Asset Management Plan

Core Assets
Water

City of Vaughan
March 2025

Table of Contents

Figures

Tables

1. Introduction

The City of Vaughan (The City) has conducted a renewal of the City's Asset Management (AM) Plans for all its infrastructure assets, including Water Assets.

1.1 Background

The City is one of nine area municipalities located within the Regional Municipality of York. As a lower tier municipality, the City is responsible for providing services such as buildings, fire protection, public works, water distribution, wastewater collection, and parks and recreation.

The next 25 years will see the City transition from a growing suburban municipality to a fully urban space. This type of transition will require long-term thinking about how best to accommodate and make the most of new opportunities. Planning for the future through strategic planning will position the City to deal with the many pressing issues impacting the organization such as community safety, access to health facilities, environment, traffic congestion and issues related to growth and the quality of municipal services.

The City is one of Canada's fastest growing cities, with a population of over 320,000 according to the latest census from Statistics Canada. It is projected that the number of residents will increase to 415,000 by 2031. In addition to its rapidly growing population, the City is home to a well-diversified and expanding employment sector with over 7,800 businesses and 231,000 employees. The City has the largest supply of new employment lands in the Greater Toronto Area (GTA) and it is projected that the number of employees will increase to 271,000 by 2031.

1.2 Objectives

In 2018, by City Council approval, the Corporate Asset Management (AM) Policy for the City came into effect; and, in 2013, the City's first Corporate AM Strategy was published. As identified in the Corporate AM Strategy, the City's first set of AM Plans (AMPs) were developed in 2014.

In early 2021, the City updated its AM Strategy and core infrastructure AMPs, as per Ontario Regulation (O. Reg.) 588/17. The purpose of this series of AMPs is to now update the infrastructure assets so as to provide the City with a comprehensive updated AM Plan.

The objective of this AMP is to deliver a financial and technical roadmap for the management of the City's roadway appurtenance assets, and to provide the means for the City to maximize value from its assets, at the lowest overall expense while, at the same time, providing enhanced service levels for its residents and promoting green initiatives.

Organizations that implement good AM practices will benefit from improved business and financial performance, effective investment decisions, and better risk management. Stakeholders can expect lower total asset life cycle costs, higher asset performance, and confidence in sustained future performance.

1.3 AM Provincial Requirements

The Ontario Regulation 588/17 (O. Reg. 588/17) came into effect in 2018 and stipulates specific AM requirements to be in place within Ontario municipalities by certain key dates (**Table 1-1**). The development of this AMP is one of the steps to guide the City towards meeting the July 1st, 2025 deadline.

Table 1-1: O. Reg. 588/17: AM Planning for Municipal Infrastructure

Description: A regulation made under the Infrastructure for Jobs and Prosperity Act, 2015, stating that every municipality shall prepare and update a Strategic AM Policy, and that every municipality shall prepare an AM Plan for its core infrastructure assets by July 1, 2022, and an AM Plan for all other infrastructure assets by July 1, 2024. The regulation outlines several requirements that each AM Plan must follow, such as including current and proposed level of service. Core municipal infrastructure assets include water, wastewater, stormwater, road, and bridge assets.	
Deadline Date	Regulatory Requirement
July 1st, 2019	All municipalities are required to prepare their first Strategic AM Policy.
July 1st, 2022	All municipalities are required to have an AM Plan for its entire core municipal infrastructure (i.e., water, sanitary, stormwater, and transportation).
July 1st, 2024	All municipalities are required to have an AM Plan for infrastructure assets not included under their core assets.
July 1st, 2025	All AM Plans must include information about the levels of service that the municipality proposes to provide, the activities required to meet those level of service, and a strategy to fund activities.

1.4 Scope

This AMP has been developed for the City's water asset categories, owned and maintained by the City, as shown in **Table 1-2**. The renewal of the City's AM Plans is consistent with the guidelines laid out in the City's Corporate AM Policy and Section 5 of O. Reg. 588 / 17.

Table 1-2: In-Scope Assets

Asset Category	Sub-Assets
Water Distribution System	Watermains, laterals, service connections, valves, hydrants, meters, and pump stations.

The following elements are included within the scope of this AMP:

- A summary of the asset inventory, including the replacement cost of the assets, the average age of the assets, the condition of the assets, and the City's approach to assessing the condition of the assets.
- Current levels of service (LoS) based on performance measures.
- Asset lifecycle management strategies to maintain identified current LoS, minimize associated asset risks, and to optimize costs over the whole lifecycle of the asset.

1.5 Approach for Asset Management Plan

The approach used in the renewal of this AM Plan is presented in **Figure 1-1**, and has been selected to ensure that the City can have the confidence to make fact-based and defensible business decisions from reliable and robust information.

Figure 1-1: AM Plan Approach

2. State of Infrastructure

Defining the state of the infrastructure involves quantifying the assets owned, examining their age, replacement value, and condition. The City's approach to each of these asset characteristics is summarized below.

2.1 Expected Service Life and Remaining Service Life

The expected service life (ESL) is defined as the period over which an asset is available for use and able to provide the required level of service at an acceptable risk (i.e., without unforeseen costs of disruption for maintenance and repair). The ESL for this assignment will be based on discussions with City staff, information from previous studies, and any additional information that might inform the ESL. In terms of determining the Remaining Service Life (RSL), the City used the installation date together with the ESL.

In reality, different assets will deteriorate at different rates and not necessarily linearly over time, however, it is important to keep in mind the level of effort required to predict failure compared with the asset value. More sophisticated deterioration modelling may be warranted for very high value assets, whilst the cost of deterioration modeling for low-value assets may very well exceed the replacement cost of the asset. The actual service life can vary significantly from the ESL. In some instances, a variation in expected vs. actual service life is evident due to the following factors:

- **Operating conditions and demands:** Some equipment is operated intermittently or even infrequently, or is being operated at lower demand than its design capacity, thus the actual operating "age" of the asset is reduced.
- **Environment:** Some equipment is exposed to very aggressive environmental conditions (e.g., corrosive chemicals), while other assets are in relatively benign conditions, thus the deterioration of assets is affected differently.
- **Maintenance:** Equipment is maintained through refurbishment or replacement of components, which prolongs the service life of the asset.
- **Technological Obsolescence:** Some assets can theoretically be maintained indefinitely, although considerations such as maintenance cost, energy inefficiency and new technologies are likely to render this approach uneconomical.

2.2 Current Asset Replacement Value

The estimated replacement value is the cost of replacing an existing asset in 2024 dollars, considering an inflation rate. These costs were developed based on the records of previous tenders and quotes, other municipalities similar in size to the City, and consultation with the City's staff. Where applicable, a CPI-based inflation rate was used to estimate the 2024 values.

2.2.1 Asset Inventory and Replacement Value

The City's Water assets are managed and maintained to meet provincially issued system and facility operating permits, as well as the City's performance and reliability targets. Valued at approximately $1.5 Billion, the water assets can be grouped into two categories: Linear and Water Facilities (

Table 2-1**).** They are further divided into five asset types ranging from watermains to water filling stations.

The City's core services, including Water, Wastewater, Stormwater, and Transportation, are coordinated with each other to ensure cost efficiencies to maintain the desired level of service while minimizing the risks. The core service areas are considered as a whole when considering the infrastructure lifecycle needs.

Table 2-1: Asset Inventory & Valuation

Asset Category	Asset Type		Number/ Length	Units	Unit Replacement Cost ($/Unit)	Replacement Value
Water Linear	Watermains		1,178	km	$230,000 - $2,310,000	$698,506,000
	Appurtenances	Service Connections	332*	km	$230,000	$184,092,000
		Valves & Curb Stops	54,162	Ea.	$2,060 - $23,620	$344,676,000
		Hydrants	10,614	Ea.	$11,250	$119,408,000
		Chambers	10,677	Ea.	$12,640 - $37,890	$144,729,000
		Pressure Reducing Valves	27	Ea.	$12,640	$341,000
	Meters	Water Meters	88,691	Ea.	$430 - $12,320	$44,965,000
Water Facilities	Pump Stations		2	Ea.	$260,000 - $1,920,000	$2,180,000
	Water Filling Stations		3	Ea.	$237,000	$711,000
Total						**$1,539,608,000**

NOTES:

- The replacement value for watermains and service connections excludes the asphalt cost, which is accounted for in the road AMP.
- *Total replacement value of service connections includes estimation of missing service connection records in GIS.

Water linear assets are the largest component of the water system inventory by replacement value, and include watermains, appurtenances (service connections, valves, hydrants, and chambers), and water meters. Pressure Reducing Valves (PRVs) are tracked as their own category given the critical nature of these valves.

2.3 Asset Condition

2.3.1 Age-Based Condition Assessment

Two-parameter Weibull distribution function was used to assess the current condition and to project the future condition of the City's Water Assets. The Weibull distribution has been used extensively in reliability studies and lifetime prediction models in industries ranging from the automotive to the oil and gas industries; it provides a suitable distribution for this type of analysis.

The Weibull probability distribution provides a left-skewed distribution that rises slowly and diminishes quickly as the population is consumed. The underlying premise of the Weibull-shaped deterioration is that while some assets fail prematurely due to severe conditions or improper installation, other assets are very long-lived and function well beyond their theoretical expected service life. In order to perform a high order network-level analysis, it was assumed that assets would fail (and require replacement) within a deterioration envelope / curve approximated by a Weibull probability distribution. The two-parameter Weibull cumulative distribution has two parameters for scale and shape, as set out in Equation [1]:

$$f(x;\alpha,\beta) = e^{-\left(\frac{x}{\beta}\right)^{\alpha}} \quad [1]$$

Where: x = Age
α = Shape parameter
β = Scale parameter (or slope)

Table 2-2 presents the condition score ranges and the corresponding range of ESL and total life consumed.

Table 2-2: Age-Based Physical Condition Scale

Condition Score (minimum)	Condition Score (maximum)	Condition Rating	Range % of ESL Consumed	Range of % Operational Life Consumed
1.0	1.5	Very Good	0% – 71%	0% – 47%
1.5	2.2	Good	72% – 84%	48% – 56%
2.2	2.8	Fair	85% – 92%	57% – 60%
2.8	5.0	Poor	93% –100%	61% – 100%

2.3.2 Age Summary

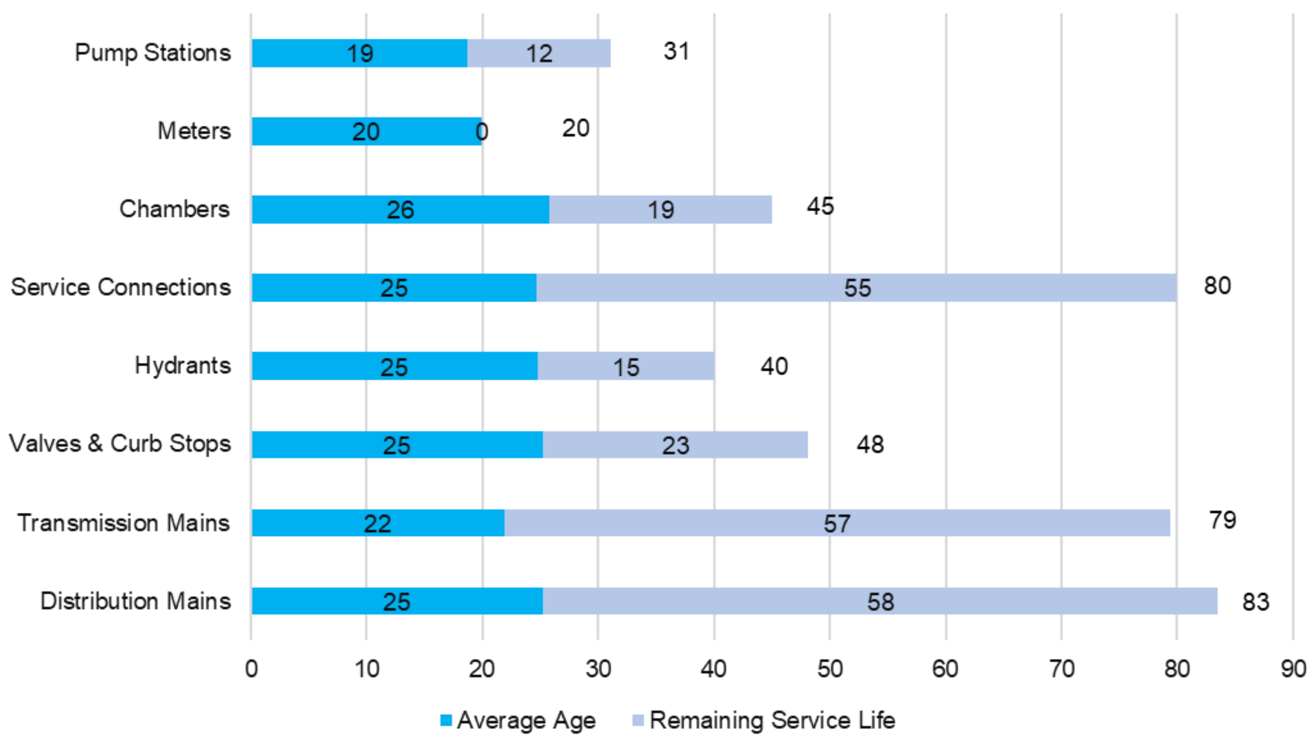


Figure 2-1 is a horizontal bar graph that shows the Water average asset age and average remaining service life in years as a proportion of average expected service life (ESL) by asset type. Asset ages have been established using data from the City's GIS database and consultant reports. The expected service life is developed using the City's Tangible Capital Asset database and through workshop discussions with City staff. It is shown for each asset type as a standalone number to the right of the graph.

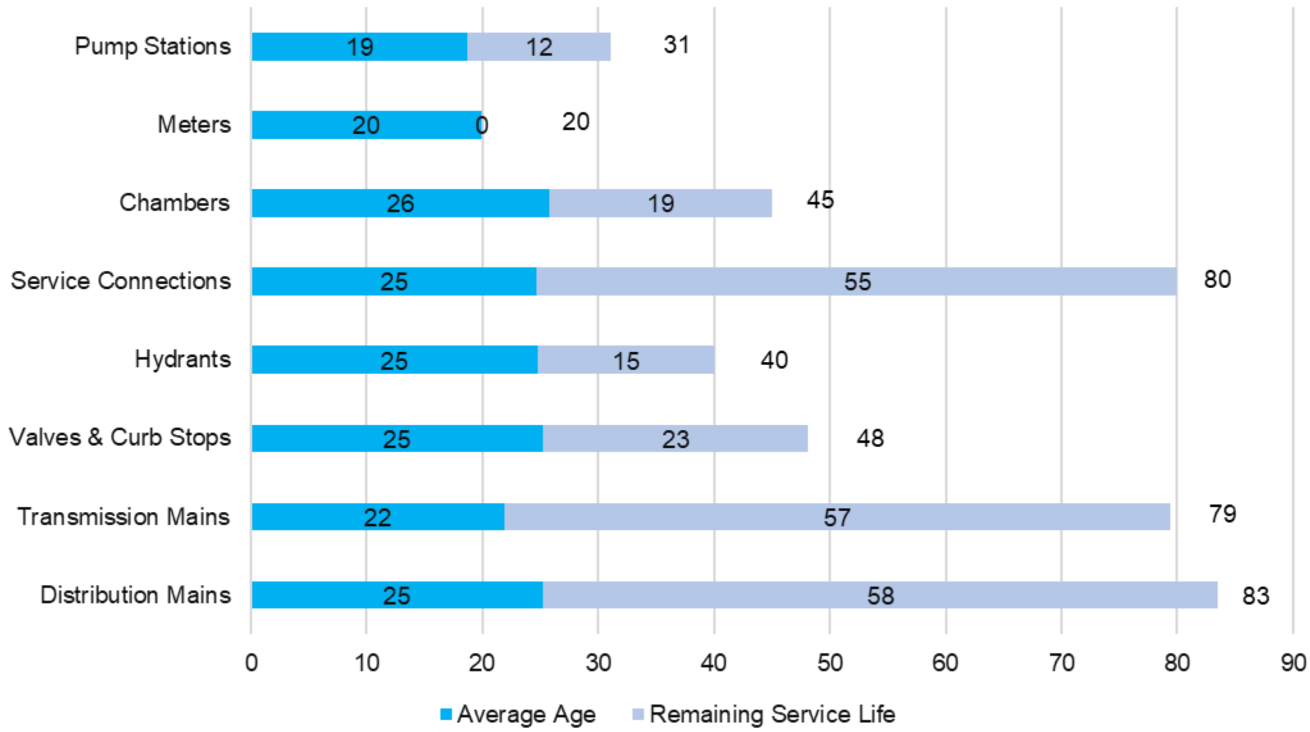


Figure 2-1: Average Asset Age as a Proportion of Average Expected Service Life

The watermains, including transmission mains and distribution mains, are approximately 29% through their ESL. Service connections are similar to watermains, approximately 31% through their ESL. Water Meters are approximately 99% through their ESL. Chambers and hydrants are about 57% and 62% through their ESL. Valves are about 53% through their ESL. The pump stations' adjusted age based on the 2017 condition assessment indicates that the assets are approximately 60% through their asset life.

2.3.3 Condition Summaries

The City's Water service assets are overall in very good condition with 85% of assets in very good condition (**Figure 2-2**) weighted by replacement value. There are 8% of assets in poor condition meaning that they are approaching or exceeded the end of their expected service lives, indicating a need for investment in the short to medium term. The remaining 7% of assets are in good and fair condition indicating that they are meeting current needs, but some are aging and may require attention.

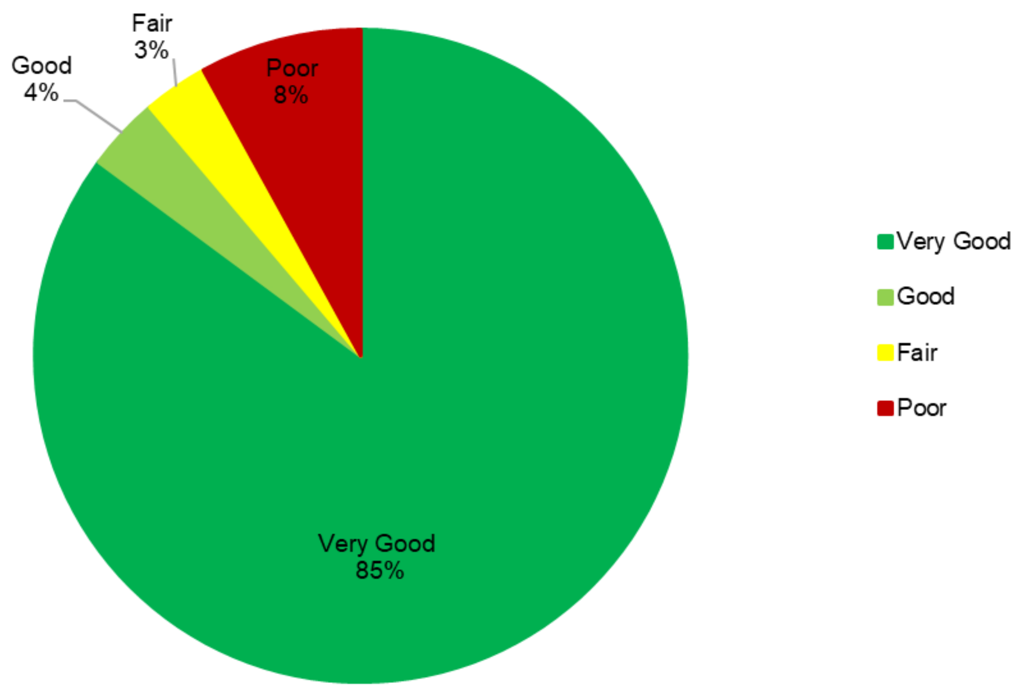


Figure 2-2: Asset Condition Summary

Asset conditions have been determined by using the data from the City' GIS database and consultant reports (**Figure 2-3**). The condition of watermains, appurtenances and meters is based on the age and expected service life. For pump stations, condition information is adopted from consultant condition assessment reports in 2017 and 2020.

Approximately 94% of watermains are in very good condition by replacement value. Only 5% are in poor condition which indicates the need for some investment in the short to medium term. Conducting condition assessments to verify the current condition of the assets prior to committing to renewal activities is necessary to meet the City's service goals.

Service connections are nearly all in very good condition. Approximately 83% of the valves are in very good condition and 9% are in poor condition, however the City regularly exercises each valve to ensure they are in working condition. Most hydrants are in good or very good condition, though 18% of hydrants are in poor condition. However, the City exercises each hydrant annually to ensure they are maintained in working condition. Chambers are mostly in very good, good, and fair conditions. Due to age, approximately 52% of water meters are deemed in poor condition. The City is currently undertaking a multi-year meter replacement program to bring benefits over the years to come, such as improved accuracy for reduction in lost water revenue.

Approximately 50% of the water facility buildings are in very good to good condition weighted by replacement value. The poor condition water facility building assets are in need for investment in the short to medium term. Pumping Stations, while currently in good condition, would deteriorate if the needs identified through periodic consultant reports were not met. The condition assessment for water pump stations is based on 2017 and 2020 consultant reports. The City is preparing to undertake a condition assessment of the water pump stations. Water filling station condition was estimated based on age and estimated ESL.

Figure 2-3: Distribution of Asset Condition by Replacement Value

3. Levels of Service

3.1 Purpose

Levels of Service (LoS) supports every aspect of the overall AM System as shown in **Figure 3-1**. The objective of establishing clearly defined service levels is to help the City meet stakeholder values, achieve its strategic goals, make informed risk-based decisions, and implement effective asset lifecycle activities.

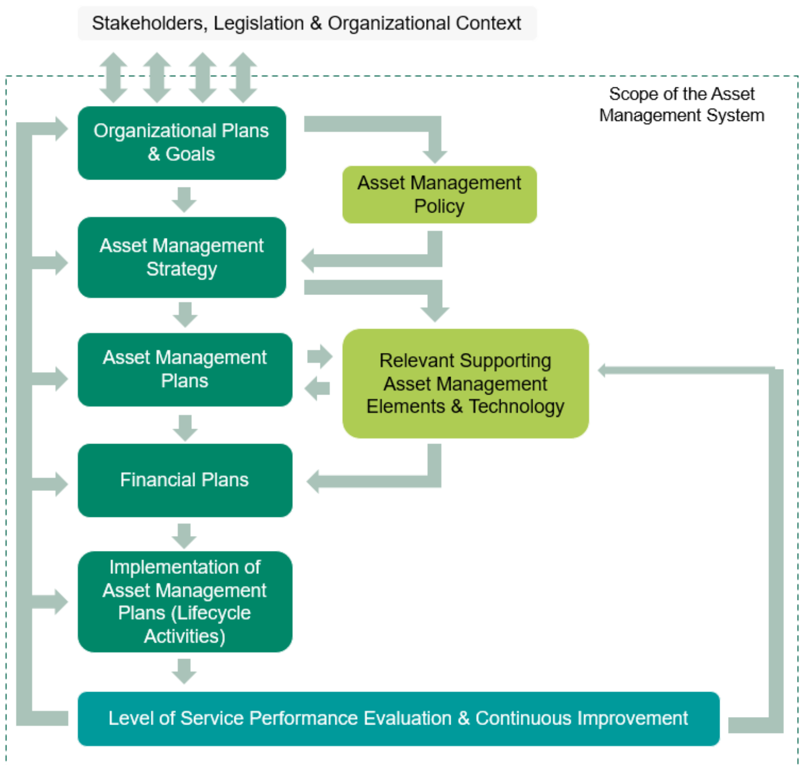


Figure 3-1: LoS within the AM System

In the City's experience, documenting LoS is a proven practice that will enable the City to:

- Link corporate strategic objectives to customer expectations and technical operations.
- Balance customer needs and expectations while evaluating the effectiveness of operations and whether the right LoS is being provided at the right cost.
- Transition from an "Asset Stewardship" approach that focuses on making decisions based on maintaining assets in an acceptable condition to a "Serviceability" approach that is geared towards making decisions based on balancing the costs, risks, and goals for the LoS being provided by the City's assets.
- Communicate the physical nature of infrastructure that the City owns and is financially responsible for while promoting the use of LoS to enable effective consultation with stakeholders regarding alternative funding options according to desired LoS outcomes.
- Make recommendations on strategies that the City can take now to minimize future renewal costs while ensuring that adequate LoS can be delivered without burdening future generations.
- Assess internal (e.g., program changes) and external (e.g., climate change) factors that have the potential to impact the City's ability to deliver services and how these factors may impact the LoS being provided.
- Implement a corporate continuous improvement program to further optimize AM across all service areas.

The O. Reg. 588/17 requires that all AMPs include information about the LoS that the City proposes to provide, the activities required to meet those service levels, and a strategy to fund those activities. The deadline for formalizing these LoS requirements is July 1, 2025 (see **Section 1.3**).

Successful AM programs aim to achieve targeted service levels through customer-based decision making. To achieve this, the City considered a customer-centric approach, where the customer is at the heart of every decision from development to implementation, consultation, and roll-out of the LoS Framework (**Figure 3-2**).

There are two types of LoS measures: Customer LoS (also called "Community" LoS) and Technical LoS. Customer LoS are recorded in a manner that attempts to describe the LoS in terms of what is actually being provided to the customer (i.e., the public) and how the customers experience the service. It is important to note that customers are not concerned with the specific operating requirements of the assets that provide the service, but rather the value they obtain from the operation of the assets. To achieve Customer LoS there needs to be line of sight between the value delivered and how that value is realized. This is the purpose of Technical LoS which attempts to describe how the City will provide and meet the expected Customer LoS.

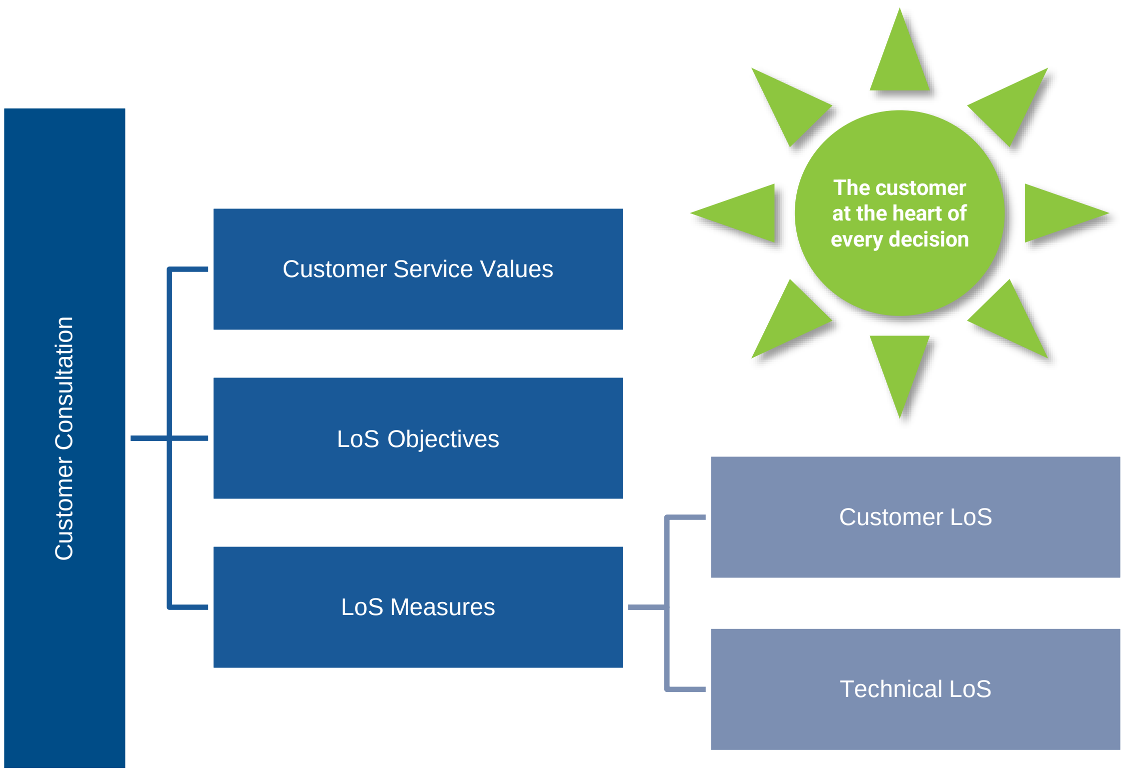


Figure 3-2: The LoS Framework Customer-Centric Approach

The LoS Framework was primarily conceived through a collaborative workshop process. In 2020, four workshops with City staff were conducted across each of the fourteen service areas.

