digital platforms and shared services.

To support these functions, London Hydro uses a combination of internal and external resources. Resourcing decisions are made based on the nature of the capability required, cost effectiveness, continuity needs, and long-term operational risk. This approach ensures agility without inflating fixed costs. Internal resources are retained for long-term asset stewardship and ensuring intellectual property remains within the utility. External resources, are used selectively to provide specialized expertise, support temporary project-driven demands, and supplement internal capacity where appropriate.

This approach helps London Hydro respond to evolving technical skill requirements without unnecessarily increasing fixed operating costs. It also supports prudent management of delivery risk by aligning resource choices to the complexity, duration, and strategic importance of the work.

3.5 Continuous Improvement

London Hydro views IT Asset Management as an evolving discipline and will continue to strengthen practices over the planning horizon to improve consistency and transparency of investment decisions.

Priority improvement areas include:

- improving asset information quality and lifecycle standardization across asset pools;
- strengthening portfolio documentation and business case consistency for material initiatives;
- improving alignment between IT assets and business needs to support more effective asset utilization and more informed lifecycle and investment decisions;
- improving cybersecurity sustainment processes (including assurance-driven remediation planning); and
- formalizing post-implementation review practices for major initiatives to support continuous learning and prudent delivery.