The following outcomes were achieved during each service area workshop:

- Staff were oriented as to the purpose and importance of establishing a consistent LoS Framework;
- Stakeholders were identified, including their expectations, interests, and any regulatory requirements;
- Customer service values were established and reviewed;
- LoS objectives were established for each customer service value;
- Staff provided several performance measures that are currently being tracked as well as those that the City would like to track in the future;
- Where information was available, current performance, targets, and data sources were documented; and
- Growth and shifts in future demand were discussed across the City's service areas.

3.2 Objectives

Defining LoS objectives is important for drawing a line of sight between the City's corporate objectives and the tangible asset performance outcomes. To do so, the LoS objectives must take into consideration stakeholder interests to develop asset performance measures that aim to meet the needs and expectations of the community. By doing this, the City will ensure that their assets are striving towards optimal performance, not only operationally, but economically, socially, and sustainably as well.

Every stakeholder has certain interests in the service being provided and in general, these interests can be categorized into six universal stakeholder values, as shown in **Table 3-1**. Each universal stakeholder value is also assigned a corporate LoS objective.

Table 3-1: The City's Values and LoS Objectives

Customer Value	LoS Objective
Quality and Reliability	The service is delivered with a high standard of excellence and the service is available when needed.
Affordability	The cost of the service is delivered in a financially sustainable manner and does not burden customers.
Environmental Sustainability	The service is delivered in a manner that does not compromise the ability of future generations to meet their needs.
Access and Capacity	Customers can easily access the service with minimal inconvenience.
Health and Safety	The service is delivered with minimal health and safety impacts.
Responsiveness	Customer service requests are responded to efficiently and in a timely manner.

3.3 Stakeholders and Their Interests

A stakeholder is any person or organization that can affect, be affected by, or perceive themselves to be affected by a decision or an activity. Stakeholder analysis is the process of understanding stakeholder needs, expectations, and perceptions relative to the stakeholder's level-of-interest and level-of-influence over the organization. An organization typically engages with their stakeholders to:

- Establish which activities or services matter most to them.
- Understand their risk appetite and risk threshold.
- Understand their willingness to pay for services.

Stakeholders can take many forms and may be internal (i.e., staff, Council) or external (i.e., the public, regulatory agencies, suppliers, neighbouring municipalities, etc.) to the organization. Historically, only service recipients who pay for City services would be considered customers; however, today customers can take many forms and should include any entity that has a legitimate interest in the service being provided. In addition to service recipients (i.e., the public), other external stakeholders may include:

- **Regulatory Agencies** – Stakeholders that set standards, compliance regulations or other legislation that govern service delivery.
- **Special Interest Groups** – Stakeholders that are affected by or have an interest in activities within the City's right of ways.

3.4 Level of Service (LoS) Performance Measures

A documented suite of LoS performance measures enables a common understanding of the service delivery that the City's customers currently receive, and the associated cost of maintaining infrastructure assets to provide the service. Having these performance measures set at the appropriate levels within the City ensures alignment from the corporate vision, to asset investment decisions, and to day-to-day operational activities. When establishing LoS performance measures it is important to keep in mind the "SMART" acronym, as follows:

- **S**pecific, easily evaluated and understood.
- **M**easurable, quantifiable, and easily collectable to ensure ongoing data availability.

- **A**ttainable, so that they work to motivate as opposed to discourage.
- **R**elevant, in that they relate and align with a specific goal.
- **T**ime-Bound, measured over a specific period, which is typically annually for benchmarking.

There are two types of LoS performance measures: Community LoS and Technical LoS. Community LoS are recorded in a manner that attempts to describe the LoS in terms of what is being provided to the community (i.e., the public) and how the customer experiences the service. Community LoS are qualitative, non-technical, and are driven by the municipality's strategic AM objectives. Community LoS are not concerned with the specific operating requirements of the assets that provide the service, but rather the value they obtain from the operation of the assets. To achieve Community LoS, there needs to be line of sight between the value delivered and how that value is realized. This is the purpose of Technical LoS which attempts to describe, quantitively, how the City will provide and meet the expected Community LoS.

3.5 LoS Performance Results

Ontario O. Reg. 588 / 17 requires legislated community levels of service for core assets. Community levels of service use qualitative descriptions to describe the scope or quality of service delivered by an asset category. O. Reg. 588 / 17 also requires legislated technical levels of service for core assets. Technical levels of service use metrics to measure the scope or quality of service being delivered by an asset category. **Table 3-2** presents a summary of the City's water service level for O. Reg. 588 / 17 Metrics. References are provided to show where O. Reg. 588/17 requirement has been attained.

A summary of the City's current and proposed community and technical service levels for Water Assets are documented in **Table 3-2.**

Table 3-2: Community and Technical Service Levels

Level of Service	Current Performance	Current Service Level Target	Proposed Service Level Target
Percentage of properties connected to the municipal water system.	93.7%	93.7%	No Change
Percentage of properties where fire flow is available.	93.1%	93.1%	No Change
The number of connection-days per year where a boil water advisory notice is in place compared to the total number of properties connected to the municipal water system.	0	0	No Change
The number of connection-days per year due to watermain breaks compared to the total number of properties connected to the municipal water system.	0	0	No Change
Watermain breaks per 100km of main.	2.67	2.67	No Change
Description, which may include maps, of the user groups or areas of the municipality that are connected to the municipal water system.	See **Figure 3-3**		No Change
Description, which may include maps, of the user groups or areas of the municipality that have fire flow.	See **Figure 3-4**		No Change
Description of boil water advisories and service interruptions.	0 days of boil water advisory and service interruptions.	0	No Change

Figure 3-3 shows a map that outlines the City's water connectivity.

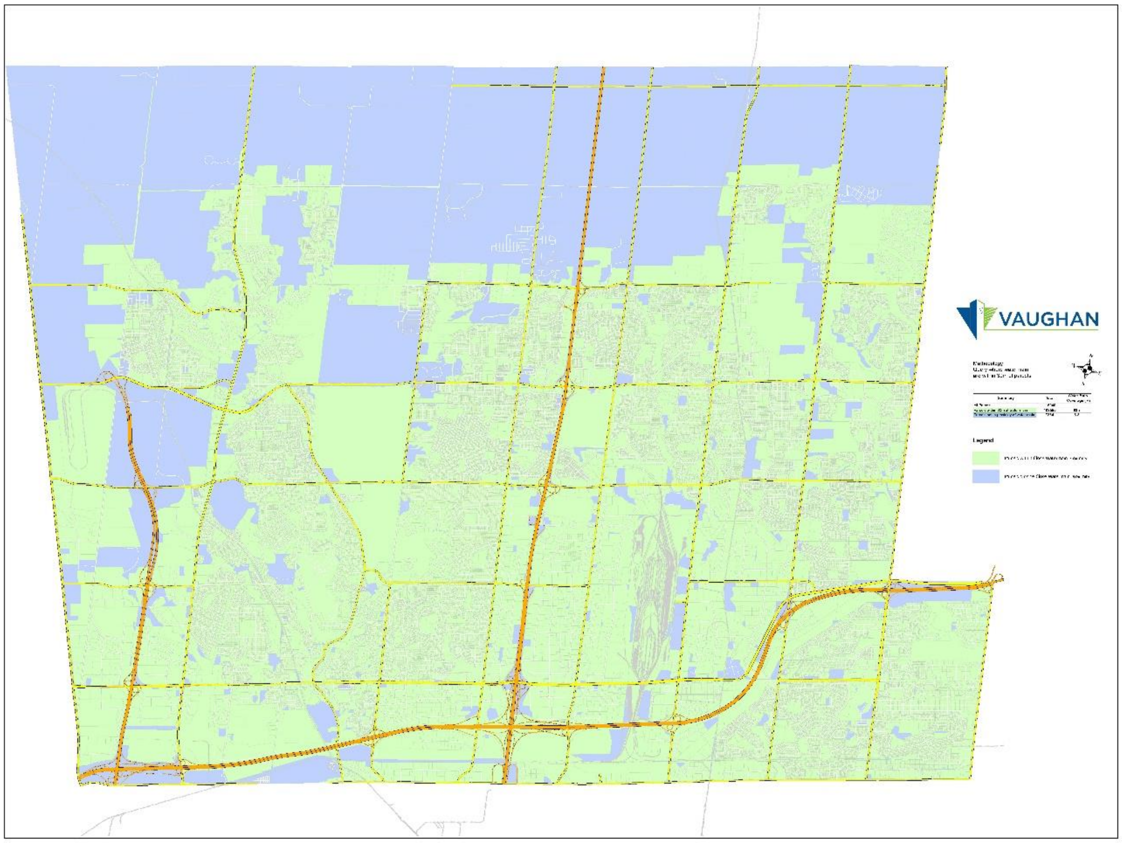


Figure 3-3: Map Outlining the City's Water Connectivity

Figure 3-4 shows a map that outlines the City's fire flow connectivity.

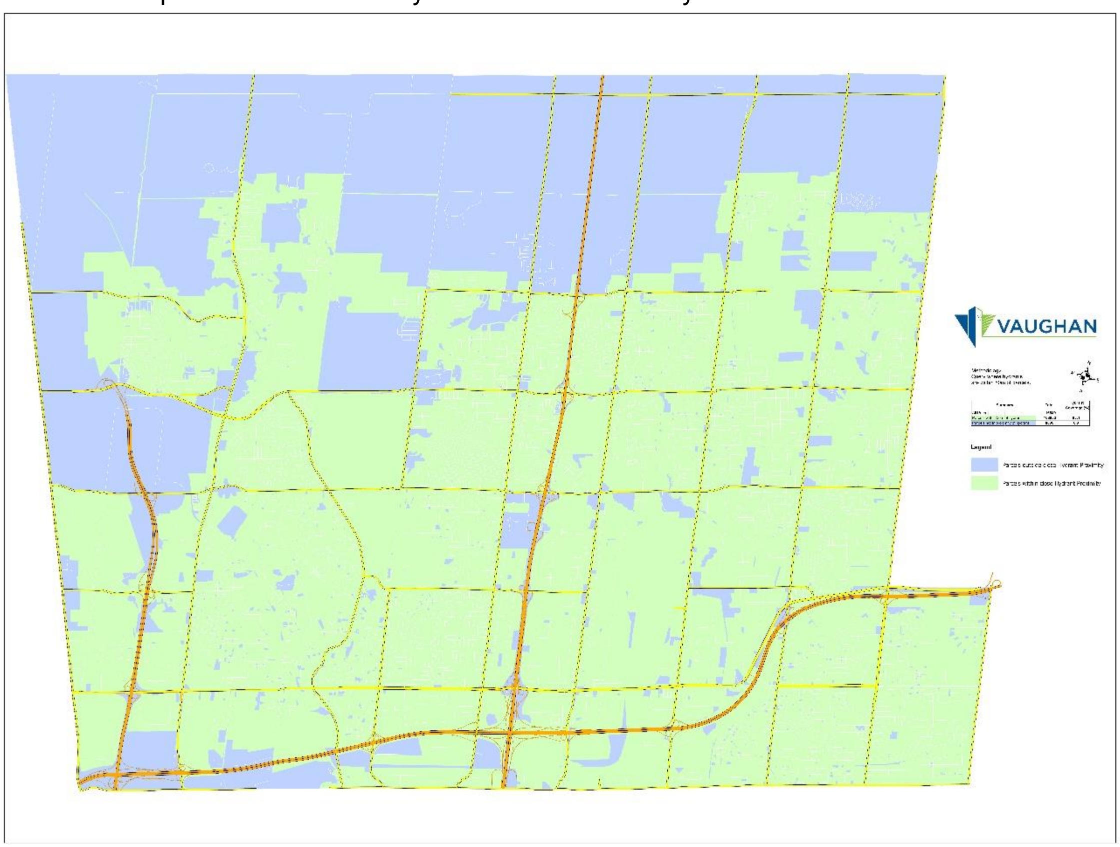


Figure 3-4: Map Outlining the City's Fire flow Connectivity

3.6 LoS Performance Targets

Establishing LoS targets is an important part of continual improvement and performance management. Without targets, it is difficult to ascertain whether goals are being met, or the extent of the gap if they are not. Incorporating targets into the City's LoS Framework helps to ensure that targets are reasonable, aligned with customer expectations, and evaluated on an objective basis by considering cost-benefit trade-offs.

One of the key challenges in setting targets in a municipal environment is that they can often become biased and/or politically motivated. Therefore, it is important to review LoS targets with stakeholders. An important aspect of evaluating LoS targets is determining how willing the user is to pay for the service. Regulatory requirements are an exception; however, they only provide the minimum service standard. Cost is still an important parameter to consider when assessing the merits of service improvements.

To deal with the financial realities, it is necessary to:

- Calculate how much the service costs based on current LoS.
- Determine the cost associated with varying the LoS.
- Assess the customers' willingness to pay.

4. Asset Lifecycle Strategies

Asset lifecycle management focuses on the specific activities we must undertake during all phases of the asset lifecycle. By considering entire asset lifecycles the City can ensure sound decision making that consider present and future service delivery needs.

The overarching goal of life cycle management is to maximize the long-term benefits and services that our assets deliver while minimizing the associated costs and risks in the long run. Every asset has a life cycle cost, which is the total cost of all the activities undertaken throughout its service life. The following sections describe activities across the life cycle of assets.

4.1 Lifecycle Activities

Any responsible owner of assets such as the City has a desire to preserve the condition of their existing assets for as long as possible, by maintaining or even extending their design lives through routine activities such as maintenance and active intervention. The City is continually acquiring infrastructure assets, but these assets require increased funding for operation and maintenance as they age. The City is also responsible for the replacement of deteriorated assets as long as the service is required. While individual assets may have a useful life that can be predicted in years or decades, the service that the asset provides could be for a substantially longer duration (perhaps in perpetuity). Part of the purpose of the AM planning process is to fully understand and predict the long-range financial requirements for the City's infrastructure to facilitate planning and resource management in the most cost-effective manner possible. **Figure 4-1** illustrates how costs typically accumulate over an asset's life. It is worth noting that the accumulation of the ongoing operations and maintenance, refurbishment and disposal / replacement costs is many multiples of the initial acquisition costs. A key and important take-away from **Figure 4-1** is therefore for the City to fully understand the entire life cycle costs before proceeding with asset acquisition.

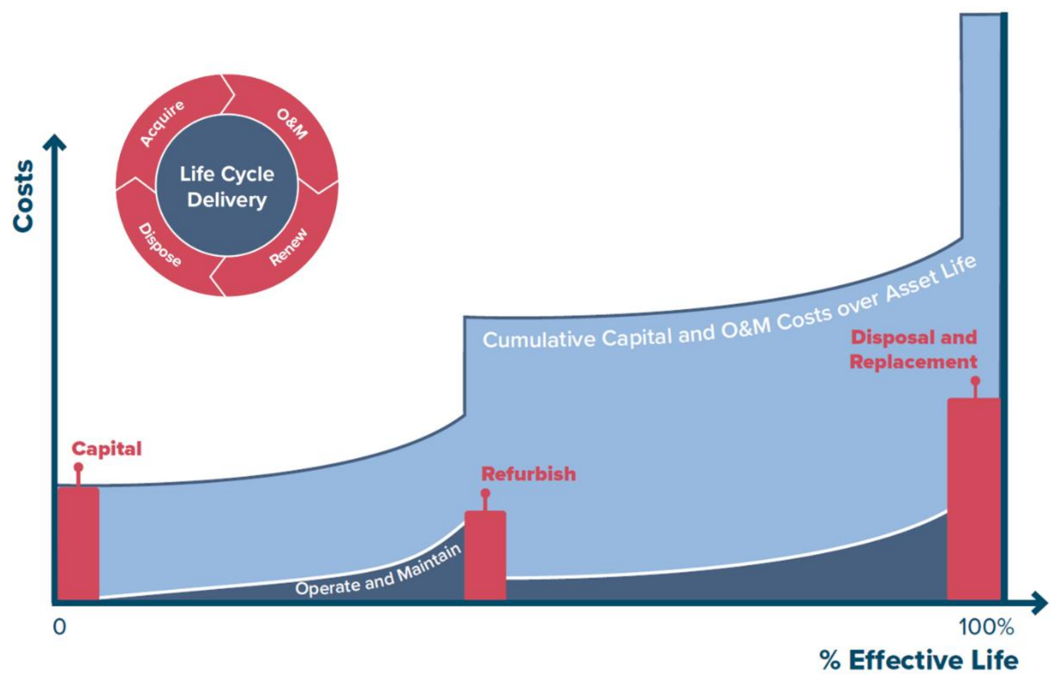
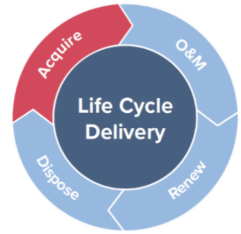
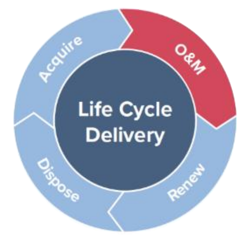


Figure 4-1: Life Cycle Cost Accumulation Over Asset Life

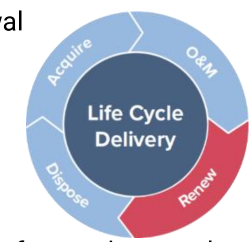
Expressed simply, full lifecycle cost of infrastructure can be accumulated under the following broad headings:



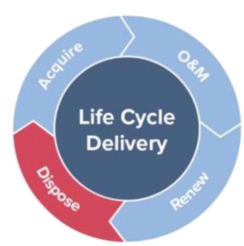
- **Asset Acquisition / Procurement / Construction**: The City has made significant investments in the design and acquisition of its municipal infrastructure assets. Added to City-purchased inventory is infrastructure that the City accepts (and takes immediate financial responsibility for) from developers as new neighborhoods are constructed. For example, as developers build new neighborhoods, the new local infrastructure (including local roads, watermains, sewer mains and storm mains) is paid for by the developer and then transferred to the City for operation, maintenance and ultimately replacement. The City's infrastructure inventory was therefore created over many decades through infrastructure paid for by the City or by developers Looking towards the future, when acquiring new assets, the City should evaluate credible alternative design solutions that consider how the asset is to be managed at each of its life cycle stages. Asset management and full life cycle considerations for the acquisition of new assets include, but are not limited to the following:
  - The asset's operability and maintainability;
  - Availability and management of spares;
  - Staff skill and availability to manage the asset;
  - The manner of the asset's eventual disposal.



- **Asset Operations and Maintenance (O&M)**: As new infrastructure is commissioned, the City accepts the responsibility of operating and maintaining the infrastructure according to O&M standards to ensure that the infrastructure is safe and reliable. Operations staff provide the day-to-day support required to operate infrastructure. In few cases, operation costs are minor, but for most there are significant increases. For example, underground pipes require almost no operational support while a facility such as a pump station requires full-time staff to operate the facility safely and efficiently. Maintenance expenses include periodic preventive maintenance to ensure that the infrastructure can provide reliable service throughout the life of the asset and corrective maintenance that is required to repair defective assets as and when needed. Inadequate funding for O&M will have an adverse impact on the lifespan of assets. The amount of O&M resources required in any period is a function of the current inventory of infrastructure and total O&M needs required for each asset. As the inventory of infrastructure grows, total O&M requirements will also grow.



- **Renewal and Replacement:** The third portion of full lifecycle costing relates to the renewal and replacement of infrastructure that has deteriorated to the point where it no longer provides the required service. Renewal cost is sometimes incurred during the life of an asset where an investment is made to improve the condition and / or functionality of the asset e.g., re-lining of a pipe or resurfacing of a road. Disposal and replacement costs are incurred at the end of an asset's life when it is disposed of and replaced by a fully new asset. Canadian municipalities, including City of Vaughan, have not traditionally factored renewal or replacement costs into future budget projections, except for assets that have a relatively short life such as computer equipment and vehicles. The main reason behind this is the fact that large portions of this infrastructure inventory can have a very long life e.g., from 75 to 100 years for underground pipes. For growing communities like the City, there has not been a historical need to forecast expenses that are not anticipated for decades. However, based on the experiences of more established Canadian cities (where vast inventories of old assets are now in dire need of renewal or replacement), it is vital that communities fully understand the looming obligations of infrastructure renewal or replacement and develop a strategy to respond in a manner that is fair and affordable.



- **Decommissioning and Disposal:** There will inevitably come a point in time when an asset must be removed from service and, depending on the type of asset, there may be significant costs associated with its decommissioning and disposal. Factors that may influence the decision to remove an asset from service include: changes to legislation that cause the asset to be in non-compliance, the inability of the asset to cope with increased service levels, technology advances that render the asset obsolete, the cost of retaining the asset is greater than the benefit gained, or the current risk associated with the asset's failure is not tolerable. Normally, major costs that may be incurred during disposal and decommissioning derive from the environmental impact of the disposal and, if required, the rehabilitation and decontamination of land. In some cases, there will be residual liabilities and risks to consider if a decision is made to partially abandon the asset as oppose to fully disposing of its components (e.g., leaving a non-functioning pipe in the ground, or an inactive building standing). However, some cost savings may be achieved through the residual value of the asset or by exploring alternative uses for the asset. In all cases, it is important to consider disposal and decommissioning as the strategy employed has the potential to attract significant stakeholder attention. For that reason, the costs and risks associated with disposal and decommissioning should be equally considered in the City's capital investment decision-making process.

The infrastructure AMPs present the City's strategy for responding to the full lifecycle costs of all its infrastructure assets. Long-range estimates were prepared together with the AMPs, based on industry best practices to ensure the financial sustainability of the City's infrastructure assets over their full life cycle, as discussed in the next Chapters.

4.2 Acquisition / Procurement / Construction Strategies

Added to City-purchased inventory is water infrastructure that the City accepts (and takes long-term financial responsibility for) from developers as new neighbourhoods are constructed. For example, as developers build new neighbourhoods, the new local infrastructure (including watermains) is paid for by the developer and then transferred to the City for operation, maintenance, and ultimately replacement. The City's infrastructure inventory was therefore created over many decades through infrastructure paid for by the City or by developers.

4.3 Operations and Maintenance Strategies

Water asset operations and maintenance (O&M) costs consists of three major components: water purchase from the Regional Municipality of York (York Region), pure water O&M activities, and overhead costs. **Table 4-1** presents the breakdown of activities and five-year average cost for the City's Water assets. All values listed in this section are the average costs of the 5 years from 2019 to 2023.

A significant expenditure is for water purchase from York Region. The average annual water purchase cost is $60,747,000, which is likely to increase in future years due to the planned population growth in Vaughan. The five-year average annual pure water O&M activities cost is $6,337,000. The overhead cost is approximately 35% of the pure water O&M activity cost.

Pure water O&M activities includes water operations, water leaking protection, backflow prevention program, material disposal, watermain repairs, watermain swabbing, flushing, flow tests, valve inspection, valve repairs/replace/inspect, chamber repairs, valve exercising, PRV inspection & maintenance, hydrant inspection/repair/maintenance/paint, hydrant winterizing, hydrant painting, hydrant daylighting, water service investigation, water service repairs, shutoff/turn-on service, water service swabbing, thawing, water service raise/lower, meter installations, meter reading, meter repairs/testing/replace, booster inspections, booster maintenance & repair, booster repair, water filling station maintenance, locates and stakeouts, sampling, stockpiling water/sewer gran, water connection services, and water AMI Program.

Table 4-1: Water O&M Activities and Five-Year Average Costs

O&M Activities	Description	Five-year Average Cost
Water Purchase	Water Division - Admin.	$60,747,000
Overhead	All overhead cost (e.g., compliance and training, business support, etc.)	$2,184,000
Pure Water O&M Activities	Include water operations, watermain activities, valve activities, chamber activities, hydrant activities, water leaking protection, water service activities, thawing, meter activities, water filling station maintenance, shutoff/turn-on service, booster station activities, AMI program, etc.	$6,337,000
Total		**$69,268,000**

4.4 Renewal and Replacement Strategies

4.4.1 Water Pipes

Pipe renewal. The following renewal activities are planned for water, wastewater, and stormwater mains:

- Pipe Bursting. Pipe bursting can be applied to brittle materials, and pipe splitting to ductile materials. The old pipe is ruptured and pressed into the surrounding soil while a new pipe follows the cone-ended bursting tool to replace the old pipe. The bursting tool is hammered through the host pipe by pneumatic or hydraulic means. The benefit of pipe bursting is that it allows for trenchless upsizing of the original pipe. The typical length of pipe replaced by pipe bursting is approximately 110m, but greater lengths have been accomplished. Pipe depth, soil conditions, adjacent utilities and service connections will dictate whether pipe bursting is appropriate. Pipe bursting can be used on almost any type of existing pipe except ductile iron (DI) or heavily reinforced concrete.

- Cured-in-Place Pipe (CIPP) Liners. Cured-in-place pipe liners (CIPP; also known as "cast"-in-place liners) have been commercially available since 1971 and are used to seal and or structurally renew existing pipes without excavation of the pipe itself. The basic CIPP liner product is a tube, impregnated with a liquid thermoset resin, inserted into a pipeline, and cured. CIPP liners were developed as a modified coating system, delivering resins in a carrying tube (often described as a "sock") that could hold the desired coating in place until the resin had time to cure. CIPP liners are either inverted, pulled in place, or manually inserted into the host pipe. All expand radially or are otherwise conformed tightly against the host pipe. Various resins are utilized including epoxy, polyester, silicate, and vinylester, and the most commonly used resins are styrene-based. Resins are either ambient cured, thermally cured (utilizing either hot water or steam), or ultraviolet light (UV) cured.

  CIPP liners will be an option for main renewal where open-cut intervention is not possible due to accessibility, and in particular, where the existing pipe is located under the following assets or in close proximity to the following features:

  - Regional roads;
  - Easements;
  - Railways;
  - Pipelines;
  - Bridges;
  - Rivers;
  - Walkways.

The use of trenchless technologies for pipe renewal and replacement is increasing and is predicted to grow into the future, as these technologies provide many benefits over open-cut pipe replacement. In terms of indirect costs, traffic disruption as a result of an open-cut pipe trench appears to be the greatest social cost to the consumer. By using trenchless technologies, utilities can reduce the societal burden by keeping roads open and not blocking business and local traffic. Other benefits of trenchless projects include improved safety (i.e., by not having an open trench) and that trenchless work does not interfere with other utilities or underground obstacles. Trenchless work is generally more cost effective than open-cut e.g., WERF estimates that cured-in-place lining enables savings of at least 10% over open cut methods. Another benefit of trenchless work is the elimination of cuts and patches in pavement which leads to the accelerated deterioration of the road surface.

Pipe replacement. Pipe replacement through trench open-cut is still fairly common within most municipalities, although open-cut work is typically disruptive to the adjacent area and requires a great deal of traffic control if the trench is located in a roadway. It tends to be slower than trenchless methods and more dangerous as workers / residents risk cave-ins when in or near the trench. Finally, trench open-cut methods generally are more expensive than trenchless methods. However, trench-open could still be the best / only option when trenchless methods are not viable.

Open-cut replacement consists of the traditional method of pipe installation, where an excavation crew typically digs a trench along the existing trench line using a track excavator or backhoe. The new pipe is laid, bedded and the trench is backfilled, compacted and the surface is reinstated as necessary.

The unit cost of pipe replacement through open-cut excavation needs to include the cost of excavation, laying the new pipe, backfilling and reinstatement. Other factors impacting costs include the installation of appurtenances such as valves, manholes, or catch basin leads and whether and how many service connections need to be re-connected. The cost of the surface reinstatement could vary significantly based on whether the excavation needs to be returned to the level of e.g., a collector road or only a landscaped surface.

Capital planning analysis. The water asset intervention process flow that governs the decision-making on when and how to intervene on the pipes in the analysis is presented in **Figure 4-2**.

The capital planning applied a conservative principle in estimating pipe and appurtenance replacement. The capital budgeting forecasts for pipes will reflect the cost of replacing or renewing pipes and its adjacent appurtenances, including service connections, chambers, valves, and hydrants. Oftentimes, the adjacent appurtenances' condition is based on the linear asset condition, thus, the investment requirement timeline is similar.

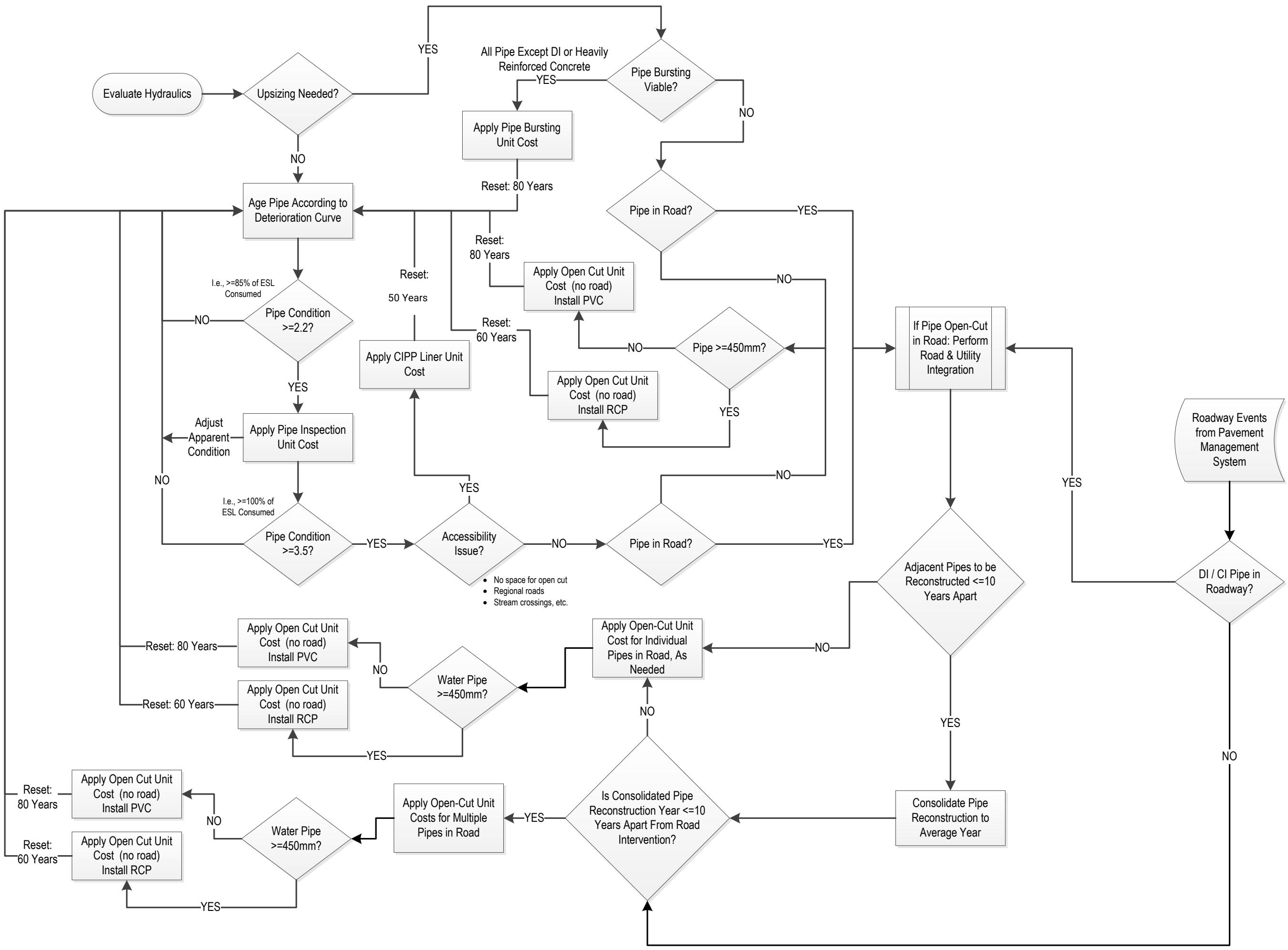


Figure 4-2: Water Asset Intervention Process Flow

Table 4-2 presents a summary of the key decision-points within the pipe intervention process flow, and an explanation of the asset management decision methodology.

Table 4-2: Pipe Intervention Process Decision Points & Explanations

Decision Point	Decision & Explanation
Upsizing Needed?	YES: If a hydraulic constraint is identified (from elsewhere e.g., the City's hydraulic model) and the pipe is required to be up sized to the required pipe diameter, the next step is to consider whether pipe bursting is viable. NO: If no hydraulic constraint is identified, no pipe upsizing is needed.
Pipe Bursting Viable?	YES: If pipe bursting is viable (i.e., viable for all pipes except for DI or heavily reinforced concrete pipes) then apply the pipe bursting unit cost to the length of pipe replaced. Reset pipe age to zero and apply an 80-year ESL to new pipe. NO: If pipe bursting is not viable (i.e., pipe is DI or heavily reinforced concrete), the next step is to consider whether the pipe is in a road.
Pipe Condition >= 2.2?	YES: If the pipe condition is equal or more than 2.2 (i.e., equal or more than 85% of the pipe ESL has been consumed), then trigger a pipe inspection and apply the inspection unit cost table. NO: If the pipe has not yet reached a condition of 2.2 then the asset management software will "age" the pipe according to the applicable deterioration curve until it reaches a condition of 2.2 and then trigger an inspection.

Decision Point	Decision & Explanation
Pipe Condition >= 3.5?	YES: If the pipe condition is equal to or greater than 3.5 (i.e., equal to or more than 100% of the pipe ESL has been consumed), then trigger a pipe renewal or replacement. The next step is to consider whether CIPP is a viable option for pipe renewal. NO: If the pipe has not yet reached a condition of 3.5 then the asset management software will "age" the pipe according to the applicable deterioration curve until it reaches a condition of 3.5 and then trigger a pipe renewal or replacement.
Accessibility Issue?	YES: If the City flags the pipe as having an accessibility issue such as within / next to a Regional road, at a stream crossing, or where there is no space for an open cut intervention, then apply the CIPP unit cost to the length of pipe. Reset pipe age to zero and apply a 25-year ESL to the re-lined pipe. NO: If accessibility is not an issue (i.e., the pipe is not within / next to a Regional road, at a stream crossing, or where there is no space for an open cut intervention), the next step is to consider whether the pipe is in a road.
Is CIPP Viable?	YES: If CIPP is viable (i.e., the pipe has not yet been re-lined or reached a condition of 3.5 / is beyond its ESL), then apply the CIPP unit cost to the length of pipe. Reset pipe age to zero and apply a 25-year ESL to the re-lined pipe. NO: If CIPP is not viable (i.e., the pipe has been re-lined once already or has reached a condition of 3.5 in 2016 / is beyond its ESL), the next step is to consider whether the pipe is in a road.
Pipe in Road?	YES: If an open-cut excavation pipe replacement is needed and the pipe is in a road, then the next step is to consider whether any adjacent pipes need to be replaced less than ten years apart. NO: If an open-cut excavation pipe replacement is needed but the pipe is not in a road, then apply the basic open-cut unit cost to the length of pipe to be replaced. Reset pipe age to zero and apply an 80-year ESL to new pipe.
Pipe => 450mm?	YES: If the pipe diameter in equal or greater than 450mm, then replace pipe with reinforced concrete pipe (RCP), and apply a 60-year ESL to the new pipe. NO: If the pipe diameter is less than 450mm, replace pipe with PVC pipe, and apply an 80-year ESL to the new pipe.
Adjacent Pipes to be Reconstructed <10 Ten Years Apart.	YES: If the years of open-cut reconstruction of two or more pipes in the same roadway are less than ten years apart, then calculate the average of the years and apply that as the year of reconstruction. Adjust the years of utility work to match the years of road work if it is within 10 years of one another. Apply the unit cost table for open-cut excavation in a roadway for two or three pipes, as needed, over the length of pipes reconstructed. Reset the pipes' age to zero and apply an 80-year ESL to new pipes. NO: If the years of open-cut reconstruction of two or more pipes in the same roadway are more ten years apart, do not adjust the reconstruction year. Adjust the years of utility work (one pipe) to match the year of road work if it is within 10 years of one another. Apply the unit cost table for open-cut exaction in a roadway for one pipe, over the length of pipe reconstructed. Reset the pipe age to zero and apply an 80-year ESL to new pipe.
Risk Category = A	YES: Pipe asset deemed critical and asset inspection & renewal should be prioritized based on risk rating; NO: Assets are less critical, and repairs can be pushed out to align with pavement renewal program. Note: Use when prioritizing within budget constraints.

4.4.2 Water Meters

Aging makes water meters become less accurate, leading to a loss in revenues as water consumption is not accurately recorded. However, the premature replacement of water meters that are still reading consumption accurately is a waste of resources. Between these two economically opposing forces there is a point that economically justifies the cost of meter replacement. As such, the optimum service life of a meter depends on prevailing water rates, rate of meter wear (and loss of accurate registration), repair and maintenance costs, and inflation and discount rates. Ultimately, there's no standard time period for meter replacement that can be broadly applied to all utilities as local conditions such as chemical composition of the water, temperature and humidity all impact on meter life. Within Canada there is significant variability in meter replacement schedules between water utilities and a recent survey by the Canadian Infrastructure Benchmarking Initiative found that utilities generally change out between approximately 4% and 10% of their meters per year. Due to more water being sold and revenue generated through ICI meters, some utilities might even have a different replacement cycle for these meters e.g., changing 20% of their ICI meters out per year. With the latter numbers in mind and for the purpose of the Water AMP, the City has applied a 5% meter change-out cycle, which is equivalent to changing all meters out every 20 years.

4.4.3 Water Pressure Reducing Valves

The City has a 4% PRV change-out cycle, which is equivalent to changing all PRVs out every 25 years.

4.4.4 Water Facilities

In 2020, the City performed a Building Condition Assessment and generated facility inventories and 10-year capital renewal plan for North Maple Booster Station and Teston Water Filling Station. In 2017, the City conducted a condition assessment for Woodland Acres Pressure Elevation System and developed a renewal plan. The full inventory of water filling stations are East Filling Station, Central Filling Station, and North Filling Station (Teston). The City has applied a flat rate based on the existing AM Plans for the capital planning analysis period.

4.5 Decommissioning and Disposal Activities Strategies

Asset decommissioning and disposal activities are performed to decommission and dispose of assets due to ageing or changes in performance and capacity requirements. This decision process includes the consideration of costs and benefits of rationalization using a whole life approach, the impact of asset rationalisation on other infrastructure and the processes for disposal of assets. More specifically, the following factors need to be evaluated when considering the decommission and disposal of assets:

- Assets not required for the delivery of services, either currently, or over the longer planning period.
- Assets that have become uneconomical to maintain or operate.
- Assets that are not suitable for service delivery.
- Assets that have a negative impact on service delivery, the environment, or community.
- Assets that no longer support the City's service objectives due to a change in type of service being delivered or the delivery method.
- Assets where their use has become uneconomical due to the limited availability of spares or the cost of their replacement parts.
- Assets where their technology has been outdated.
- Assets which can no longer be used for the purpose originally intended.

Considerations for the City's asset decommissioning and disposal activities include, but are not limited to:

- Updates to the City's Statement of Tangible Capital Assets. Considerations related to the determination of residual value and the disposal of assets include:
  - ➢ Residual value and the useful life of an asset should be reviewed, at the very least, at each financial year-end and, if expectations differ from previous estimates, any change should be accounted for prospectively as a change in estimate.
  - ➢ The depreciation method used should reflect the pattern in which the asset's economic benefits are consumed.
  - ➢ The depreciation method should be reviewed, at the very least, annually and, if the pattern of consumption of benefits has changed, the depreciation method should be changed prospectively as a change in estimate.
- Updates to asset databases such as the GIS and CMMS.
- Environmental impact of disposal and implications for land rehabilitation, where applicable.
- Continued service delivery while a new asset is being constructed / commissioned: overlap of the start-up of new assets / facilities and the decommissioning of existing assets / facilities being replaced.
- Cost of decommissioning and disposal.

4.6 Capital Planning

Capital investment is to address community growth or changes, or to renew existing assets to maintain service levels. For the actual funding needs assessment, please refer to **Section 5**.

- **Life Cycle Cost Analysis Approach**. The City's analysis enables optimized decision making and mathematical deterioration modelling of infrastructure assets and the development of short, medium and long-term forecasts of renewal and replacement costs of a number of decision criteria and the ability to compare different intervention options to find the optimal solution in terms of timing and the intervention option chosen.
- **Forecast Periods.** The City aims to develop Short- to Medium-Term and Long-Term capital plans. Typically, short to medium-term capital plan identifies the activities required to meet current and future demand, the cost of those activities and a financing approach. It is developed or renewed every three to five years and should coincide with regulations on short to medium-term expenditure planning. A long-term plan can serve as part of Strategic Asset Management Plan, which indicates what will be spent, by service areas, over a set period of time. Long-term plans tend to focus only on costs.

  Consistent with the approach of other asset management plans, the analysis periods for funding need assessments are 20 years. Given the longer expected service life of water assets, a 100-year forecast was also modelled to provide a directional estimate of long-term costs.

4.7 Asset Prioritization

4.7.1 Risk Assessment

Infrastructure-related risk exposure is assessed based on the combined consideration of probability and consequences of an asset failure, which is used to drive the selection and prioritization of appropriate action, based on risk tolerance thresholds and funding availability. Understanding the risk exposure for a given set of assets allows the City to identify where they are most exposed to risk, and to target their investments to most effectively reduce that exposure.

In addressing risk for infrastructure assets, the first step in the analysis is to identify assets that are most critical to the business. Critical assets are those that will potentially have the greatest impact on service delivery should they fail. It should be noted that the parameters, criteria and weighting factors area starting point, and should be reviewed and modified to reflect the priorities of the City on an ongoing basis.

The fundamental principle of consequence (or criticality) models is that they evaluate the relative importance of assets based on select criteria. The approach to risk analysis within this project utilizes a triple-bottom-line assessment approach utilizing the following four criticality indices:

- **Economic** – influence of the asset's failure on monetary resources
- **Operational** – influence of the asset's failure on operational ability
- **Social** – influence of the asset's failure on society
- **Environmental** – influence of the asset's failure on the environment

By applying specific indices, the risk assessment framework generates a risk (or priority) score for each asset. The risk score is a rating of the asset based on the detailed assessment of the likelihood and consequence of failure based on a number of key parameters. All parameters are then equated using equation [2].

$$\textit{Risk} = \textit{Likelihood of Failure} \times \textit{Consequence of Failure} \qquad [2]$$

Based on this principal, the risk associated with a given asset's failure can be managed by limiting the likelihood of this occurring, or the impact realized, should it occur.

Consequence of Failure (CoF) reflects the relative "impact" of a given asset's failure. While traditionally these have been looked at as purely economic terms (i.e. repair cost, loss of revenue, etc.), the truth is that investment decisions are often driven by non-economic factors. Understanding both the economic and non-economic impacts associated with loss or limitation of service help in categorizing an asset's "criticality" and justifying infrastructure decisions in a consistent, defensible manner.

4.7.2 Risk Assessment Results

A detailed risk assessment was performed as part of a 2016 project for the City. A risk score was calculated for each watermain using its Likelihood of Failure (LoF) and Consequence of Failure (CoF) score. LoF for watermains was estimated using a combination of the Weibull age deterioration and expected service life approach and the City's main break history. The age of mains contributed to 75% of the LoF score while the break history was responsible for the remaining 25%. The relative contributing percentage values of age versus main breaks are variable and can be adjusted, as applicable. The potential exists to incorporate soil corrosivity in the future assessment of LoF, once the City has a better idea of which soils contribute to the exterior corrosion of metallic mains. The CoF for the new developed assets after 2016 were determined by a multi-regression method. Please refer to 2016 Risk Management Framework Report for more details.

Figure 4-3 shows the risk map for watermains. As the City's assets are relatively young, most of the watermains fall in Low-risk category.

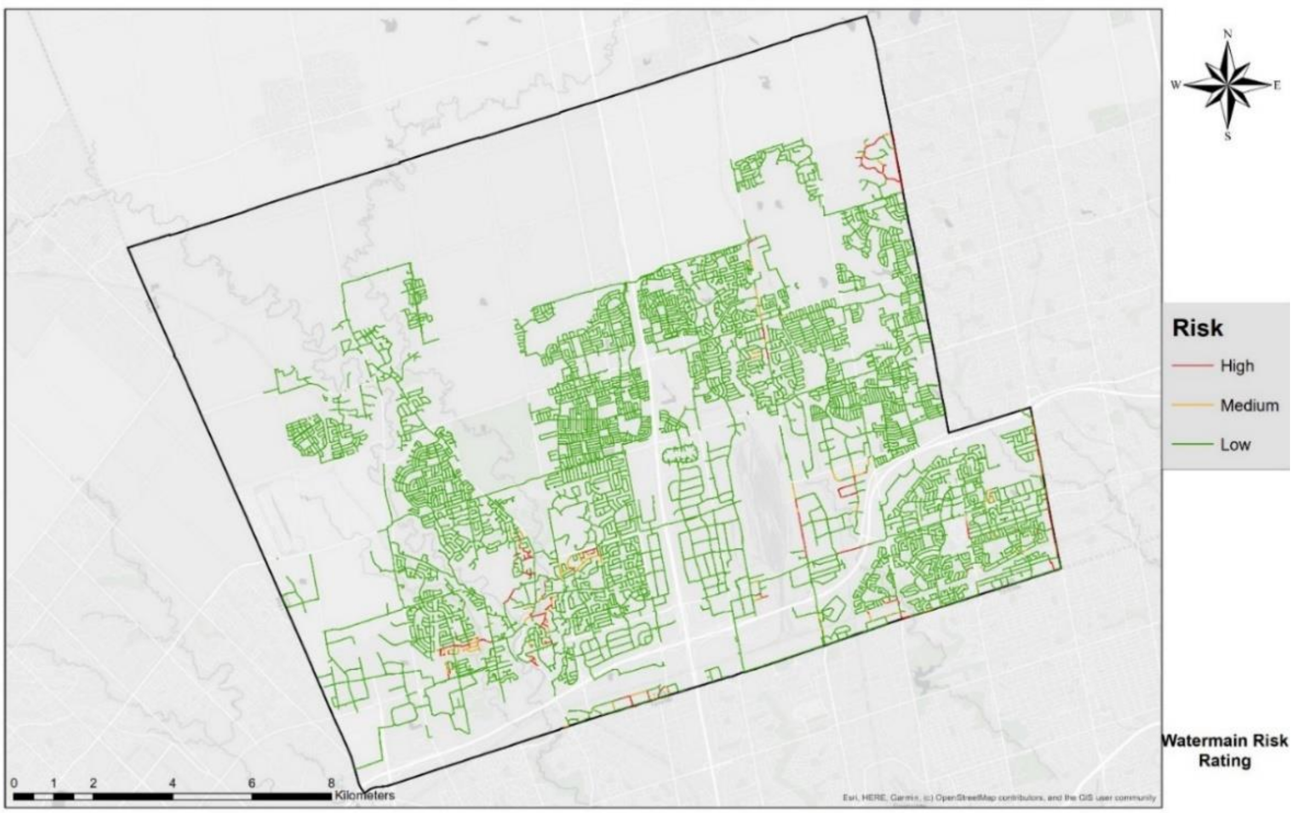


Figure 4-3: Watermain Risk Map

4.7.3 Analytical Logic to Sequence Interventions

The asset criticality score can be used to prioritize projects within a funding constrained environment. **Figure 4-4** illustrates this logic of carrying unfunded needs to the next year in the period where they receive a higher probability of receiving funds based on their criticality score.

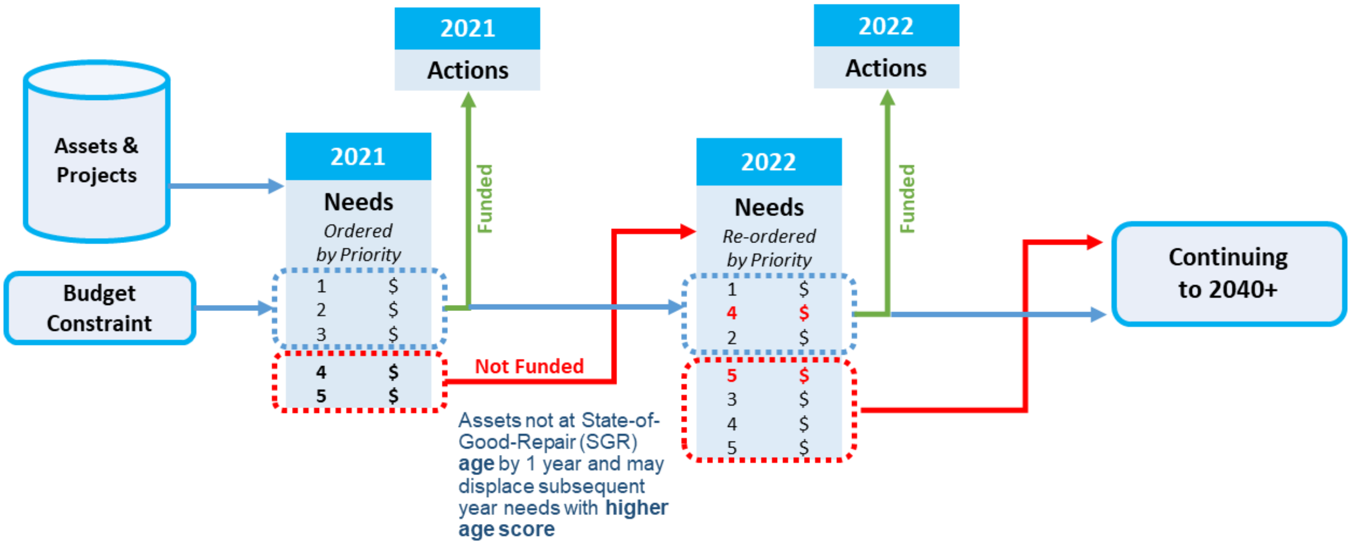


Figure 4-4: The Role of Criticality to Prioritize Projects Within A Funding Constrained Environment

4.8 Financial Planning

4.8.1 Financial Policies

The City has taken the initiative to establish financial asset management policies in 2018, which provides directions on how financial principles apply to assets to ensure that service goals are met. The policy aligns the business model of AM with the City's financial planning, financial reporting, cost management, treasury and taxation functions. The City will integrate findings from the AM Plans into its long-term financial planning and budgeting processes. Sound financial analysis will be encompassed in AM planning in order for the AM Plan to be a sought-after guide for employees in budgeting and financial planning.

4.8.2 Financial Analysis

Financial analysis activities for asset management are centered on two essential quantities: revenues and expenditures. Revenues can come from many sources. Through asset operations, the City generate its own source revenues from taxes, development charges, etc. Expenditures are all the direct and indirect costs associated with capital, operating and maintaining, and disposing of assets.

Assessing the financial implications support the decision-making when there are competing priorities and trade-offs between projects. Financial analysis provides a better picture of how to fund the capital plan and make critical decisions about service delivery while providing the greatest benefit for the community at the lowest cost.

4.8.3 Aligning the Financial and Non-Financial Functions of AM

ISO 55010[1] identifies the that the financial and non-financial functions of AM within organizations are generally inadequately aligned, as follows:

- **Financial Accounting Functions:** Focused on retrospective reporting of accounting / regulatory financial activities. However, there is a growing awareness in organizations of the need to focus on providing a managerial costing approach in order to support decision-making for the future.

[1] International Organization for Standardization (2019): ISO 55010 - Asset management — Guidance on the alignment of financial and non-financial functions in asset management

- **Non-Financial Functions:** Have a limited understanding of financial accounting functions but are recognizing the need to improve their understanding of the financial implications of their activities.

The lack of alignment between financial and non-financial functions can be attributed to silos in an organization, including reporting structures, functional / operational business processes, and related technical data. Silos generally bring forth the necessary level of specialization. However, with a lack a communication between the silos, organizations are at risk of inefficiencies and errors in AM results, or AM failures due to a lack of alignment between AM staff and senior management. Financial and non-financial alignment needs to work both "vertically" and "horizontally", as follows:

- **Vertical Alignment:** Financial and non-financial asset-related directives by management are informed by accurate upward information flows, effectively implemented across the appropriate levels of the organization.
- **Horizontal alignment:** Financial and non-financial information that flows between departments (conducting functions such as operations, engineering, maintenance, financial accounting and management) uses the same terminology and refers to the assets identified in the same way.

Figure 4-5 presents the key elements in a framework to address the need to achieve the alignment.

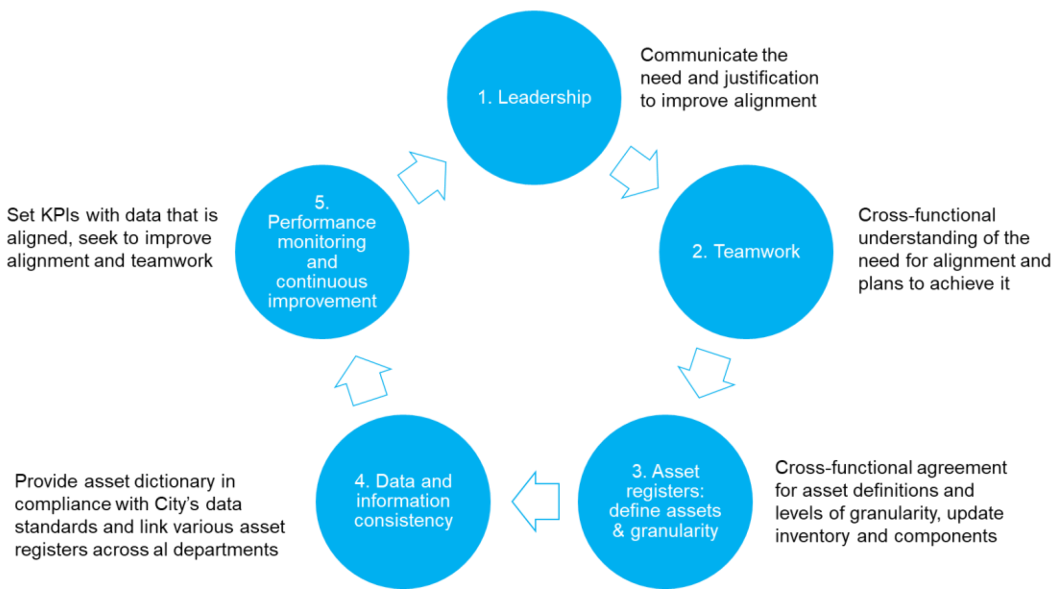


Figure 4-5: Key Elements of a Framework to Achieve Financial and Non-Financial Alignment

4.8.4 Long-Term Financial Planning

Strengthening the City's AM planning according to the recommendations in the Asset Management Strategy will improve the City's long-term financial planning, by accounting for whole life cycle costs as presented in Section 4. This includes all capital, annual operation and maintenance, and disposal costs over the planning timeframe, thereby aligning financial requirements with long-term level of service objectives.

The challenge is often one of agreeing on a timeframe for such planning, recognizing that the AM perspective is ideally focused on the asset life cycle, versus the political / election cycle that could be as short as a three to four-year Council term. Accordingly, financial and non-financial staff, as well as top management and politicians, should agree on a long enough timeframe to provide useful forward planning information that aligns the financial and non-financial perspectives, as presented in Figure 4-6.

Figure 4-6: AM Planning Alignment Across the Organization

The City should have an appropriate long-term financial planning process that achieves the following:

- Stimulates long-term strategic thinking and perspective for stakeholders and decision-makers.
- Can be used as a tool to prevent or predict future financial shocks and demonstrate financial sustainability.
- Demonstrates to internal and external stakeholders that the organization has a financial strategy in place to meet their demands, now and in the future.

The long-term financial planning process needs to involve financial and non-financial staff working together to combine the important elements of strategy development, asset management planning and financial forecasting (**Figure 4-5** and **Figure 4-6**).

5. Funding Need Analysis

5.1 Water 20-Year Funding Need Analysis

The average annual reinvestment rate required to fund all replacement and rehabilitation activities for the City's water infrastructure assets over the next 20 years is $15.3M per year in 2024 dollars, as presented in **Figure 5-1**. This is equivalent to a total of $306M over the next 20-year period.

Given that the expected service life of water assets can be close to 100 years, the City modelled a 100-year forecast to determine the average annual reinvestment rate over the next century. This results in an average annual reinvestment rate over the next century of $22M per year. This is equivalent to a total of approximately $2.2B over the next 100-year period.

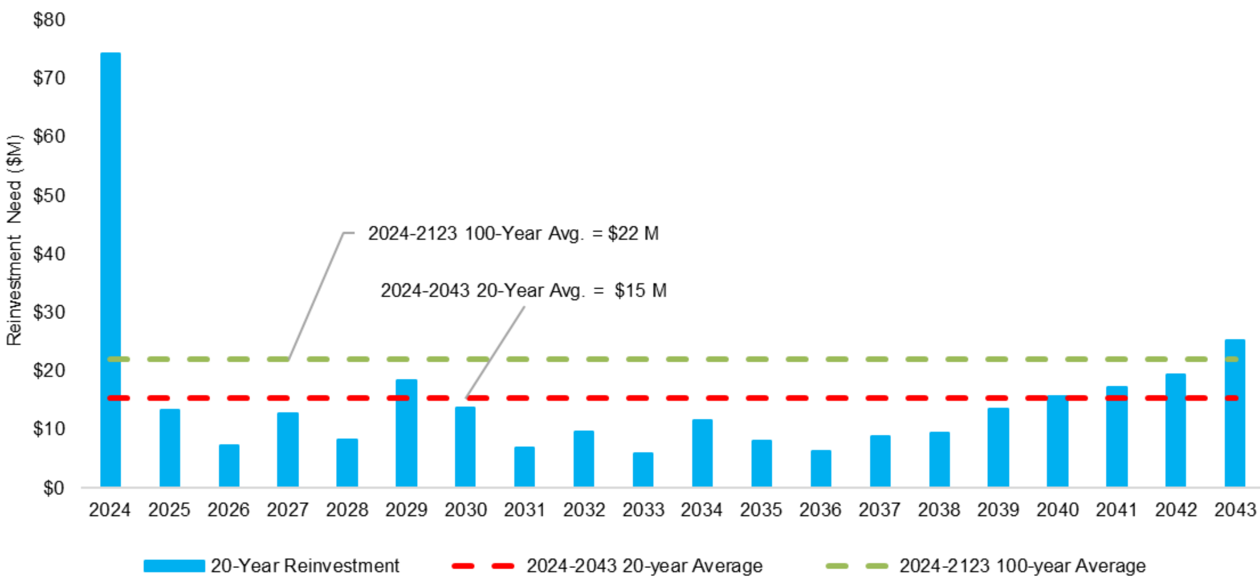


Figure 5-1: Water 20-Year Total Reinvestment Need

Figure 5-2 breaks down the 20-year reinvestment value into 3 sub-categories:

- **Mains and direct appurtenances** refer to all assets that might be replaced or rehabilitated at the same time as a main, including mains, services, curb stops, hydrants, valves, and chambers.
- **Non-linear assets** refer to all assets that would be replaced independently from a nearby main replacement. This category includes pressure reducing valves (PRVs), pump stations, water meters, and filling stations.
- **OpEx** refers to asset inspection and major repair/maintenance programs. There are currently no programs in this category.

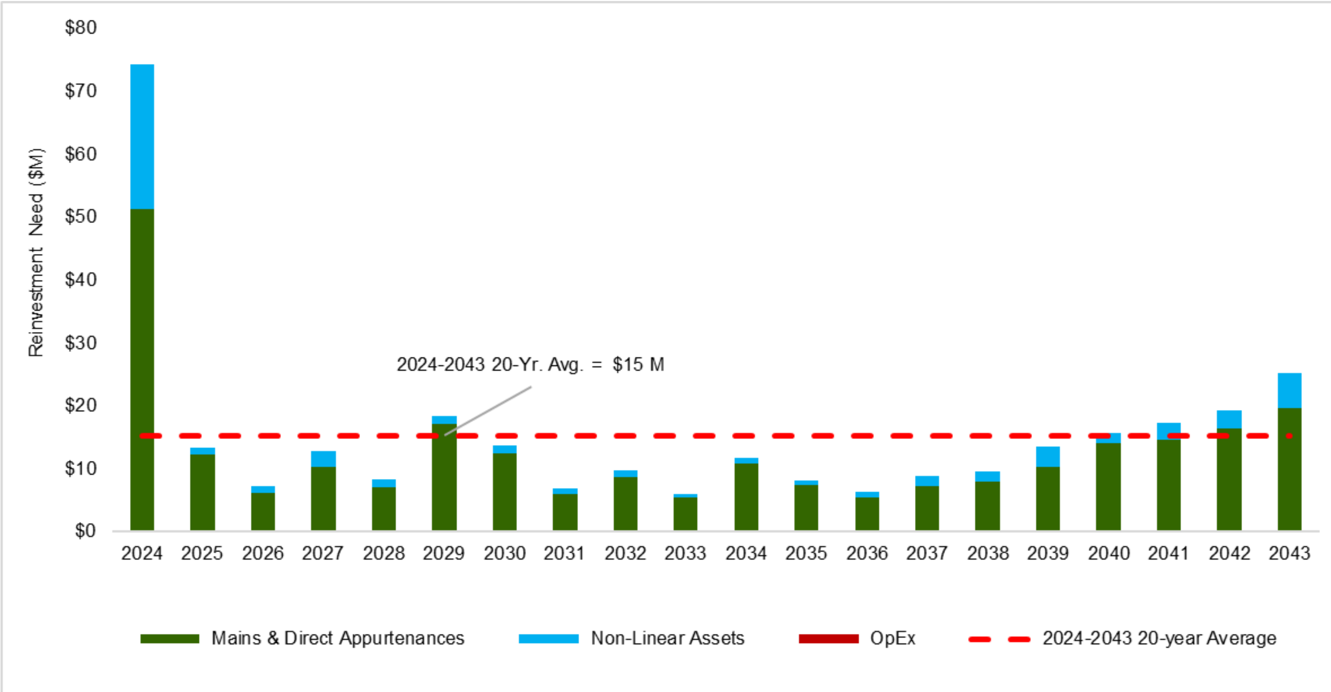


Figure 5-2: Water 20-Year Reinvestment Need Details

As shown in **Figure 5-2** above and **Table 5-1** below, 82% of expenditures over the next 20 years are for the renewal of mains and direct appurtenances. Water meters account for most of the remaining expenditures (17%), while facilities and PRVs account for approximately 1% combined.

Looking at the next 100 years, these ratios change slightly. Approximately nine-tenths (89%) of expenditures over the next century are for the renewal of mains and direct appurtenances, while water meters represent 11%. Facilities and PRVs account for approximately 0.6% combined. The City should prepare for more reinvestment funding as the assets continue to age.

Table 5-1: 20-Year Total and Annual Average Reinvestment Need

	Mains & Direct Appurtenances	Water Meters	Facilities	PRVs	Total
Annual Average Need	$ 12,497,000	$ 2,618,000	$ 168,000	$ 15,000	$ 15,298,000
20-Year Total	$ 249,939,000	$ 52,357,000	$ 3,367,000	$ 303,000	$ 305,663,000
% of Total Expenditures – 20-Year Forecast	82%	17%	1%	0.1%	
% of Total Expenditures – 100-Year Forecast	89%	11%	0.5%	0.1%	

The total annual reinvestment rate from **Figure 5-1** has been overlaid with the O&M annual budget (based on 5 year historical values, using 2024 dollars), as presented in **Figure 5-3**.

Water assets require approximately $170.4M O&M funding over the next 20 years, equivalent to $8.5M per year in 2024 dollars. As such, with the addition of O&M, the total average annual reinvestment rate for the City's water infrastructure assets increases to approximately $23.8M annually, for a total of $476.4M over the next 20-year period, as presented in **Figure 5-3**.

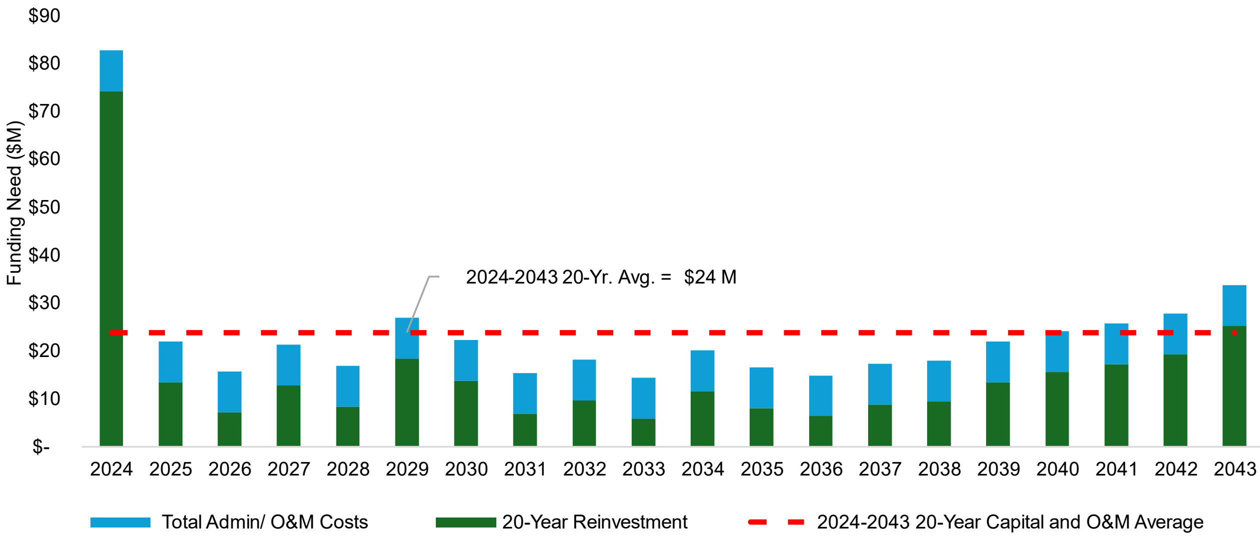


Figure 5-3: Water 20-Year Capital Investment and O&M Cost Forecast

5.2 Full Funding Need Profile

Figure 5-4 shows a full picture of the City's Water Service funding need forecast over the next 20 years, which provides the City the full funding requirements in order to perform effective financial planning activities. The total annual reinvestment rate and O&M cost from **Figure 5-3** has been overlaid with the City's five-year annual average water purchase cost.

The City's water service funding requirement increases to approximately $1.7B over the next 20 years with additional funding requirement of water purchase, and O&M, equivalent to $85M per year in 2024 dollars. It is notable that the funding requirement for the Regional water purchase is significant compared to capital requirement and O&M requirement, as presented in **Figure 5-4**.

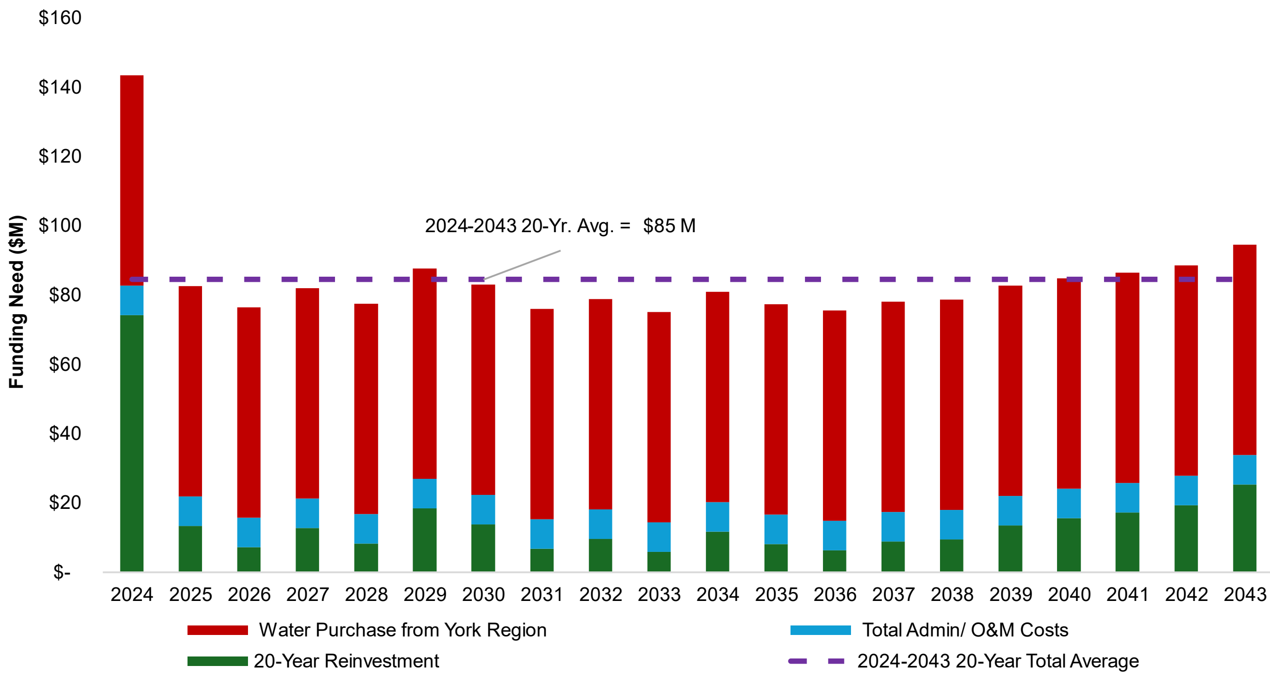


Figure 5-4: Water Full Funding Need Profile

5.3 Infrastructure Reserves Funding Forecast

Reserve funds are important tools in the planning and management of the City's financial resources and provide a strong indicator of the City's overall financial health and are fundamental to the City's long-term financial sustainability. The City is committed to maintaining healthy reserve fund balances which are collected through various means (i.e., development charges, contributions, dedications, taxation, etc.).

There are specific infrastructure reserves for the rate-supported service areas of Water, Wastewater and Stormwater. These reserves contain funds set aside through annual contributions from ratepayers to help pay for the repair and replacement of infrastructure assets. Like many municipalities across Canada, Vaughan is facing increased costs associated with maintaining aging infrastructure. Corporate Asset Management Plans for both core and non-core assets suggest the City's infrastructure deficit is large and growing. The City has continued with robust strategies and plans by developing a comprehensive Long-Range Fiscal Plan and model, which was used to better inform the 2025 and future budgets by providing information about the financial requirements to sustain growth, delivery of services and the community's infrastructure needs.

Prudent financial planning requires ongoing contributions to water, wastewater, and stormwater reserves to fund the repair and replacement of infrastructure. Safe and reliable drinking water distribution, effective wastewater collection and efficient stormwater management are cornerstones of a sustainable and healthy community. To achieve this, continued operating and infrastructure investments are critical to ensure the City's water, wastewater and stormwater systems remain financially sustainable now and into the future. This objective is supported by continuing to build service area infrastructure reserves. The 2025 budgeted rates and charges will generate net total reserve contributions of $23.2 million to fund water, wastewater and stormwater-related programs and services. The City is committed to ensuring the financial sustainability of these systems and the ongoing protection of the environment in alignment with the Safe Drinking Water Act, Ontario Water Resources Act, the Environmental Protection Act and the Growth Plan for the Greater Golden Horseshoe.

The City's Asset Management Plans assess average reinvestment requirements over the next 20 years for the City's core assets, including water, wastewater and stormwater infrastructure. Annual reserve contributions should generally be in line with the asset reinvestment requirement to ensure sufficient funds are set aside for asset rehabilitation and replacement needs.

For the Water reserve, the forecasted 20-year average funding need is $15.3M. In comparison, the average annual funding forecasted over the next 10 years is estimated to be $12.1M representing a funding coverage of 79% as illustrated in **Figure 5-5**. The funding sources in this forecast are limited to annual reserve contributions and the

Canada Community-Building Fund (CCBF is provided from the Federal Government). Other available funding sources not included are debentures and non-CCBF grants, which would mitigate any infrastructure funding gaps.

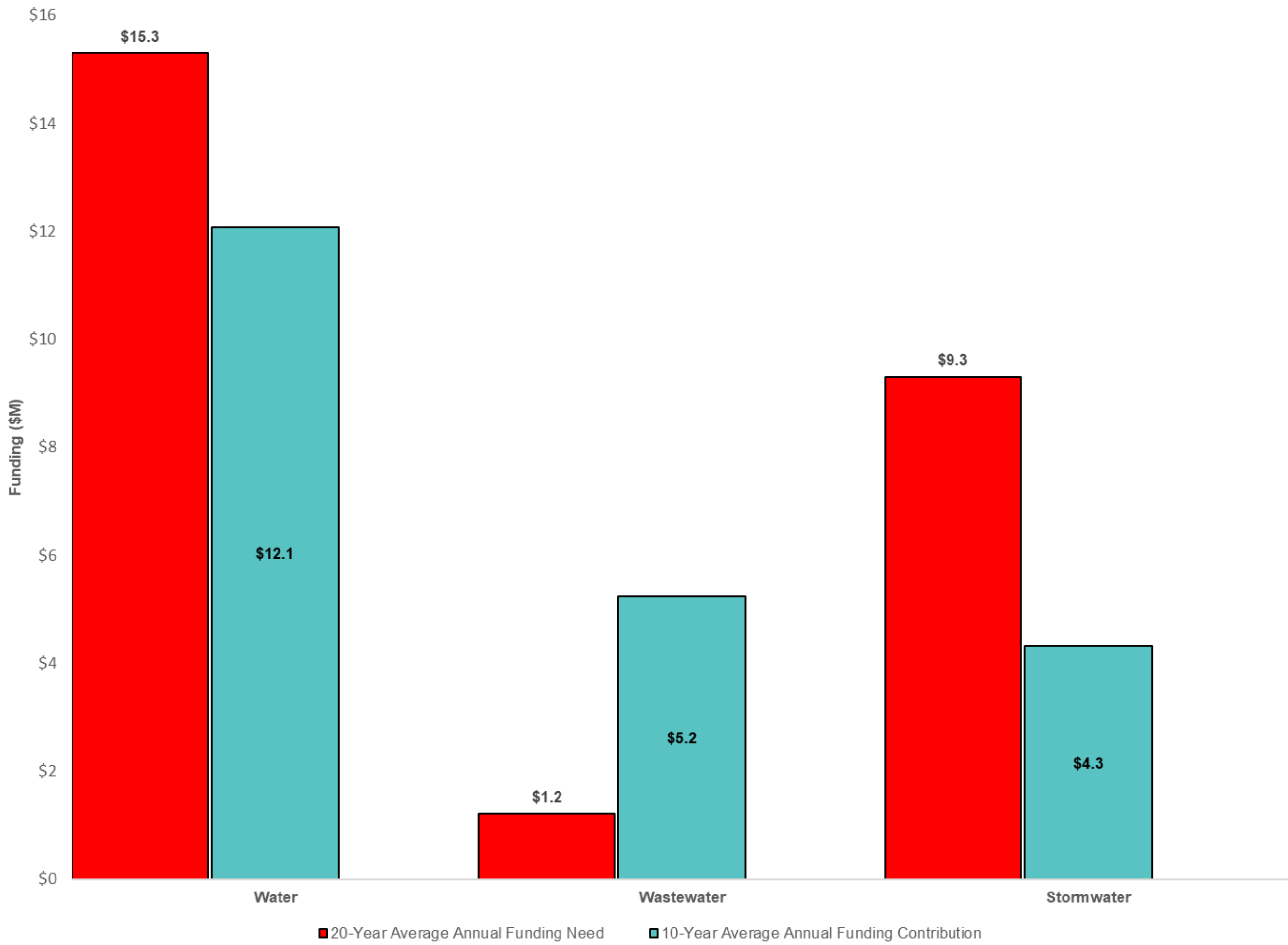


Figure 5-5: Coverage of Average Annual Funding Needs for Rate-Supported Service Areas

Revisiting the timing and scope of capital projects, optimizing the use of existing funding tools and revenue sources, such as debt and dedicated contributions to capital reserves, can help increase the City's capacity to begin to close an infrastructure funding gap.

5.4 Growth-related Assets Funding Need

The City completed the Integrated Urban Water Plan (IUWP) Master Plan Study in 2024. The objective of the study was to develop a plan to meet the water, wastewater and stormwater infrastructure needs as the City's communities continue to grow. This study analyzed the city-wide infrastructure needs to identify the required infrastructure that will meet future servicing demands. The study assessed the existing and future servicing needs and provides servicing recommendations to meet the City's growth plans. Based on the IUWP, the forecasted funding need estimates for the construction of new Water assets out to 2051 is illustrated in **Figure 5-6** with a primary funding source for these needs being Development Charges.

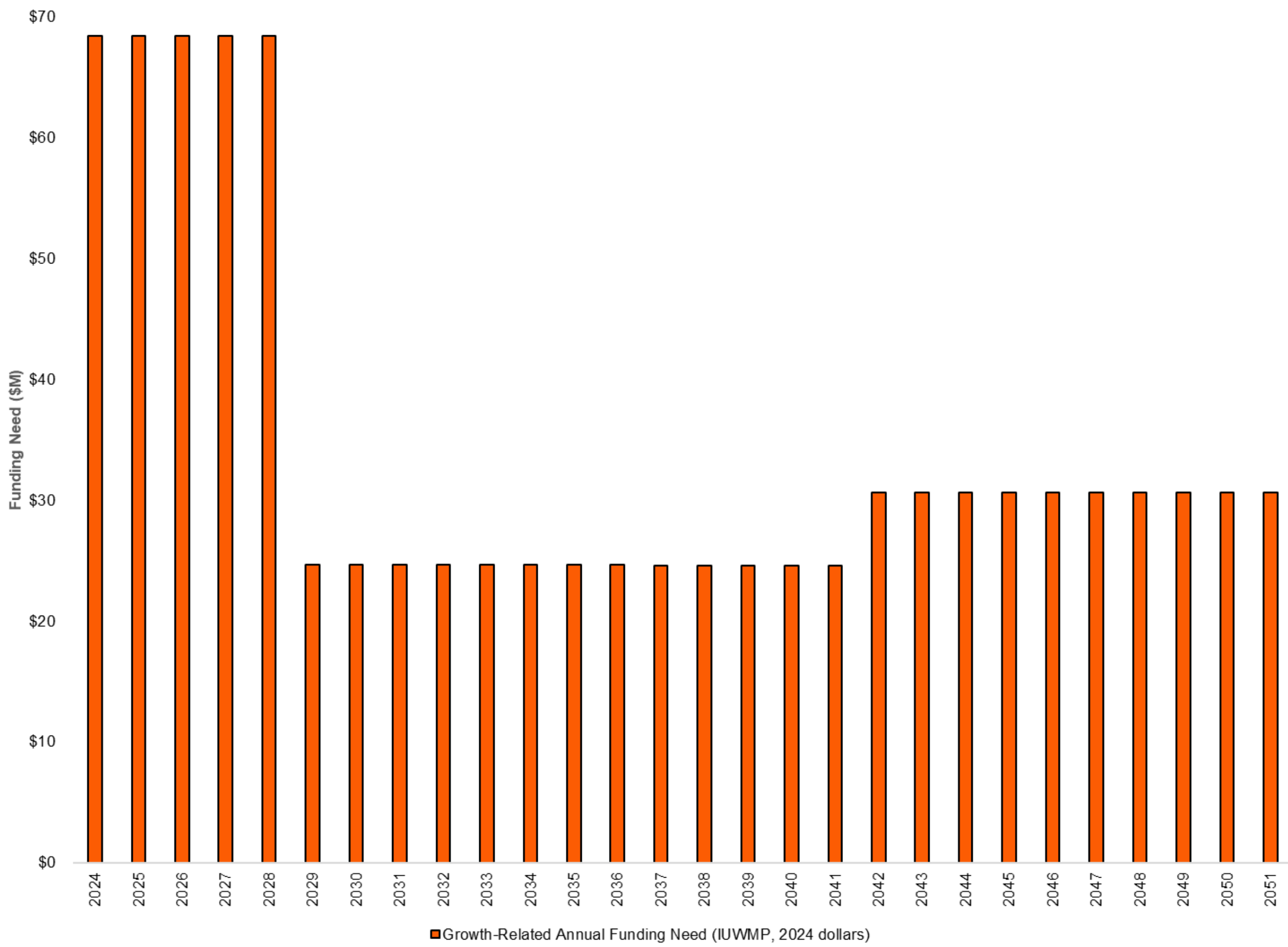


Figure 5-6: Forecasted Funding Needs for Construction of New Water Assets

One of the next steps in the further development of the IUWMP is to apply added detail to the forecasted funding need estimates. This will provide a more refined forecast, which will serve to provide additional guidance for Asset Management planning in the future at the City of Vaughan.

Asset Management Plan

Core Assets
Wastewater

City of Vaughan
March 2025

Table of Contents

Figures

Tables

1. Introduction

The City of Vaughan (The City) has conducted a renewal of the City's Asset Management (AM) Plans for all its infrastructure assets, including Wastewater Assets.

1.1 Background

The City is one of nine area municipalities located within the Regional Municipality of York. As a lower tier municipality, the City is responsible for providing services such as buildings, fire protection, public works, water distribution, wastewater collection, and parks and recreation.

The next 25 years will see the City transition from a growing suburban municipality to a fully urban space. This type of transition will require long-term thinking about how best to accommodate and make the most of new opportunities. Planning for the future through strategic planning will position the City to deal with the many pressing issues impacting the organization such as community safety, access to health facilities, environment, traffic congestion and issues related to growth and the quality of municipal services.

The City is one of Canada's fastest growing cities, with a population of over 320,000 according to the latest census from Statistics Canada. It is projected that the number of residents will increase to 415,000 by 2031. In addition to its rapidly growing population, the City is home to a well-diversified and expanding employment sector with over 7,800 businesses and 231,000 employees. The City has the largest supply of new employment lands in the Greater Toronto Area (GTA) and it is projected that the number of employees will increase to 271,000 by 2031.

1.2 Objectives

In 2018, by City Council approval, the Corporate Asset Management (AM) Policy for the City came into effect; and, in 2013, the City's first Corporate AM Strategy was published. As identified in the Corporate AM Strategy, the City's first set of AM Plans (AMPs) were developed in 2014.

In early 2021, the City updated its AM Strategy and core infrastructure AMPs, as per Ontario Regulation (O. Reg) 588/17. The purpose of this series of AMPs is to now update the infrastructure assets so as to provide the City with a comprehensive updated AM Plan.

The objective of this AMP is to deliver a financial and technical roadmap for the management of the City's roadway appurtenance assets, and to provide the means for the City to maximize value from its assets, at the lowest overall expense while, at the same time, providing enhanced service levels for its residents and promoting green initiatives.

Organizations that implement good AM practices will benefit from improved business and financial performance, effective investment decisions, and better risk management. Stakeholders can expect lower total asset life cycle costs, higher asset performance, and confidence in sustained future performance.

1.3 AM Provincial Requirements

The Ontario Regulation 588/17 (O. Reg. 588/17) came into effect in 2018 and stipulates specific AM requirements to be in place within Ontario municipalities by certain key dates (**Table 1-1**). The development of this AMP is one of the steps to guide the City towards meeting the July 1st, 2025 deadline.

Table 1-1: O. Reg. 588/17: AM Planning for Municipal Infrastructure

Description: A regulation made under the Infrastructure for Jobs and Prosperity Act, 2015, stating that every municipality shall prepare and update a Strategic AM Policy, and that every municipality shall prepare an AM Plan for its core infrastructure assets by July 1, 2022, and an AM Plan for all other infrastructure assets by July 1, 2024. The regulation outlines several requirements that each AM Plan must follow, such as including current and proposed level of service. Core municipal infrastructure assets include water, wastewater, stormwater, road, and bridge assets.	
Deadline Date	Regulatory Requirement
July 1st, 2019	All municipalities are required to prepare their first Strategic AM Policy.
July 1st, 2022	All municipalities are required to have an AM Plan for its entire core municipal infrastructure (i.e., water, sanitary, stormwater, and transportation).
July 1st, 2024	All municipalities are required to have an AM Plan for infrastructure assets not included under their core assets.
July 1st, 2025	All AM Plans must include information about the levels of service that the municipality proposes to provide, the activities required to meet those level of service, and a strategy to fund activities.

1.4 Scope

This AMP has been developed for the City's Wastewater Assets categories, owned and maintained by the City, as shown in **Table 1-2**: In-Scope Assets. The renewal of the City's AM Plans is consistent with the guidelines laid out in the City's Corporate AM Policy and Section 5 of O. Reg. 588 / 17.

Table 1-2: In-Scope Assets

Asset Category	Sub-Assets
Wastewater Collection System	Wastewater mains, laterals, maintenance holes, flowmeters, pump stations, and generator stations.

The following elements are included within the scope of this AMP:

- A summary of the asset inventory, including the replacement cost of the assets, the average age of the assets, the condition of the assets, and the City's approach to assessing the condition of the assets.
- Current levels of service (LoS) based on performance measures.
- Asset lifecycle management strategies to maintain identified current LoS, minimize associated asset risks, and to optimize costs over the whole lifecycle of the asset.

1.5 Approach for Asset Management Plan

The approach used in the renewal of this AM Plan is presented in **Figure 1-1**, and has been selected to ensure that the City can have the confidence to make fact-based and defensible business decisions from reliable and robust information.

Figure 1-1: AM Plan Approach

2. State of Infrastructure

Defining the state of the infrastructure involves quantifying the assets owned, examining their age, replacement value, and condition. The City's approach to each of these asset characteristics is summarized below.

2.1 Expected Service Life and Remaining Service Life

The expected service life (ESL) is defined as the period over which an asset is available for use and able to provide the required level of service at an acceptable risk (i.e., without unforeseen costs of disruption for maintenance and repair). The ESL for this assignment will be based on discussions with City staff, information from previous studies, and any additional information that might inform the ESL. In terms of determining the Remaining Service Life (RSL), the City used the installation date together with the ESL.

In reality, different assets will deteriorate at different rates and not necessarily linearly over time, however, it is important to keep in mind the level of effort required to predict failure compared with the asset value. More sophisticated deterioration modelling may be warranted for very high value assets, whilst the cost of deterioration modeling for low-value assets may very well exceed the replacement cost of the asset. The actual service life can vary significantly from the ESL. In some instances, a variation in expected vs. actual service life is evident due to the following factors:

- **Operating conditions and demands:** Some equipment is operated intermittently or even infrequently, or is being operated a lower demand than its design capacity, thus the actual operating "age" of the asset is reduced.
- **Environment:** Some equipment is exposed to very aggressive environmental conditions (e.g., corrosive chemicals), while other assets are in relatively benign conditions, thus the deterioration of assets is affected differently.
- **Maintenance:** Equipment is maintained through refurbishment or replacement of components, which prolongs the service life of the asset.
- **Technological Obsolescence:** Some assets can theoretically be maintained indefinitely, although considerations such as maintenance cost, energy inefficiency and new technologies are likely to render this approach uneconomical.

2.2 Current Asset Replacement Value

The estimated replacement value is the cost of replacing an existing asset in 2024 dollars, considering an inflation rate. These costs were developed based on the records of previous tenders and quotes, other municipalities similar in size to the City, and consultation with the City's staff. Where applicable, a CPI-based inflation rate was used to estimate the 2024 values.

2.2.1 Asset Inventory and Replacement Value

The City's wastewater assets are managed and maintained to meet provincially issued system and facility operating permits, as well as the City's technical targets for performance and reliability. Valued at approximately $1.1 Billion, the extensive wastewater collection network of assets is categorized into Wastewater Linear and Wastewater Facilities (

Table 2-1). They are further divided into six asset types ranging from wastewater mains and appurtenances to facilities.

The City's core services, including Water, Wastewater, Stormwater, and Transportation, are coordinated with each other to ensure cost efficiencies to maintain the desired level of service while minimizing the risks. The core service areas are considered as a whole when considering the infrastructure lifecycle needs.

Table 2-1: Asset Inventory & Valuation

Asset Category	Asset Type	No.	Unit of Measure	Unit Replacement Cost ($/Unit)	Replacement Value
Wastewater Linear	Mains	1,026	km	$440,000 - $1,120,000	$505,420,000
	Laterals	265	km	$440,000 - $660,000	$416,217,000
	Maintenance Holes	16,721	Ea.	$12,630 - $37,880	$212,957,000
	Flow Meters	36	Ea.	$34,960	$1,259,000
Wastewater Facilities	Pump Stations	12	Ea.	$69,890 - $1,828,810	$7,683,000
	Generator Station	1	Ea.	$462,000	$462,000
***Total**					**$1,143,998,000**

NOTES:

- The replacement value for mains and laterals excludes the asphalt cost, which is accounted for in the road AMP.
- *Total replacement value of laterals includes estimation of missing lateral records in GIS.

Wastewater linear assets represent the largest component of the wastewater system inventory by replacement value, and include pipes, laterals, maintenance holes, and flowmeters. Within the wastewater mains, there are 889 km local sewers (diameter < 450 mm) and 113 km trunk sewers (diameter >= 450 mm). There are approximately 13 km force mains that convey the City’s wastewater under pressure. There is 10 km of unknown diameter gravity pipe.

Pumping stations are fixed facilities dispersed throughout the collection system. The City's wastewater collection system includes 12 pumping stations and one generator station. The generator station provides hydro service and emergency power connected to two nearby pump stations that operate below grade pumping facilities.

2.3 Asset Condition

2.3.1 Age-Based Condition Assessment

Two-parameter Weibull distribution function was used to assess the current condition and to project the future condition of the City’s Wastewater Assets. The Weibull distribution has been used extensively in reliability studies and lifetime prediction models in industries ranging from the automotive to the oil and gas industries; it provides a suitable distribution for this type of analysis.

The Weibull probability distribution provides a left-skewed distribution that rises slowly and diminishes quickly as the population is consumed. The underlying premise of the Weibull-shaped deterioration is that while some assets fail prematurely due to severe conditions or improper installation, other assets are very long-lived and function well beyond their theoretical expected service life. In order to perform a high order network-level analysis, it was assumed that assets would fail (and require replacement) within a deterioration envelope / curve approximated by a Weibull probability distribution. The two-parameter Weibull cumulative distribution has two parameters for scale and shape, as set out in Equation [1]:

$$f(x;\alpha,\beta) = e^{-\left(\frac{x}{\beta}\right)^{\alpha}} \qquad [1]$$

Where: x = Age
α = Shape parameter
β = Scale parameter (or slope)

Table 2-2 presents the condition score ranges and the corresponding range of ESL and total life consumed.

Table 2-2: Age-Based Physical Condition Scale

Condition Score (minimum)	Condition Score (maximum)	Condition Rating	Range % of ESL Consumed	Range of % Operational Life Consumed
1.0	1.5	Very Good	0% – 71%	0% – 47%
1.5	2.2	Good	72% – 84%	48% – 56%
2.2	2.8	Fair	85% – 92%	57% – 60%
2.8	5.0	Poor	93% – 100%	61% – 100%

2.3.2 Age Summary

Figure 2-1 is a horizontal bar graph that shows the Wastewater average asset age and average remaining service life in years as a proportion of average expected service life (ESL) by asset type. Asset ages have been established using data from the City's GIS database and consultant reports. The expected service life is developed using the City's Tangible Capital Asset database and through workshop discussions with City staff. It is shown for each asset type as a standalone number to the right of the graph.

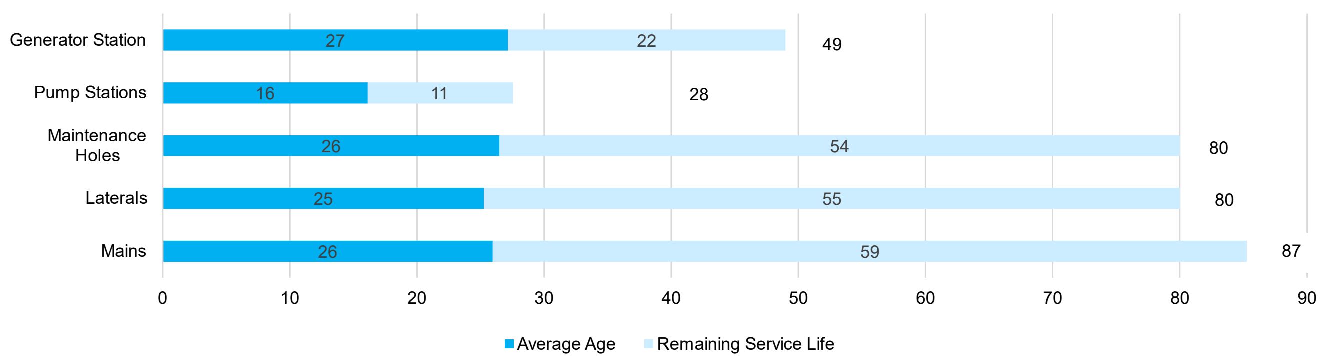


Figure 2-1: Average Asset Age as a Proportion of Average Expected Service Life

The wastewater mains are 32% through their expected service life. Laterals and maintenance holes are similar to wastewater mains, 32% - 33% through their expected service life. Pump stations are 58% through their expected service life. The generator station is 55% through its expected service life.

2.3.3 Condition Summaries

The City's Wastewater service assets are overall in very good condition with 99.6% of assets in very good condition (**Figure 2-2**) weighted by replacement value. There are close to 0.0% of assets in poor condition meaning that they are approaching or exceeded the end of their expected service lives, indicating little to no need for investment in the short to medium term. The remaining 0.4% of assets are in good and fair condition indicating that they are meeting current needs, but some are aging and may require attention.

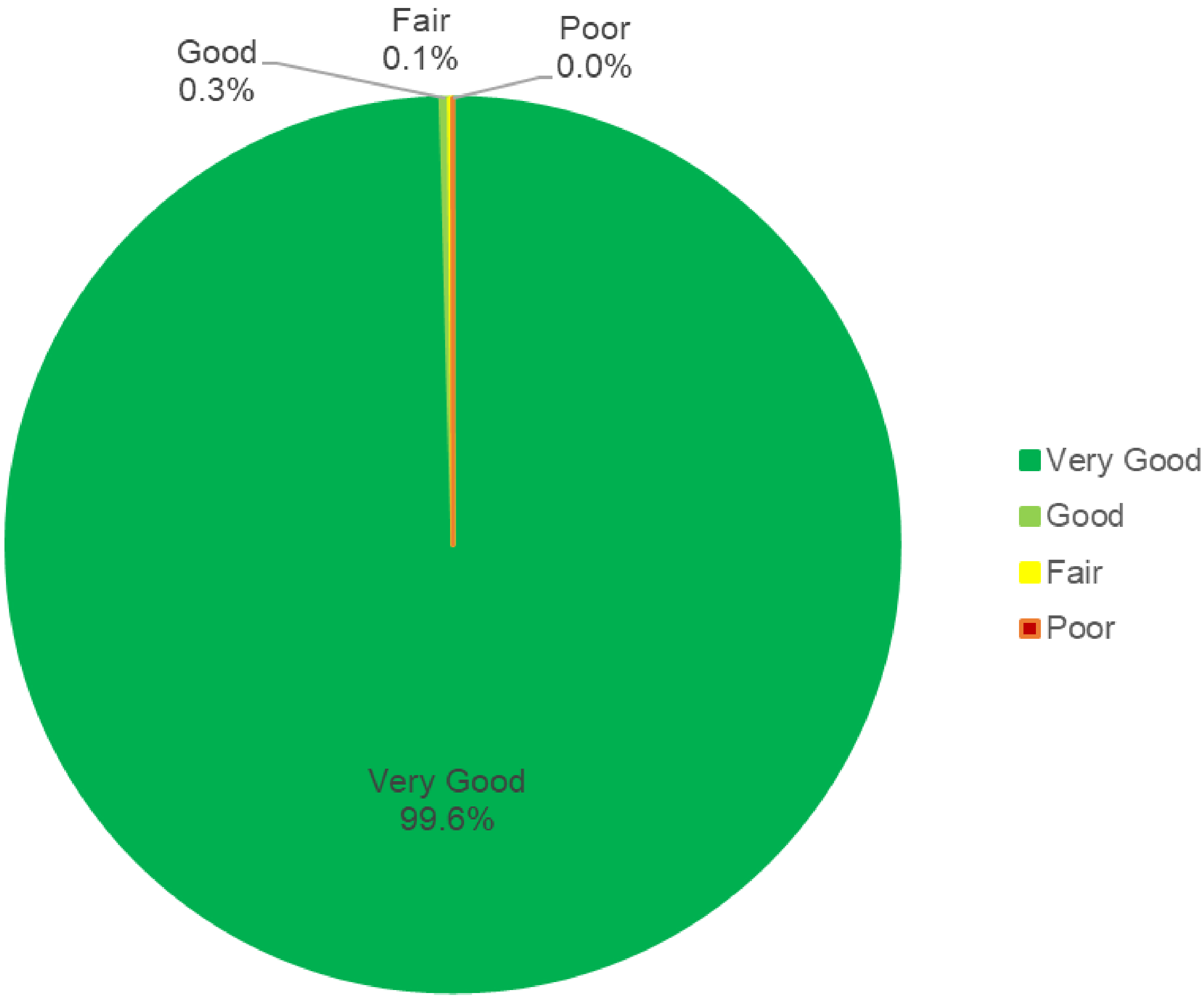


Figure 2-2: Asset Condition Summary

Asset conditions have been determined by using the data from the City' GIS database and consultant reports (**Figure 2-3**). The condition of wastewater mains, laterals and maintenance holes is based on the age and expected service life. For facilities, condition information is adopted from consultant condition assessment reports in 2017 and 2020.

Wastewater mains, laterals and maintenance holes are overall rated in very good condition (**Figure 2-3**). Facilities are nearly in good to fair condition. Pumping Stations, while currently in good condition, would deteriorate if the needs identified through consultant reports are not met. The condition assessment for wastewater pump stations is based on 2017 and 2020 consultant reports. The City is preparing to undertake a condition assessment of the wastewater pump stations.

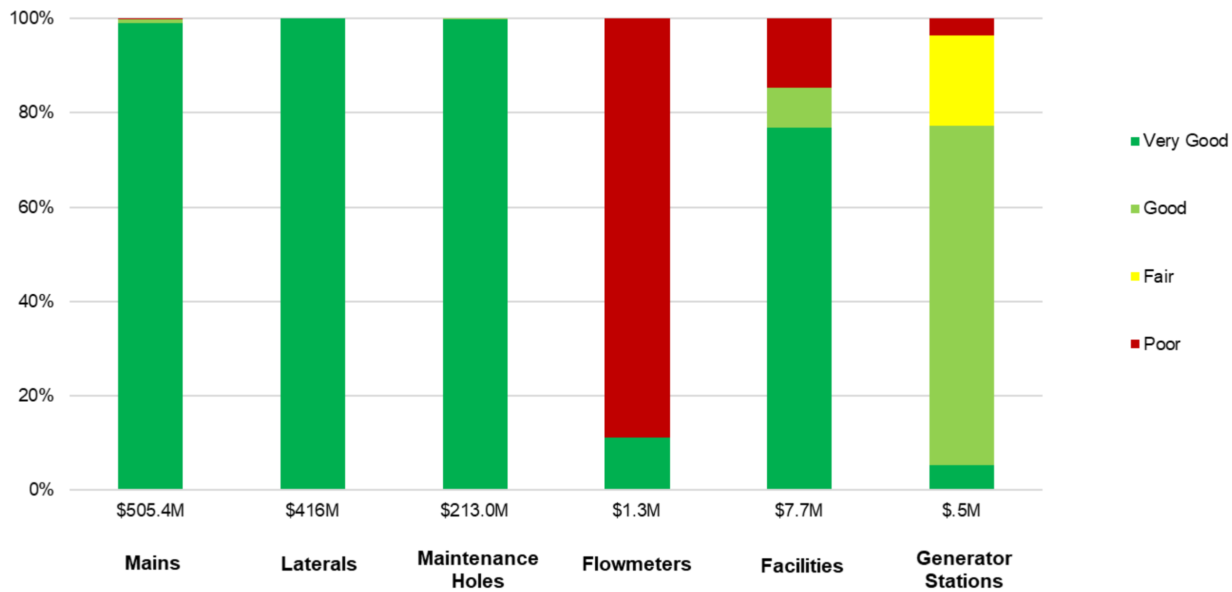


Figure 2-3: Distribution of Asset Condition by Replacement Value

3. Levels of Service

3.1 Purpose

Levels of Service (LoS) supports every aspect of the overall AM System as shown in **Figure 3-1**. The objective of establishing clearly defined service levels is to help the City meet stakeholder values, achieve its strategic goals, make informed risk-based decisions, and implement effective asset lifecycle activities.

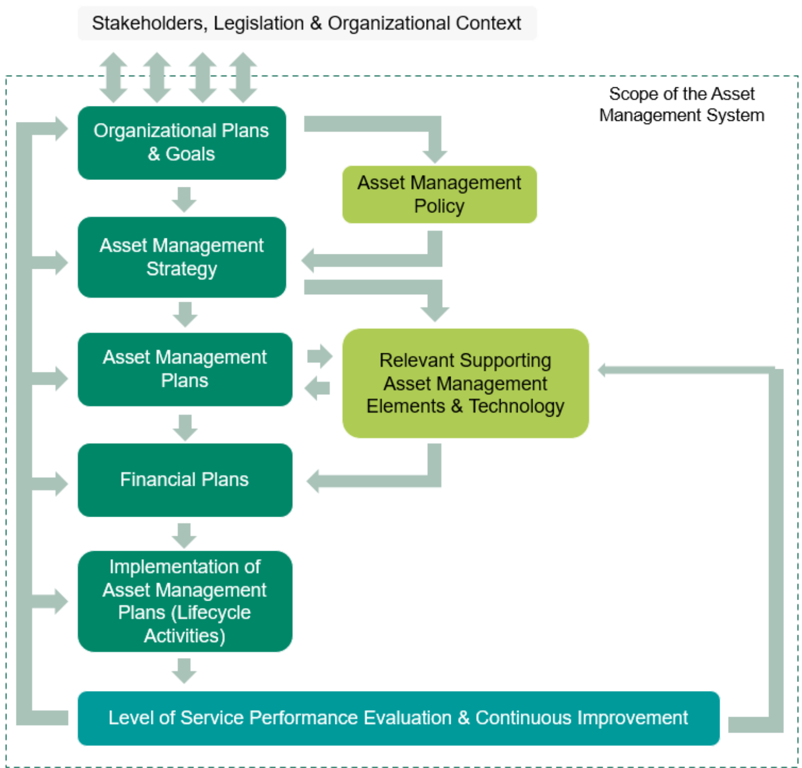


Figure 3-1: LoS within the AM System

In the City's experience, documenting LoS is a proven practice that will enable the City to:

- Link corporate strategic objectives to customer expectations and technical operations.
- Balance customer needs and expectations while evaluating the effectiveness of operations and whether the right LoS is being provided at the right cost.
- Transition from an "Asset Stewardship" approach that focuses on making decisions based on maintaining assets in an acceptable condition to a "Serviceability" approach that is geared towards making decisions based on balancing the costs, risks, and goals for the LoS being provided by the City's assets.
- Communicate the physical nature of infrastructure that the City owns and is financially responsible for while promoting the use of LoS to enable effective consultation with stakeholders regarding alternative funding options according to desired LoS outcomes.
- Make recommendations on strategies that the City can take now to minimize future renewal costs while ensuring that adequate LoS can be delivered without burdening future generations.
- Assess internal (e.g., program changes) and external (e.g., climate change) factors that have the potential to impact the City's ability to deliver services and how these factors may impact the LoS being provided.
- Implement a corporate continuous improvement program to further optimize AM across all service areas.

The O. Reg. 588/17 requires that all AMPs include information about the LoS that the City proposes to provide, the activities required to meet those service levels, and a strategy to fund those activities. The deadline for formalizing these LoS requirements is July 1, 2025 (see **Section 1.3**).

Successful AM programs aim to achieve targeted service levels through customer-based decision making. To achieve this, the City considered a customer-centric approach, where the customer is at the heart of every decision from development to implementation, consultation, and roll-out of the LoS Framework (**Figure 3-2**).

There are two types of LoS measures: Customer LoS (also called "Community" LoS) and Technical LoS. Customer LoS are recorded in a manner that attempts to describe the LoS in terms of what is actually being provided to the customer (i.e., the public) and how the customers experience the service. It is important to note that customers are not concerned with the specific operating requirements of the assets that provide the service, but rather the value they obtain from the operation of the assets. To achieve Customer LoS there needs to be line of sight between the value delivered and how that value is realized. This is the purpose of Technical LoS which attempts to describe how the City will provide and meet the expected Customer LoS.

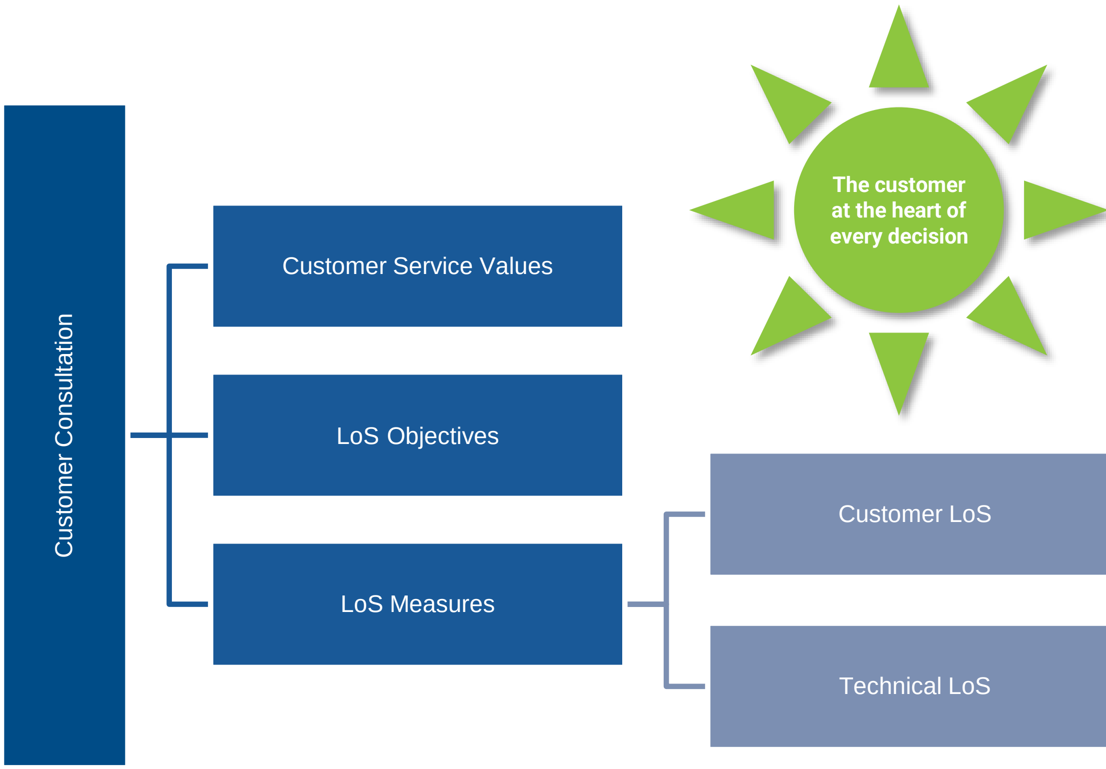


Figure 3-2: The LoS Framework Customer-Centric Approach

The LoS Framework was primarily conceived through a collaborative workshop process. In 2020, four workshops with City staff were conducted across each of the fourteen service areas.

The following outcomes were achieved during each service area workshop:

- Staff were oriented as to the purpose and importance of establishing a consistent LoS Framework;
- Stakeholders were identified, including their expectations, interests, and any regulatory requirements;
- Customer service values were established and reviewed;
- LoS objectives were established for each customer service value;
- Staff provided several performance measures that are currently being tracked as well as those that the City would like to track in the future;
- Where information was available, current performance, targets, and data sources were documented; and
- Growth and shifts in future demand were discussed across the City's service areas.

3.2 Objectives

Defining LoS objectives is important for drawing a line of sight between the City's corporate objectives and the tangible asset performance outcomes. To do so, the LoS objectives must take into consideration stakeholder interests to develop asset performance measures that aim to meet the needs and expectations of the community. By doing this, the City will ensure that their assets are striving towards optimal performance, not only operationally, but economically, socially, and sustainably as well.

Every stakeholder has certain interests in the service being provided and in general, these interests can be categorized into six universal stakeholder values, as shown in **Table 3-1**. Each universal stakeholder value is also assigned a corporate LoS objective.

Table 3-1: The City's Values and LoS Objectives

Customer Value	LoS Objective
Quality and Reliability	The service is delivered with a high standard of excellence and the service is available when needed.
Affordability	The cost of the service is delivered in a financially sustainable manner and does not burden customers.
Environmental Sustainability	The service is delivered in a manner that does not compromise the ability of future generations to meet their needs.
Access and Capacity	Customers can easily access the service with minimal inconvenience.
Health and Safety	The service is delivered with minimal health and safety impacts.
Responsiveness	Customer service requests are responded to efficiently and in a timely manner.

3.3 Stakeholders and Their Interests

A stakeholder is any person or organization that can affect, be affected by, or perceive themselves to be affected by a decision or an activity. Stakeholder analysis is the process of understanding stakeholder needs, expectations, and perceptions relative to the stakeholder's level-of-interest and level-of-influence over the organization. An organization typically engages with their stakeholders to:

- Establish which activities or services matter most to them.
- Understand their risk appetite and risk threshold.
- Understand their willingness to pay for services.

Stakeholders can take many forms and may be internal (i.e., staff, Council) or external (i.e., the public, regulatory agencies, suppliers, neighbouring municipalities, etc.) to the organization. Historically, only service recipients who pay for City services would be considered customers; however, today customers can take many forms and should include any entity that has a legitimate interest in the service being provided. In addition to service recipients (i.e., the public), this may include:

- **Regulatory Agencies** – Stakeholders that set standards, compliance regulations or other legislation that govern service delivery.
- **Special Interest Groups** – Stakeholders that are affected by or have an interest in activities within the City's right of ways.

3.4 Level of Service (LoS) Performance Measures

A documented suite of LoS performance measures enables a common understanding of the service delivery that the City's customers currently receive, and the associated cost of maintaining infrastructure assets to provide the service. Having these performance measures set at the appropriate levels within the City ensures alignment from the corporate vision, to asset investment decisions, and to day-to-day operational activities. When establishing LoS performance measures it is important to keep in mind the "SMART" acronym, as follows:

- **S**pecific, easily evaluated and understood.
- **M**easurable, quantifiable, and easily collectable to ensure ongoing data availability.

- **A**ttainable, so that they work to motivate as opposed to discourage.
- **R**elevant, in that they relate and align with a specific goal.
- **T**ime-Bound, measured over a specific period, which is typically annually for benchmarking.

There are two types of LoS performance measures: Community LoS and Technical LoS. Community LoS are recorded in a manner that attempts to describe the LoS in terms of what is being provided to the community (i.e., the public) and how the customer experiences the service. Community LoS are qualitative, non-technical, and are driven by the municipality's strategic AM objectives. Community LoS are not concerned with the specific operating requirements of the assets that provide the service, but rather the value they obtain from the operation of the assets. To achieve Community LoS, there needs to be line of sight between the value delivered and how that value is realized. This is the purpose of Technical LoS which attempts to describe, quantitively, how the City will provide and meet the expected Community LoS.

3.5 LoS Performance Results

Ontario O. Reg. 588 / 17 requires legislated community levels of service for core assets. Community levels of service use qualitative descriptions to describe the scope or quality of service delivered by an asset category. O. Reg. 588 / 17 also requires legislated technical levels of service for core assets. Technical levels of service use metrics to measure the scope or quality of service being delivered by an asset category. **Table 3-2** presents a summary of the City's wastewater service level for O. Reg 588 / 17 Metrics. References are provided to show where O. Reg 588/17 requirement has been attained.

A summary of the City's current and proposed community and technical service levels for Wastewater Assets are documented in **Table 3-2.**

Table 3-2: Community and Technical Service Levels

Level of Service	Current Performance	Current Service Level Target	Proposed Service Level Target
Percentage of properties connected to the municipal wastewater system.	93.3%	93.3%	No Change
The number of events per year where combined sewer flow in the municipal wastewater system exceeds system capacity compared to the total number of properties connected to the municipal wastewater system.	N/A	N/A	No Change
The number of connection-days per year due to wastewater backups compared to the total number of properties connected to the municipal wastewater system.	0	0	No Change
The number of effluent violations per year due to wastewater discharge compared to the total number of properties connected to the municipal wastewater system.	N/A	N/A	No Change
Description, which may include maps, of the user groups or areas of the municipality that are connected to the municipal wastewater system.	See **Figure 3-3**		No Change
Description of how combined sewers in the municipal wastewater system are designed with overflow structures in place which allow overflow during storm events to prevent backups into homes.	N/A, City of Vaughan does not operate combined wastewater/stormwater systems.		
Description of the frequency and volume of overflows in combined sewers in the municipal wastewater system that occur in habitable areas or beaches.	N/A, City of Vaughan does not operate combined wastewater/stormwater systems.		
Description of the effluent that is discharged from sewage treatment plants in the municipal wastewater system.	N/A, City of Vaughan does not operate sewage treatment plants.		

Figure 3-3 shows a map that outlines the City's wastewater connectivity.

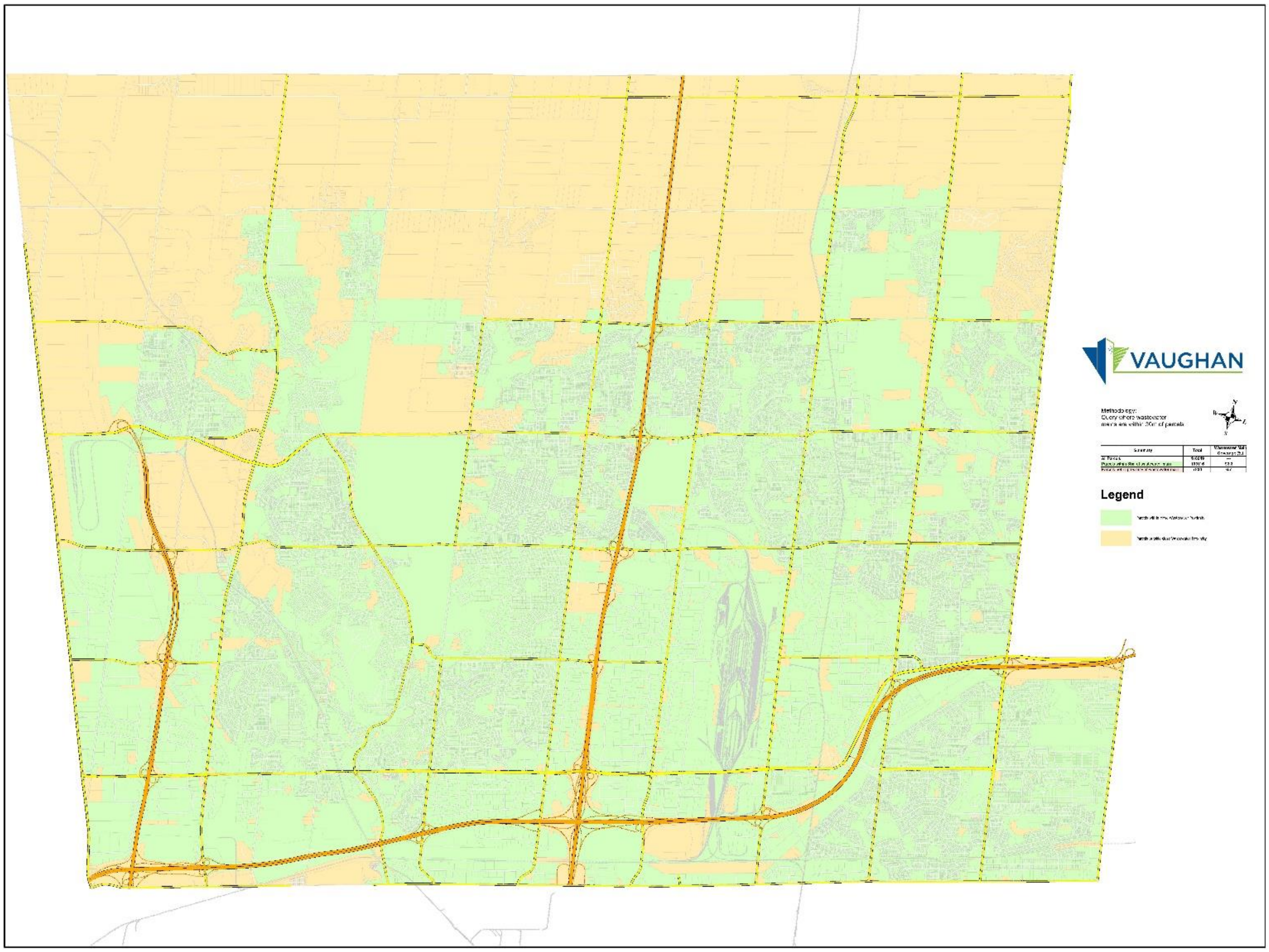


Figure 3-3: Map Outlining the City's Wastewater Connectivity

3.6 LoS Performance Targets

Establishing LoS targets is an important part of continual improvement and performance management. Without targets, it is difficult to ascertain whether goals are being met, or the extent of the gap if they are not. Incorporating targets into the City's LoS Framework helps to ensure that targets are reasonable, aligned with customer expectations, and evaluated on an objective basis by considering cost-benefit trade-offs.

One of the key challenges in setting targets in a municipal environment is that they can often become biased and/or politically motivated. Therefore, it is important to review LoS targets with stakeholders. An important aspect of evaluating LoS targets is determining how willing the user is to pay for the service. Regulatory requirements are an exception; however, they only provide the minimum service standard. Cost is still an important parameter to consider when assessing the merits of service improvements.

To deal with the financial realities, it is necessary to:

- Calculate how much the service costs based on current LoS.
- Determine the cost associated with varying the LoS.
- Assess the customers' willingness to pay.

4. Asset Lifecycle Strategies

Asset lifecycle management focuses on the specific activities we must undertake during all phases of the asset lifecycle. By considering entire asset lifecycles the City can ensure sound decision making that consider present and future service delivery needs.

The overarching goal of life cycle management is to maximize the long-term benefits and services that our assets deliver while minimizing the associated costs and risks in the long run. Every asset has a life cycle cost, which is the total cost of all the activities undertaken throughout its service life. The following sections describe activities across the life cycle of assets.

4.1 Lifecycle Activities

Any responsible owner of assets such as the City has a desire to preserve the condition of their existing assets for as long as possible, by maintaining or even extending their design lives through routine activities such as maintenance and active intervention. The City is continually acquiring infrastructure assets, but these assets require increased funding for operation and maintenance as they age. The City is also responsible for the replacement of deteriorated assets as long as the service is required. While individual assets may have a useful life that can be predicted in years or decades, the service that the asset provides could be for a substantially longer duration (perhaps in perpetuity). Part of the purpose of the AM planning process is to fully understand and predict the long-range financial requirements for the City's infrastructure to facilitate planning and resource management in the most cost-effective manner possible. **Figure 4-1** illustrates how costs typically accumulate over an asset's life. It is worth noting that the accumulation of the ongoing operations and maintenance, refurbishment and disposal / replacement costs is many multiples of the initial acquisition costs. A key and important take-away from **Figure 4-1** is therefore for the City to fully understand the entire life cycle costs before proceeding with asset acquisition.

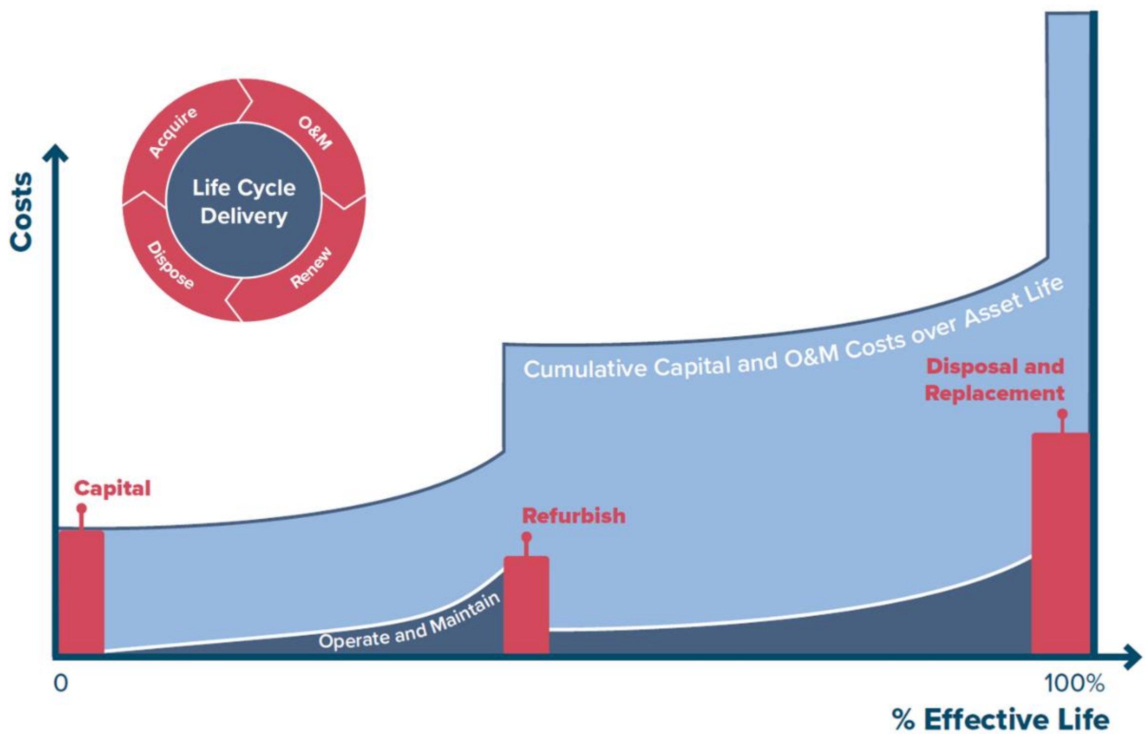
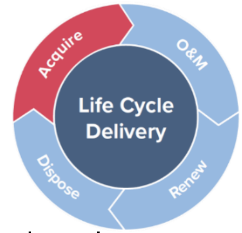


Figure 4-1: Life Cycle Cost Accumulation Over Asset Life

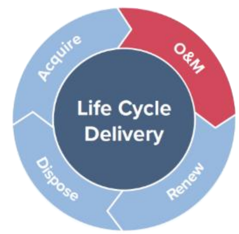
Expressed simply, full lifecycle cost of infrastructure can be accumulated under the following broad headings:

- **Asset Acquisition / Procurement / Construction**: The City has made significant investments in the design and acquisition of its municipal infrastructure assets. Added to City-purchased inventory is infrastructure that the City accepts (and takes immediate financial responsibility for) from developers as new neighborhoods are constructed. For example, as developers build new neighborhoods, the new local infrastructure (including local roads, water mains, sewer mains and storm mains) is paid for by the developer and then transferred to the City for operation, maintenance and ultimately replacement. The City's infrastructure inventory was therefore created over many decades through infrastructure paid for by the City or by developers Looking towards the future, when acquiring new assets, the City should evaluate credible alternative design solutions that consider how the asset is to be managed at each of its life cycle stages. Asset management and full life cycle considerations for the acquisition of new assets include, but are not limited to the following:

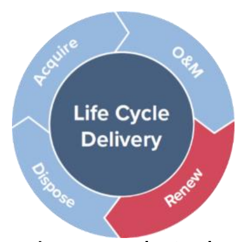


  – The asset's operability and maintainability;
  – Availability and management of spares;
  – Staff skill and availability to manage the asset;
  – The manner of the asset's eventual disposal.

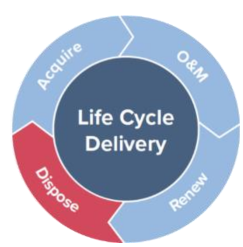
- **Asset Operations and Maintenance (O&M)**: As new infrastructure is commissioned, the City accepts the responsibility of operating and maintaining the infrastructure according to O&M standards to ensure that the infrastructure is safe and reliable. Operations staff provide the day-to-day support required to operate infrastructure. In few cases, operation costs are minor, but for most there are significant increases. For example, underground pipes require almost no operational support while a facility such as a pump station requires full-time staff to operate the facility safely and efficiently. Maintenance expenses include periodic preventive maintenance to ensure that the infrastructure can provide reliable service throughout the life of the asset and corrective maintenance that is required to repair defective assets as and when needed. Inadequate funding for O&M will have an adverse impact on the lifespan of assets. The amount of O&M resources required in any period is a function of the current inventory of infrastructure and total O&M needs required for each asset. As the inventory of infrastructure grows, total O&M requirements will also grow.



- **Renewal and Replacement:** The third portion of full life cycle costing relates to the renewal and replacement of infrastructure that has deteriorated to the point where it no longer provides the required service. Renewal cost is sometimes incurred during the life of an asset where an investment is made to improve the condition and / or functionality of the asset e.g., re-lining of a pipe or resurfacing of a road. Disposal and replacement costs are incurred at the end of an asset's life when it is disposed of and replaced by a fully new asset. Canadian municipalities, including City of Vaughan, have not traditionally factored renewal or replacement costs into future budget projections, except for assets that have a relatively short life such as computer equipment and vehicles. The main reason behind this is the fact that large portions of this infrastructure inventory can have a very long life e.g., from 75 to 100 years for underground pipes. For growing communities like the City, there has not been a historical need to forecast expenses that are not anticipated for decades. However, based on the experiences of more established Canadian cities (where vast inventories of old assets are now in dire need of renewal or replacement), it is vital that communities fully understand the looming obligations of infrastructure renewal or replacement and develop a strategy to respond in a manner that is fair and affordable.



- **Decommissioning and Disposal:** There will inevitably come a point in time when an asset must be removed from service and, depending on the type of asset, there may be significant costs associated with its decommissioning and disposal. Factors that may influence the decision to remove an asset from service include: changes to legislation that cause the asset to be in non-compliance, the inability of the asset to cope with increased service levels, technology advances that render the asset obsolete, the cost of retaining the asset is greater than the benefit gained, or the current risk associated with the asset's failure is not tolerable. Normally, major costs that may be incurred during disposal and decommissioning derive from the environmental impact of the disposal and, if required, the rehabilitation and decontamination of land. In some cases, there will be residual liabilities and risks to consider if a decision is made to partially abandon the asset as opposed to fully disposing of its components



(e.g., leaving a non-functioning pipe in the ground, or an inactive building standing). However, some cost savings may be achieved through the residual value of the asset or by exploring alternative uses for the asset. In all cases, it is important to consider disposal and decommissioning as the strategy employed has the potential to attract significant stakeholder attention. For that reason, the costs and risks associated with disposal and decommissioning should be equally considered in the City's capital investment decision-making process.

The infrastructure AMPs present the City's strategy for responding to the full lifecycle costs of all its infrastructure assets. Long-range estimates were prepared together with the AMPs, based on industry best practices to ensure the financial sustainability of the City's infrastructure assets over their full life cycle, as discussed in the next Chapters.

4.2 Acquisition / Procurement / Construction Strategies

Added to City-purchased inventory is wastewater infrastructure that the City accepts (and takes long-term financial responsibility for) from developers as new neighborhoods are constructed. For example, as developers build new neighborhoods, the new local infrastructure (including wastewater mains) is paid for by the developer and then transferred to the City for operation, maintenance, and ultimately replacement. The City's infrastructure inventory was therefore created over many decades through infrastructure paid for by the City or by developers.

4.3 Operations and Maintenance Strategies

Wastewater asset operations and maintenance (O&M) costs consist of three major components: wastewater service cost to the Regional Municipality of York (York Region), pure wastewater O&M activities, and overhead costs. **Table 4-1** presents the breakdown of activities and five-year average cost for the City's Wastewater assets. All values listed in this section are the average costs of the 5 years from 2019 to 2023.

A significant expenditure is for wastewater service to York Region. The average annual wastewater service cost is $86,613,000, which is likely to increase in future years due to the planned population growth in Vaughan. The five-year average annual pure wastewater O&M activities cost is $3,354,000. The overhead cost is approximately 40% of the pure wastewater O&M activities cost.

The pure wastewater O&M activities includes wastewater operations, main inspections, main repairs, material disposal, CCTV sewer program, flushing and cleaning, sanitary lateral installation, lateral repairs, lateral blockage, service investigations, maintenance hole inspections, maintenance hole repairs, methane gas inspections, sample/contamination inspections, spill and cleanups, flow monitoring, backwater valve installation, inflow & infiltration reduction, lift station inspection/repair/maintenance, and wastewater AMI program.

Table 4-1: Wastewater O&M Activities and Five-year Average Costs

O&M Activities	Description	Five-year Average Cost
Wastewater Service to Region of York	Wastewater Division - Admin.	$86,613,000
Overhead	All overhead cost (e.g., compliance and training, business support, etc.)	$1,363,000
Pure Wastewater O&M Activities	Wastewater operations, wastewater main activities, lateral activities, maintenance hole activities, flow monitoring, backwater valve installation, inflow & infiltration reduction, lift station activities, and wastewater AMI program	$3,354,000
Total		**$91,330,000**

4.4 Renewal and Replacement Strategies

4.4.1 Wastewater Pipes

Pipe renewal. The following renewal activities are planned for water, wastewater, and stormwater mains:

- Pipe Bursting. Pipe bursting can be applied to brittle materials, and pipe splitting to ductile materials. The old pipe is ruptured and pressed into the surrounding soil while a new pipe follows the cone-ended bursting tool to replace the old pipe. The bursting tool is hammered through the host pipe by pneumatic or hydraulic means. The benefit of pipe bursting is that it allows for trenchless upsizing of the original pipe. The typical length of pipe replaced by pipe bursting is approximately 110m, but greater lengths have been accomplished. Pipe depth, soil conditions, adjacent utilities and service connections will dictate whether pipe bursting is appropriate. Pipe bursting can be used on almost any type of existing pipe except ductile iron (DI) or heavily reinforced concrete.
- Cured-in-Place Pipe (CIPP) Liners. Cured-in-place pipe liners (CIPP; also known as "cast"-in-place liners) have been commercially available since 1971 and are used to seal and or structurally renew existing pipes without excavation of the pipe itself. The basic CIPP liner product is a tube, impregnated with a liquid thermoset resin, inserted into a pipeline, and cured. CIPP liners were developed as a modified coating system, delivering resins in a carrying tube (often described as a "sock") that could hold the desired coating in place until the resin had time to cure. CIPP liners are either inverted, pulled in place, or manually inserted into the host pipe. All expand radially or are otherwise conformed tightly against the host pipe. Various resins are utilized including epoxy, polyester, silicate, and vinylester, and the most commonly used resins are styrene-based. Resins are either ambient cured, thermally cured (utilizing either hot water or steam), or ultraviolet light (UV) cured.

  CIPP liners will be an option for main renewal where open-cut intervention is not possible due to accessibility, and in particular, where the existing pipe is located under the following assets or in close proximity to the following features:

  - Regional roads;
  - Easements;
  - Railways;
  - Pipelines;
  - Bridges;
  - Rivers;
  - Walkways.

The use of trenchless technologies for pipe renewal and replacement is increasing and is predicted to grow into the future, as these technologies provide many benefits over open-cut pipe replacement. In terms of indirect costs, traffic disruption as a result of an open-cut pipe trench appears to be the greatest social cost to the consumer. By using trenchless technologies, utilities can reduce the societal burden by keeping roads open and not blocking business and local traffic. Other benefits of trenchless projects include improved safety (i.e., by not having an open trench) and that trenchless work does not interfere with other utilities or underground obstacles. Trenchless work is generally more cost effective than open-cut e.g., WERF estimates that cured-in-place lining enables savings of at least 10% over open cut methods. Another benefit of trenchless work is the elimination of cuts and patches in pavement which leads to the accelerated deterioration of the road surface.

Pipe replacement. Pipe replacement through trench open-cut is still fairly common within most municipalities, although open-cut work is typically disruptive to the adjacent area and requires a great deal of traffic control if the trench is located in a roadway. It tends to be slower than trenchless methods and more dangerous as workers / residents risk cave-ins when in or near the trench. Finally, trench open-cut methods generally are more expensive than trenchless methods. However, trench-open could still be the best / only option when trenchless methods are not viable.

Open-cut replacement consists of the traditional method of pipe installation, where an excavation crew typically digs a trench along the existing trench line using a track excavator or backhoe. The new pipe is laid, bedded and the trench is backfilled, compacted and the surface is reinstated as necessary.

The unit cost of pipe replacement through open-cut excavation needs to include the cost of excavation, laying the new pipe, backfilling and reinstatement. Other factors impacting costs include the installation of appurtenances such as valves, maintenance holes, or catchbasin leads and whether and how many laterals need to be re-connected. The cost of the surface reinstatement could vary significantly based on whether the excavation needs to be returned to the level of e.g., a collector road or only a landscaped surface.

Capital planning analysis. The wastewater asset intervention process flow that governs the decision-making on when and how to intervene on the pipes in the analysis is presented in

Figure 4-2 and **Figure 4-3**.

The capital planning applied a conservative principle in estimating pipe and appurtenance replacement. The capital budgeting forecasts for pipes will reflect the cost of replacing or renewing pipes and its adjacent appurtenances, including laterals and maintenance holes. Oftentimes, the adjacent appurtenances’ condition are based on the linear asset condition, thus, the investment requirement timeline is similar.

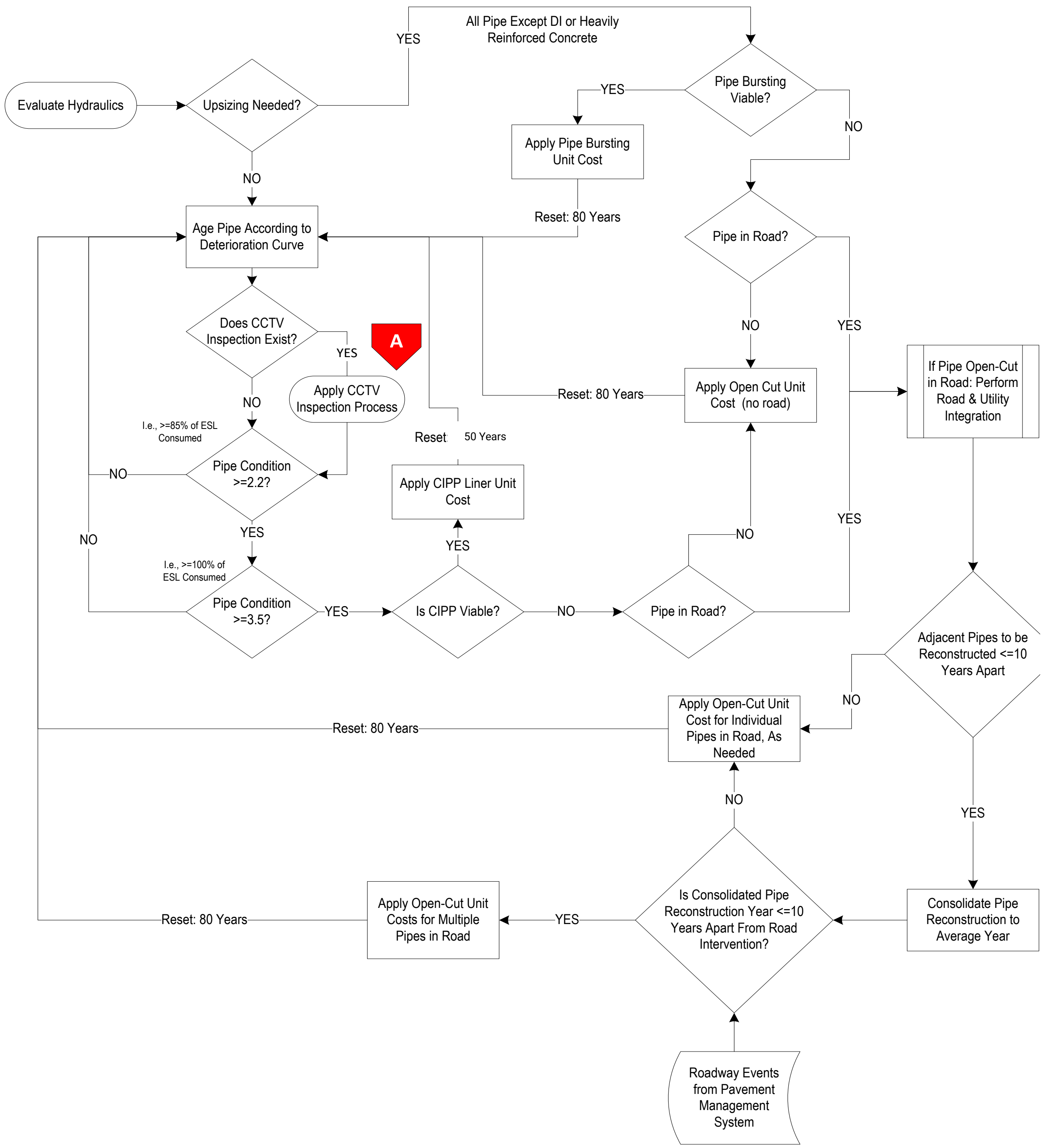


Figure 4-2: Wastewater Process Flow

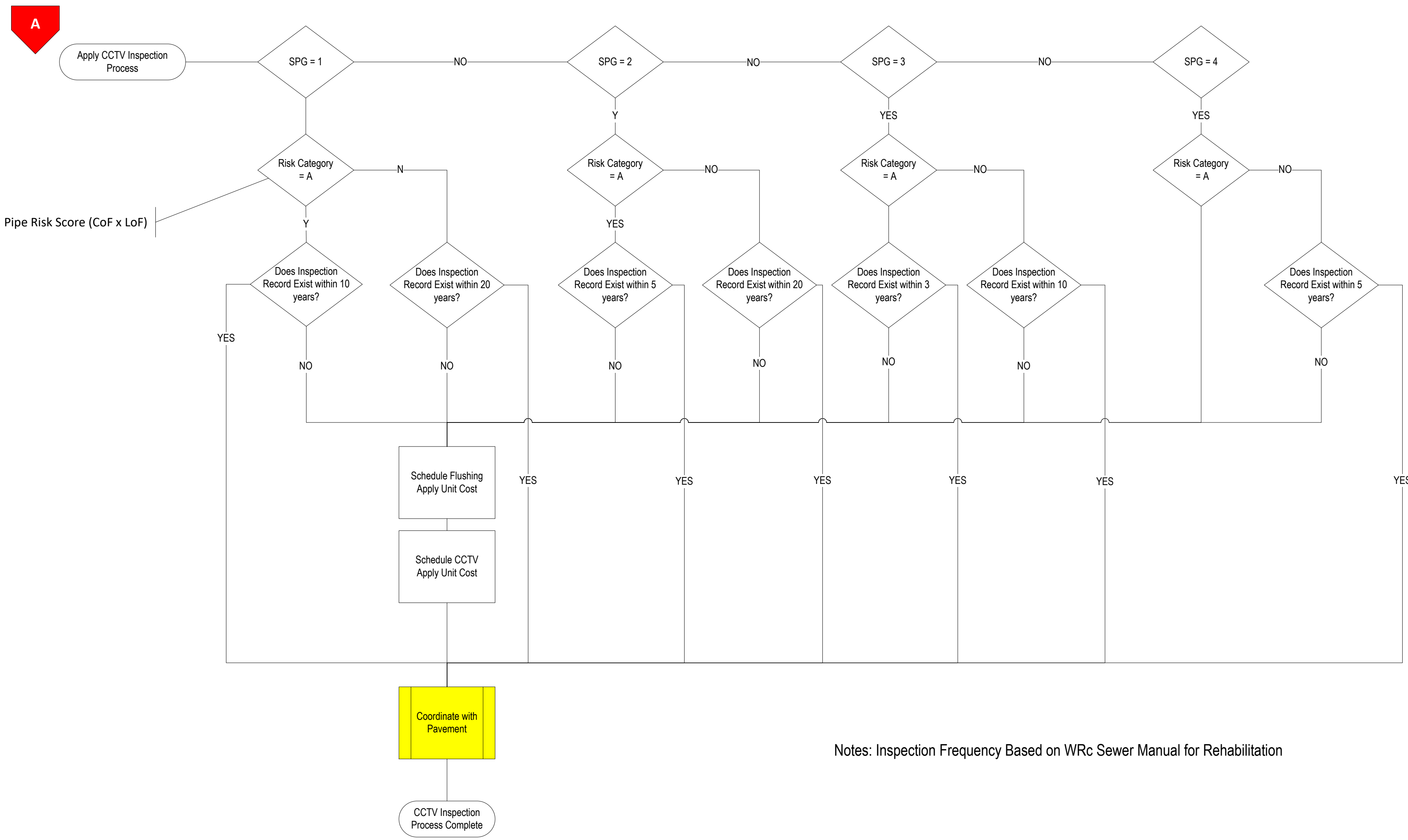


Figure 4-3: CCTV Process Flow

CCTV data and resultant structural grade scores were not available and not incorporated in this report but could be incorporated in a future iteration of AM plans. Table 4-2 presents a summary of the key decision-points within the pipe intervention process flow, and an explanation of the asset management decision methodology.

Table 4-2: Pipe Intervention Process Decision Points & Explanations

Decision Point	Decision & Explanation
Upsizing Needed?	YES: If a hydraulic constraint is identified (from elsewhere e.g., the City's hydraulic model) and the pipe is required to be up sized to the required pipe diameter, the next step is to consider whether pipe bursting is viable. NO: If no hydraulic constraint is identified, no pipe upsizing is needed.
Pipe Bursting Viable?	YES: If pipe bursting is viable (i.e., viable for all pipes except for DI or heavily reinforced concrete pipes) then apply the pipe bursting unit cost to the length of pipe replaced. Reset pipe age to zero and apply an 80-year ESL to new pipe. NO: If pipe bursting is not viable (i.e., pipe is DI or heavily reinforced concrete), the next step is to consider whether the pipe is in a road.
Pipe Condition >= 2.2?	YES: If the pipe condition is equal or more than 2.2 (i.e., equal or more than 85% of the pipe ESL has been consumed), then trigger a pipe inspection and apply the inspection unit cost table. NO: If the pipe has not yet reached a condition of 2.2 then wait until it reaches a condition of 2.2 which will trigger an inspection.
Pipe Condition >= 3.5?	YES: If the pipe condition is equal to or greater than 3.5 (i.e., equal to or more than 100% of the pipe ESL has been consumed), then trigger a pipe renewal or replacement. The next step is to consider whether CIPP is a viable option for pipe renewal. NO: If the pipe has not yet reached a condition of 3.5 then wait until it reaches a condition of 3.5 which will trigger a pipe renewal or replacement.
Accessibility Issue?	YES: If the City flags the pipe as having an accessibility issue such as within / next to a Regional road, at a stream crossing, or where there is no space for an open cut intervention, then apply the CIPP unit cost to the length of pipe. Reset pipe age to zero and apply a 25-year ESL to the re-lined pipe. NO: If accessibility is not an issue (i.e., the pipe is not within / next to a Regional road, at a stream crossing, or where there is no space for an open cut intervention), the next step is to consider whether the pipe is in a road.
Is CIPP Viable?	YES: If CIPP is viable (i.e., the pipe has not yet been re-lined or reached a condition of 3.5 / is beyond its ESL), then apply the CIPP unit cost to the length of pipe. Reset pipe age to zero and apply a 25-year ESL to the re-lined pipe. NO: If CIPP is not viable (i.e., the pipe has been re-lined once already or has reached a condition of 3.5 / is beyond its ESL), the next step is to consider whether the pipe is in a road.
Pipe in Road?	YES: If an open-cut excavation pipe replacement is needed and the pipe is in a road, then the next step is to consider whether any adjacent pipes need to be replaced less than ten years apart. NO: If an open-cut excavation pipe replacement is needed but the pipe is not in a road, then apply the basic open-cut unit cost to the length of pipe to be replaced. Reset pipe age to zero and apply an 80-year ESL to new pipe.
Pipe => 450mm?	YES: If the pipe diameter in equal or greater than 450mm, then replace pipe with reinforced concrete pipe (RCP) and apply a 60-year ESL to the new pipe. NO: If the pipe diameter is less than 450mm, replace pipe with PVC pipe, and apply an 80-year ESL to the new pipe.
Adjacent Pipes to be Reconstructed <10 Ten Years Apart.	YES: If the years of open-cut reconstruction of two or more pipes in the same roadway are less than ten years apart, then calculate the average of the years and apply that as the year of reconstruction. Adjust the years of utility work to match the years of road work if it is within 10 years of one another. Apply the unit cost table for open-cut excavation in a roadway for two or three pipes, as needed, over the length of pipes reconstructed. Reset the pipes' age to zero and apply an 80-year ESL to new pipes. NO: If the years of open-cut reconstruction of two or more pipes in the same roadway are more ten years apart, do not adjust the reconstruction year. Adjust the years of utility work (one pipe) to match the year of road work if it is within 10 years of one another. Apply the unit cost table for open-cut exaction in a roadway for one pipe, over the length of pipe reconstructed. Reset the pipe age to zero and apply an 80-year ESL to new pipe.

Decision Point	Decision & Explanation
Gravity Sewer SPG (Structural Performance Grade) > = 4	YES: Align scheduled pipe rehabilitation with the Road program. Pipes with structural grades of 5 should be prioritized in the current planning year and pipes equal to 4 in the subsequent year NO: Pipe with a structural grade of 3 and the pipe does not have a high-risk profile, a CCTV inspection should be scheduled with the next 10 year otherwise schedule CCTV inspection within the next 5 years. Pipe with a structural grade of 2 and the pipe does not have a high risk profile, a CCTV inspection should be scheduled with the next 15-20 years otherwise schedule CCTV inspection within the next 10 years with a structural grade of 2 and the pipe does not have a high risk profile, a CCTV inspection should be scheduled with the next 20 years otherwise schedule CCTV inspection within the next 10 year. Note: Apply when structural grade available.
Risk Category = A	YES: Pipe asset deemed critical and asset inspection & renewal should be prioritized based on risk rating; NO: Assets are less critical, and repairs can be pushed out to align with pavement renewal program. Note: Use when prioritizing within budget constraints.

4.4.2 Wastewater Flowmeters

The City has applied a 6.7% flowmeter change-out cycle, which is equivalent to changing all flowmeters out every 15 years.

4.4.3 Wastewater Facilities

In 2020, the City performed Building Condition Assessment and generated facility inventories and 10-year capital renewal plan for 10 of the wastewater facilities (Pine Valley North SPS, Pine Grove SPS, Block 55 SPS, Block 39 SPS, Nashville-Hwy 27 SPS, Molise SPS, Vaughan Hospital SPS, Maplewood SPS, Camlaren Generating Station, and Kerrowood SPS). The City has also conducted condition assessment for five facilities and developed a renewal plan in 2017. A change out cycle of 30 years was assumed for capital planning of the wastewater facilities to achieve consistency between various consultant reports / data sources.

4.5 Decommissioning and Disposal Activities Strategies

Asset decommissioning and disposal activities are performed to decommission and dispose of assets due to ageing or changes in performance and capacity requirements. This decision process includes the consideration of costs and benefits of rationalization using a whole life approach, the impact of asset rationalisation on other infrastructure and the processes for disposal of assets. More specifically, the following factors need to be evaluated when considering the decommission and disposal of assets:

- Assets not required for the delivery of services, either currently, or over the longer planning period.
- Assets that have become uneconomical to maintain or operate.
- Assets that are not suitable for service delivery.
- Assets that have a negative impact on service delivery, the environment, or community.
- Assets that no longer support the City's service objectives due to a change in type of service being delivered or the delivery method.
- Assets where their use has become uneconomical due to the limited availability of spares or the cost of their replacement parts.
- Assets where their technology has been outdated.
- Assets which can no longer be used for the purpose originally intended.

Considerations for the City's asset decommissioning and disposal activities include, but are not limited to:

- Updates to the City's Statement of Tangible Capital Assets. Considerations related to the determination of residual value and the disposal of assets include:
  - ➢ Residual value and the useful life of an asset should be reviewed, at the very least, at each financial year-end and, if expectations differ from previous estimates, any change should be accounted for prospectively as a change in estimate.

    - The depreciation method used should reflect the pattern in which the asset's economic benefits are consumed.
    - The depreciation method should be reviewed, at the very least, annually and, if the pattern of consumption of benefits has changed, the depreciation method should be changed prospectively as a change in estimate.

- Updates to asset databases such as the GIS and CMMS.
- Environmental impact of disposal and implications for land rehabilitation, where applicable.
- Continued service delivery while a new asset is being constructed / commissioned: overlap of the start-up of new assets / facilities and the decommissioning of existing assets / facilities being replaced.
- Cost of decommissioning and disposal.
- Disposing Asbestos Cement (AC) mains

    - In normal use, Asbestos fibres in drinking water will not affect public health since there is low concentration of asbestos in drinking water. However, when AC pipes are severely deteriorated, asbestos can be released into the water.
    - While the City does not have extensive AC pipelines in its wastewater collection system (approximately 77 km), additional health and safety measures should be taken into considerations when attempting to repair, remove, or dispose such a material. These types of activities, if not well managed, may release asbestos fibres into the air causing risks to the public health. Work associated with assets made of AC material should be in accordance with the City's specifications related to hazardous material management (i.e. asbestos management) and in accordance with O. Reg. 278 / 05, which is made under the Occupational Health and Safety Act.

4.6 Capital Planning

Capital investment is to address community growth or changes, or to renew existing assets to maintain service levels. For the actual funding needs assessment, please refer to **Section 5**.

- **Life Cycle Cost Analysis Approach**. The City's analysis enables optimized decision making and mathematical deterioration modelling of infrastructure assets and the development of short, medium and long-term forecasts of renewal and replacement costs of a number of decision criteria and the ability to compare different intervention options to find the optimal solution in terms of timing and the intervention option chosen.
- **Forecast Periods.** The City aims to develop Short- to Medium-Term and Long-Term capital plans. Typically, short to medium-term capital plan identifies the activities required to meet current and future demand, the cost of those activities and a financing approach. It is developed or renewed every three to five years and should coincide with regulations on short to medium-term expenditure planning. A long-term plan can serve as part of Strategic Asset Management Plan, which indicates what will be spent, by service areas, over a set period of time. Long-term plans tend to focus only on costs.

  Consistent with the approach of other asset management plans, the analysis periods for funding need assessments are 20 years. Given the longer expected service life of wastewater assets, a 100-year forecast was also modelled to provide a directional estimate of long-term costs.

4.7 Asset Prioritization

4.7.1 Risk Assessment

Infrastructure-related risk exposure is assessed based on the combined consideration of probability and consequences of an asset failure, which is used to drive the selection and prioritization of appropriate action, based on risk tolerance thresholds and funding availability. Understanding the risk exposure for a given set of assets allows the City to identify where they are most exposed to risk, and to target their investments to most effectively reduce that exposure.

In addressing risk for infrastructure assets, the first step in the analysis is to identify assets that are most critical to the business. Critical assets are those that will potentially have the greatest impact on service delivery should they fail. It should be noted that the parameters, criteria and weighting factors area starting point, and should be reviewed and modified to reflect the priorities of the City on an ongoing basis.

The fundamental principle of consequence (or criticality) models is that they evaluate the relative importance of assets based on select criteria. The approach to risk analysis within this project utilizes a triple-bottom-line assessment approach utilizing the following four criticality indices:

- **Economic** – influence of the asset's failure on monetary resources
- **Operational** – influence of the asset's failure on operational ability
- **Social** – influence of the asset's failure on society
- **Environmental** – influence of the asset's failure on the environment

By applying specific indices, the risk assessment framework generates a risk (or priority) score for each asset. The risk score is a rating of the asset based on the detailed assessment of the likelihood and consequence of failure based on a number of key parameters. All parameters are then equated using equation [2].

$$\textit{Risk} = \textit{Likelihood of Failure} \times \textit{Consequence of Failure} \qquad [2]$$

Based on this principal, the risk associated with a given asset's failure can be managed by limiting the likelihood of this occurring, or the impact realized, should it occur.

Consequence of Failure (CoF) reflects the relative "impact" of a given asset's failure. While traditionally these have been looked at as purely economic terms (i.e. repair cost, loss of revenue, etc.), the truth is that investment decisions are often driven by non-economic factors. Understanding both the economic and non-economic impacts associated with loss or limitation of service help in categorizing an asset's "criticality" and justifying infrastructure decisions in a consistent, defensible manner.

4.7.2 Risk Assessment Results

A detailed risk assessment was performed as part of a 2016 project for the City. A risk score was calculated for each wastewater main using its Likelihood of Failure (LoF) and Consequence of Failure (CoF) score. LoF for wastewater mains had two potential options based on whether Closed-Circuit Television (CCTV) condition data was available for the sewer segment or not. If a sewer segment was not visually inspected by CCTV, LoF was estimated using the Weibull age deterioration approach which determines where the wastewater main segment sits on a deterioration curve relative to age and its expected service life. If a sewer had undergone CCTV inspection and its structural condition score ranged between 2 and 5, its age was adjusted by selecting an appropriate age value that corresponded with the sewer's structural condition on a deterioration score chart.

For example, the age of a sewer with a structural condition score equal to 5 was adjusted so that its apparent age was increased to reflect greater ageing close to or beyond its expected service life. In this way, a sewer with a relatively low age but which is in a poor structural condition will be triggered for replacement in the immediate future. In addition, if a pipe is located within a "Hotspot" area, its LoF score was increased with the application of an adjustment factor. Based on the availability of the data, LoF was estimated using the Weibull age deterioration approach. The potential exists to incorporate CCTV condition data in the future assessment of LoF. The CoF for the new developed assets after 2016 were determined by a multi-regression method. Please refer to 2016 Risk Management Framework Report for more details.

A Risk Score was calculated for each wastewater main asset using its LoF and CoF scores. As the City's assets are relatively young with very low LoF scores, most of the wastewater mains fall in low-risk category. In this case, the City can prioritize wastewater work using the CoF (criticality) scores. **Figure 4-4** shows the criticality map for wastewater mains, indicating the location of the mains that are considered to be in the high, medium, and low criticality categories.

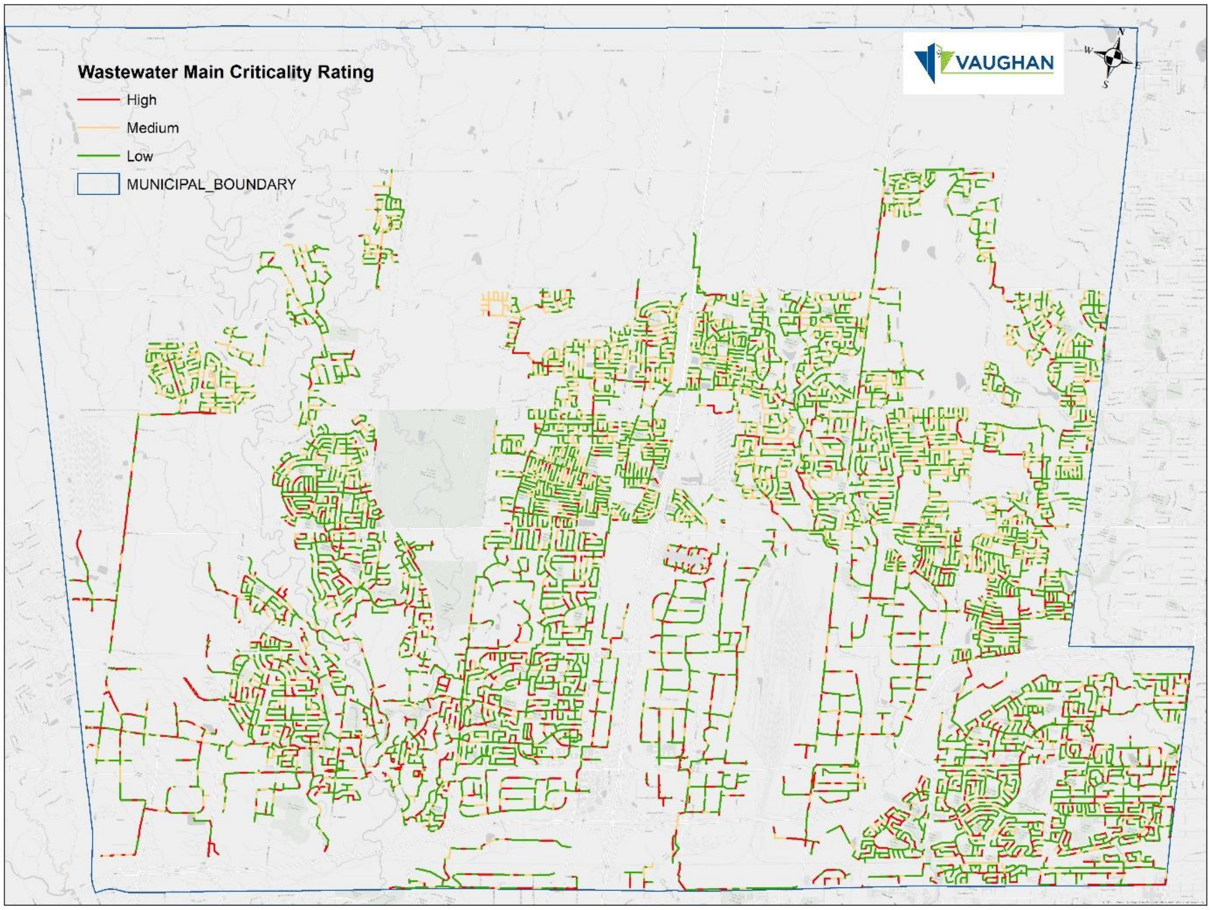


Figure 4-4: Wastewater Main Criticality Map

4.7.3 Analytical Logic to Sequence Interventions

The asset criticality score can be used to prioritize projects within a funding constrained environment. Figure 4-5 illustrates this logic of carrying unfunded needs to the next year in the period where they receive a higher probability of receiving funds based on their criticality score.

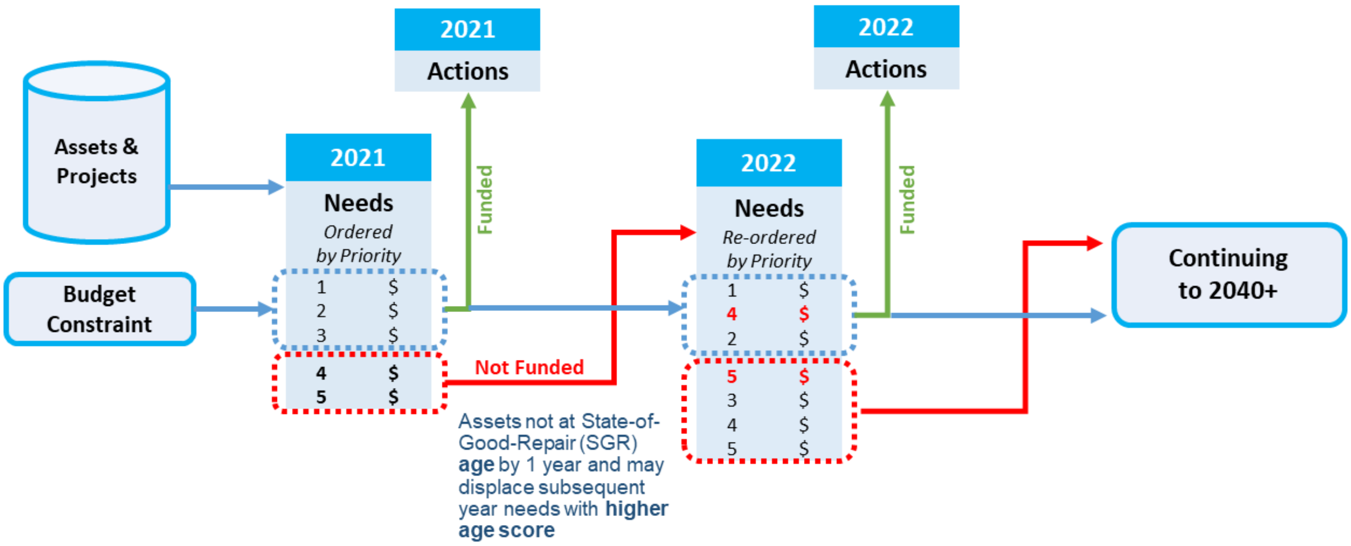


Figure 4-5: The Role of Criticality to Prioritize Projects Within A Funding Constrained Environment

4.8 Financial Planning

4.8.1 Financial Policies

The City has taken the initiative to establish financial asset management policies in 2018, which provides directions on how financial principles apply to assets to ensure that service goals are met. The policy aligns the business model of AM with the City's financial planning, financial reporting, cost management, treasury and taxation functions. The City will integrate findings from the AM Plans into its long-term financial planning and budgeting processes. Sound financial analysis will be encompassed in AM planning in order for the AM Plan to be a sought-after guide for employees in budgeting and financial planning.

4.8.2 Financial Analysis

Financial analysis activities for asset management are centered on two essential quantities: revenues and expenditures. Revenues can come from many sources. Through asset operations, the City generate its own source revenues from taxes, development charges, etc. Expenditures are all the direct and indirect costs associated with capital, operating and maintaining, and disposing of assets.

Assessing the financial implications support the decision-making when there are competing priorities and trade-offs between projects. Financial analysis provides a better picture of how to fund the capital plan and make critical decisions about service delivery while providing the greatest benefit for the community at the lowest cost.

4.8.3 Aligning the Financial and Non-Financial Functions of AM

ISO 55010[1] identifies the that the financial and non-financial functions of AM within organizations are generally inadequately aligned, as follows:

- **Financial Accounting Functions:** Focused on retrospective reporting of accounting / regulatory financial activities. However, there is a growing awareness in organizations of the need to focus on providing a managerial costing approach in order to support decision-making for the future.

[1] International Organization for Standardization (2019): ISO 55010 - Asset management — Guidance on the alignment of financial and non-financial functions in asset management

- **Non-Financial Functions:** Have a limited understanding of financial accounting functions but are recognizing the need to improve their understanding of the financial implications of their activities.

The lack of alignment between financial and non-financial functions can be attributed to silos in an organization, including reporting structures, functional / operational business processes, and related technical data. Silos generally bring forth the necessary level of specialization. However, with a lack a communication between the silos, organizations are at risk of inefficiencies and errors in AM results, or AM failures due to a lack of alignment between AM staff and senior management. Financial and non-financial alignment needs to work both "vertically" and "horizontally", as follows:

- **Vertical Alignment:** Financial and non-financial asset-related directives by management are informed by accurate upward information flows, effectively implemented across the appropriate levels of the organization.
- **Horizontal alignment:** Financial and non-financial information that flows between departments (conducting functions such as operations, engineering, maintenance, financial accounting and management) uses the same terminology and refers to the assets identified in the same way.

Figure 4-6 presents the key elements in a framework to address the need to achieve the alignment.

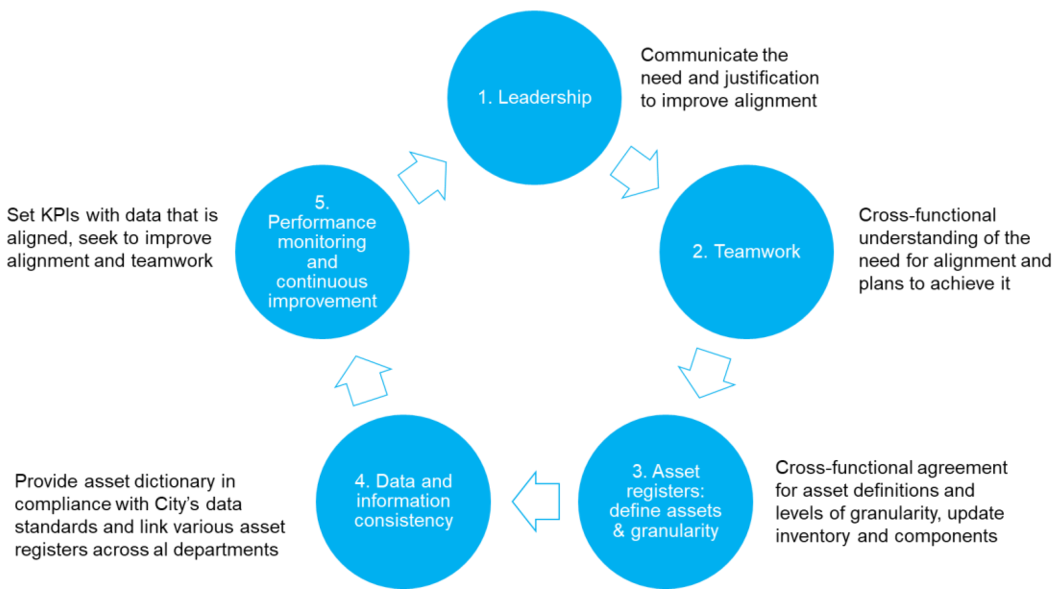


Figure 4-6: Key Elements of a Framework to Achieve Financial and Non-Financial Alignment

4.8.4 Long-Term Financial Planning

Strengthening the City's AM planning according to the recommendations in the Asset Management Strategy will improve the City's long-term financial planning, by accounting for whole life cycle costs as presented in **Section 4**. This includes all capital, annual operation and maintenance, and disposal costs over the planning timeframe, thereby aligning financial requirements with long-term level of service objectives.

The challenge is often one of agreeing on a timeframe for such planning, recognizing that the AM perspective is ideally focused on the asset life cycle, versus the political / election cycle that could be as short as a three to four-year Council term. Accordingly, financial and non-financial staff, as well as top management and politicians, should agree on a long enough timeframe to provide useful forward planning information that aligns the financial and non-financial perspectives, as presented in **Figure 4-7**.

Figure 4-7: AM Planning Alignment Across the Organization

The City should have an appropriate long-term financial planning process that achieves the following:

- Stimulates long-term strategic thinking and perspective for stakeholders and decision-makers.
- Can be used as a tool to prevent or predict future financial shocks and demonstrate financial sustainability.
- Demonstrates to internal and external stakeholders that the organization has a financial strategy in place to meet their demands, now and in the future.

The long-term financial planning process needs to involve financial and non-financial staff working together to combine the important elements of strategy development, asset management planning and financial forecasting (**Figure 4-6** and **Figure 4-7**).

5. Funding Need Analysis

5.1 Wastewater 20-Year Funding Need Analysis

The average annual reinvestment rate required to fund all replacement and rehabilitation activities for the City's wastewater infrastructure assets over the next 20 years is $1.2M per year in 2024 dollars, as presented in **Figure 5-1**. This is equivalent to a total of $24.1M over the next 20-year period.

Given that the expected service life of wastewater assets can be close to 100 years, the City modelled a 100-year forecast to determine the average annual reinvestment rate over the next century. This results in an average annual reinvestment rate over the next century of $9.4M per year. This is equivalent to a total of approximately $940M over the next 100-year period.

Figure 5-1: Wastewater 20-Year Total Reinvestment Need

Figure 5-2 breaks down the 20-year reinvestment value into 3 sub-categories:

- **Mains and direct appurtenances** refer to all assets that might be replaced or rehabilitated at the same time as a main, including mains, maintenance holes, and laterals.
- **Non-linear assets** refer to all assets that would be replaced independently from a nearby main replacement. This category includes flowmeters, pump stations, and generator stations.
- **OpEx** refers to asset inspection and major repair/maintenance programs. This includes CCTV inspections.

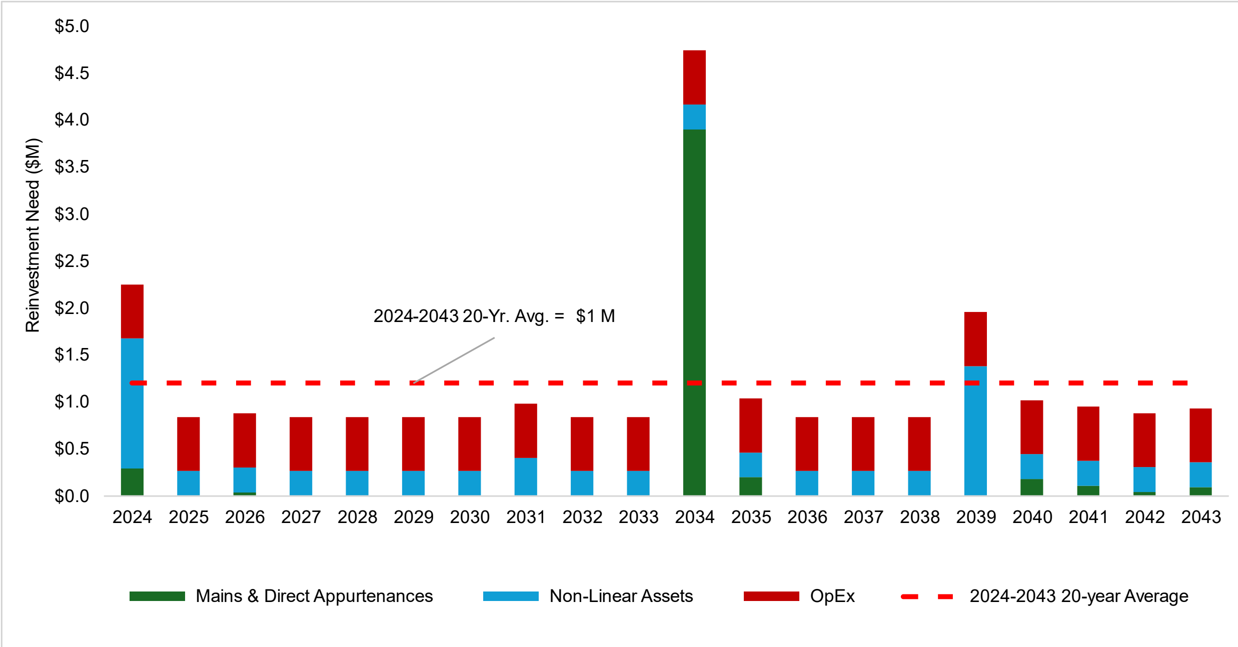


Figure 5-2: Wastewater 20-Year Reinvestment Need Details

As shown in **Figure 5-2** above and **Table 5-1** below, a fifth (20%) of expenditures over the next 20 years are for the renewal of mains and direct appurtenances. The non-linear assets, including the City's wastewater facilities account for approximately one third (32%) of expenditures. Approximately, the remaining half (48%) come from OpEx expenditures.

Looking at the next 100 years, these ratios change significantly. Most (90%) of expenditures over the next century are for the renewal of mains and direct appurtenances, while non-linear assets and OpEx represent 4% and 6%, respectively. The City should prepare for more reinvestment funding as the assets continue to age.

Table 5-1: 20-Year Total and Annual Average Reinvestment Need

	Mains & Direct Appurtenances	Non-Linear Assets	OpEx	Total
Annual Average Need	$ 243,000	$ 384,000	$ 576,000	$ 1,203,000
20-Year Total	$ 4,859,000	$ 7,688,000	$ 11,525,000	$ 24,072,000
% of Total Expenditures – 20-Year Forecast	20%	32%	48%	
% of Total Expenditures – 100-Year Forecast	90%	4%	6%	

The total annual reinvestment rate from **Figure 5-1** has been overlaid with the O&M annual budget (based on 5 year historical values, using 2024 dollars), as presented in **Figure 5-3**.

Wastewater assets require approximately $94.4M O&M funding over the next 20 years, equivalent to approximately $4.7M per year in 2024 dollars. As such, with the addition of O&M, the total average annual reinvestment rate for the City's wastewater infrastructure assets increases to approximately $6M annually, for a total of $118M over the next 20-year period, as presented in **Figure 5-3**.

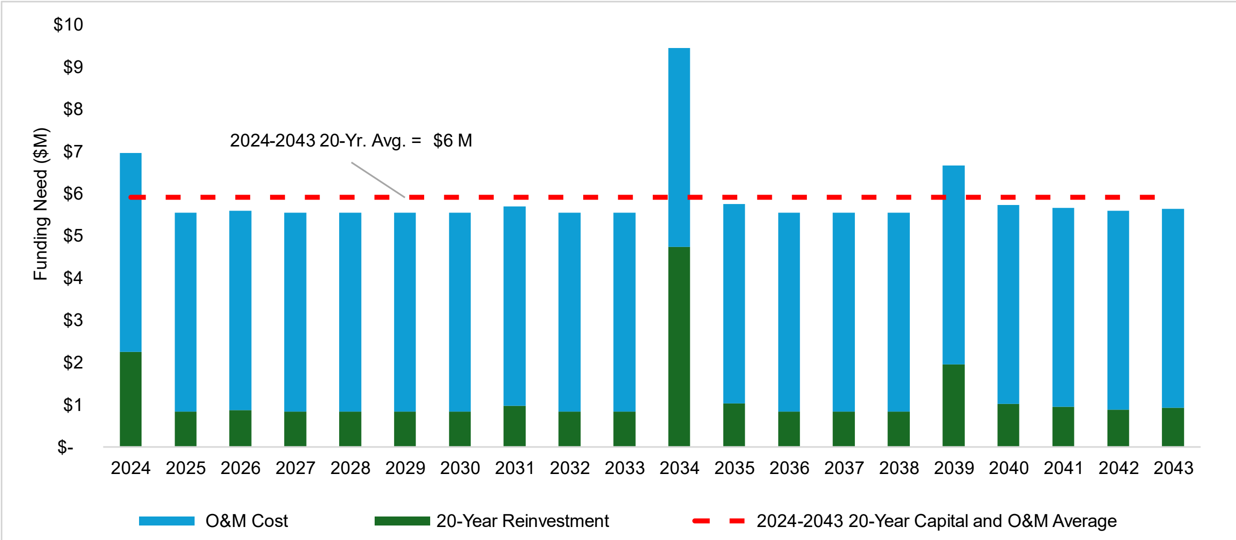


Figure 5-3: Wastewater 20-Year Capital Investment and O&M Cost Forecast

5.2 Full Funding Need Profile

Figure 5-4 shows a full picture of the City's Wastewater Service funding need forecast over the next 20 years, which provides the City the full funding requirements in order to perform effective financial planning activities. The total annual reinvestment rate and O&M cost from **Figure 5-3** has been overlaid with the City's five-year annual average wastewater service cost.

The City's wastewater service funding requirement increases to approximately $1.85B over the next 20 years with additional funding requirement of wastewater service to the Region, and O&M, equivalent to $93M per year in 2024 dollars. It is notable that the funding requirement for the Regional wastewater service cost is significant compared to capital requirement and O&M requirement, as presented in **Figure 5-4**.

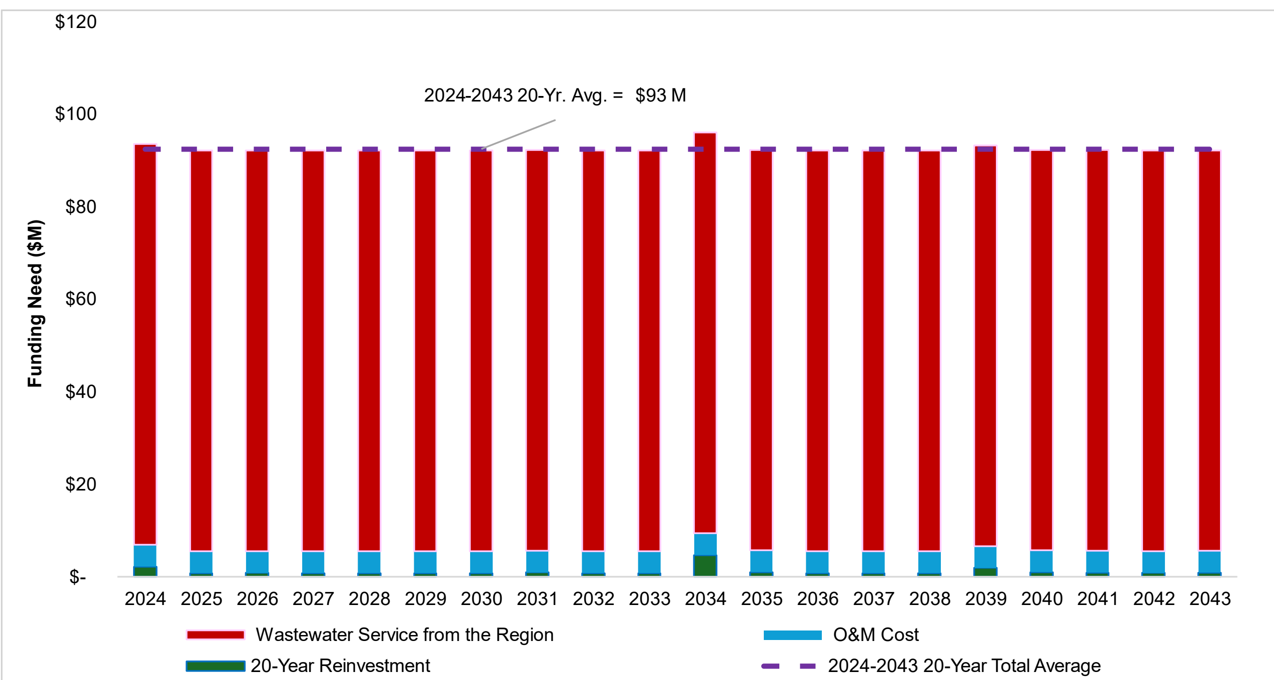


Figure 5-4: Wastewater Full Funding Need Profile

5.3 Infrastructure Reserves Funding Forecast

Reserve funds are important tools in the planning and management of the City's financial resources and provide a strong indicator of the City's overall financial health and are fundamental to the City's long-term financial sustainability. The City is committed to maintaining healthy reserve fund balances which are collected through various means (i.e., development charges, contributions, dedications, taxation, etc.).

There are specific infrastructure reserves for the rate-supported service areas of Water, Wastewater and Stormwater. These reserves contain funds set aside through annual contributions from ratepayers to help pay for the repair and replacement of infrastructure assets. Like many municipalities across Canada, Vaughan is facing increased costs associated with maintaining aging infrastructure. Corporate Asset Management Plans for both core and non-core assets suggest the City's infrastructure deficit is large and growing. The City has continued with robust strategies and plans by developing a comprehensive Long-Range Fiscal Plan and model, which was used to better inform the 2025 and future budgets by providing information about the financial requirements to sustain growth, delivery of services and the community's infrastructure needs.

Prudent financial planning requires ongoing contributions to water, wastewater, and stormwater reserves to fund the repair and replacement of infrastructure. Safe and reliable drinking water distribution, effective wastewater collection and efficient stormwater management are cornerstones of a sustainable and healthy community. To achieve this, continued operating and infrastructure investments are critical to ensure the City's water, wastewater and stormwater systems remain financially sustainable now and into the future. This objective is supported by continuing to build service area infrastructure reserves. The 2025 budgeted rates and charges will generate net total reserve contributions of $23.2 million to fund water, wastewater and stormwater-related programs and services. The City is committed to ensuring the financial sustainability of these systems and the ongoing protection of the environment in alignment with the Safe Drinking Water Act, Ontario Water Resources Act, the Environmental Protection Act and the Growth Plan for the Greater Golden Horseshoe.

The City's Asset Management Plans assess average reinvestment requirements over the next 20 years for the City's core assets, including water, wastewater and stormwater infrastructure. Annual reserve contributions should generally be in line with the asset reinvestment requirement to ensure sufficient funds are set aside for asset rehabilitation and replacement needs.

For the Wastewater service area, the forecasted 20-year average funding need is $1.2M. In comparison, the average annual funding forecasted over the next 10 years is estimated to be $5.2M representing a funding coverage of over 100% as illustrated in Error! Reference source not found.. The funding sources in this forecast are limited to annual reserve contributions and the Canada Community-Building Fund (CCBF is provided from the Federal Government). Other available funding sources not included are debentures and non-CCBF grants, which would mitigate any infrastructure funding gaps.

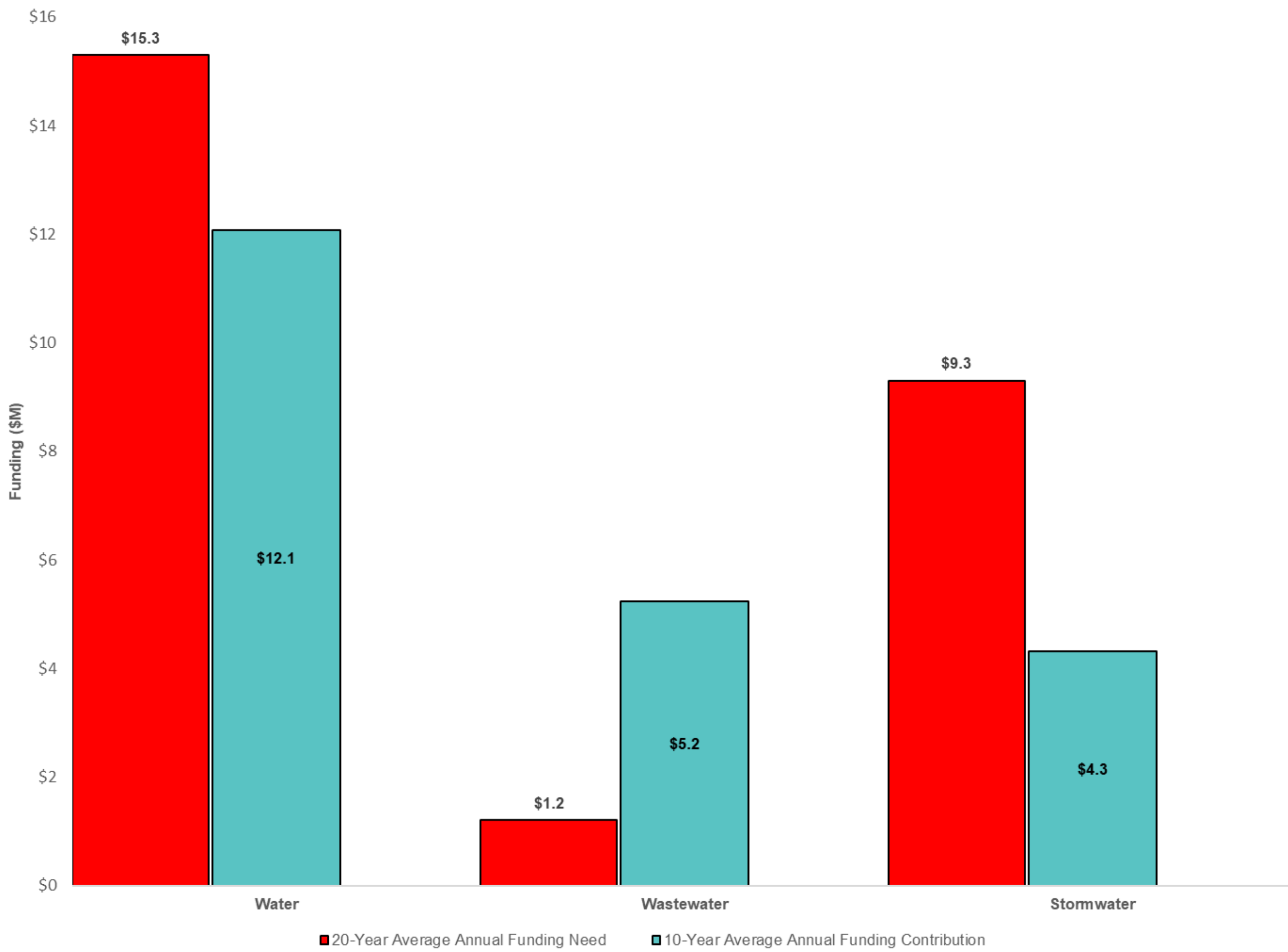


Figure 5-5: Coverage of Average Annual Funding Needs for Rate-Supported Service Areas

Revisiting the timing and scope of capital projects, optimizing the use of existing funding tools and revenue sources, such as debt and dedicated contributions to capital reserves, can help increase the City's capacity to begin to close an infrastructure funding gap.

5.4 Growth-related Assets Funding Need

The City completed the Integrated Urban Water Plan (IUWP) Master Plan Study in 2024. The objective of the study was to develop a plan to meet the water, wastewater and stormwater infrastructure needs as the City's communities continue to grow. This study analyzed the city-wide infrastructure needs to identify the required infrastructure that will meet future servicing demands. The study assessed the existing and future servicing needs and provides servicing recommendations to meet the City's growth plans. Based on the IUWP, the forecasted funding need estimates for the construction of new Wastewater assets out to 2051 is illustrated in Error! Reference source not found. with a primary funding source for these needs being Development Charges.

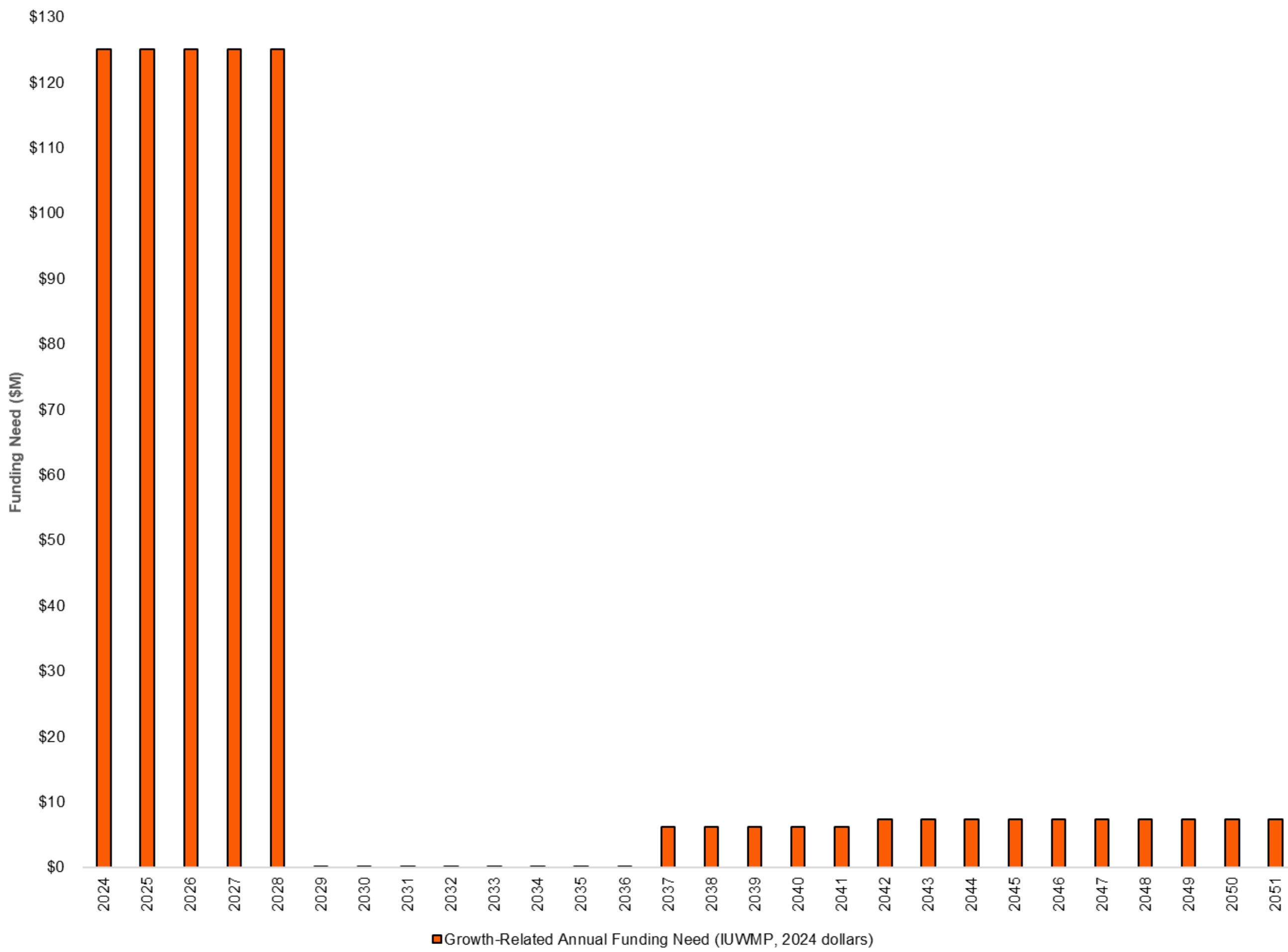


Figure 5-6: Forecasted Funding Needs for Construction of New Wastewater Assets

One of the next steps in the further development of the IUWMP is to apply added detail to the forecasted funding need estimates. This will provide a more refined forecast, which will serve to provide additional guidance for Asset Management planning in the future at the City of Vaughan.

Asset Management Plan

Core Assets
Stormwater

City of Vaughan
March 2025

Table of Contents

Figures

Tables

1. Introduction

The City of Vaughan (The City) has conducted a renewal of the City's Asset Management (AM) Plans for all its infrastructure assets, including Stormwater Assets.

1.1 Background

The City is one of nine area municipalities located within the Regional Municipality of York. As a lower tier municipality, the City is responsible for providing services such as buildings, fire protection, public works, water distribution, wastewater collection, and parks and recreation.

The next 25 years will see the City transition from a growing suburban municipality to a fully urban space. This type of transition will require long-term thinking about how best to accommodate and make the most of new opportunities. Planning for the future through strategic planning will position the City to deal with the many pressing issues impacting the organization such as community safety, access to health facilities, environment, traffic congestion and issues related to growth and the quality of municipal services.

The City is one of Canada's fastest growing cities, with a population of over 320,000 according to the latest census from Statistics Canada. It is projected that the number of residents will increase to 415,000 by 2031. In addition to its rapidly growing population, the City is home to a well-diversified and expanding employment sector with over 7,800 businesses and 231,000 employees. The City has the largest supply of new employment lands in the Greater Toronto Area (GTA) and it is projected that the number of employees will increase to 271,000 by 2031.

1.2 Objectives

In 2018, by City Council approval, the Corporate Asset Management (AM) Policy for the City came into effect; and, in 2013, the City's first Corporate AM Strategy was published. As identified in the Corporate AM Strategy, the City's first set of AM Plans (AMPs) were developed in 2014.

In early 2021, the City updated its AM Strategy and core infrastructure AMPs, as per Ontario Regulation (O. Reg) 588/17. The purpose of this series of AMPs is to now update the infrastructure assets so as to provide the City with a comprehensive updated AM Plan.

The objective of this AMP is to deliver a financial and technical roadmap for the management of the City's roadway appurtenance assets, and to provide the means for the City to maximize value from its assets, at the lowest overall expense while, at the same time, providing enhanced service levels for its residents and promoting green initiatives.

Organizations that implement good AM practices will benefit from improved business and financial performance, effective investment decisions, and better risk management. Stakeholders can expect lower total asset life cycle costs, higher asset performance, and confidence in sustained future performance.

1.3 AM Provincial Requirements

The Ontario Regulation 588/17 (O. Reg. 588/17) came into effect in 2018 and stipulates specific AM requirements to be in place within Ontario municipalities by certain key dates (**Table 1-1**). The development of this AMP is one of the steps to guide the City towards meeting the July 1st, 2025 deadline.

Table 1-1: O. Reg. 588/17: AM Planning for Municipal Infrastructure

Description: A regulation made under the Infrastructure for Jobs and Prosperity Act, 2015, stating that every municipality shall prepare and update a Strategic AM Policy, and that every municipality shall prepare an AM Plan for its core infrastructure assets by July 1, 2022, and an AM Plan for all other infrastructure assets by July 1, 2024. The regulation outlines several requirements that each AM Plan must follow, such as including current and proposed level of service. Core municipal infrastructure assets include water, wastewater, stormwater, road, and bridge assets.	
Deadline Date	Regulatory Requirement
July 1st, 2019	All municipalities are required to prepare their first Strategic AM Policy.
July 1st, 2022	All municipalities are required to have an AM Plan for its entire core municipal infrastructure (i.e., water, sanitary, stormwater, and transportation).
July 1st, 2024	All municipalities are required to have an AM Plan for infrastructure assets not included under their core assets.
July 1st, 2025	All AM Plans must include information about the levels of service that the municipality proposes to provide, the activities required to meet those level of service, and a strategy to fund activities.

1.4 Scope

This AMP has been developed for the City's Stormwater Assets categories, owned and maintained by the City, as shown in **Table 1-2**: In-Scope Assets. The renewal of the City's AM Plans is consistent with the guidelines laid out in the City's Corporate AM Policy and Section 5 of O. Reg. 588 / 17.

Table 1-2: In-Scope Assets

Asset Category	Sub-Assets
Stormwater Management System	Stormwater mains, laterals, maintenance holes, catchbasins, culverts, in/out structures, devices, ditches, and stormwater management facilities.

The following elements are included within the scope of this AMP:

- A summary of the asset inventory, including the replacement cost of the assets, the average age of the assets, the condition of the assets, and the City's approach to assessing the condition of the assets.
- Current levels of service (LoS) based on performance measures.
- Asset lifecycle management strategies to maintain identified current LoS, minimize associated asset risks, and to optimize costs over the whole lifecycle of the asset.

1.5 Approach for Asset Management Plan

The approach used in the renewal of this AM Plan is presented in **Figure 1-1**, and has been selected to ensure that the City can have the confidence to make fact-based and defensible business decisions from reliable and robust information.

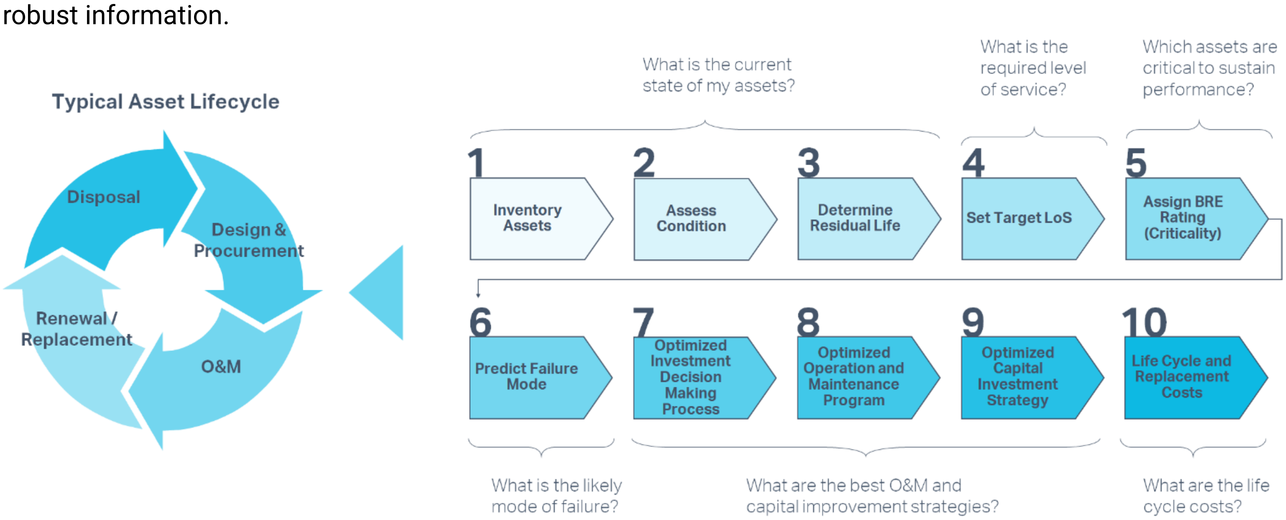


Figure 1-1: AM Plan Approach

2. State of Infrastructure

Defining the state of the infrastructure involves quantifying the assets owned, examining their age, replacement value, and condition. The City's approach to each of these asset characteristics is summarized below.

2.1 Expected Service Life and Remaining Service Life

The expected service life (ESL) is defined as the period over which an asset is available for use and able to provide the required level of service at an acceptable risk (i.e., without unforeseen costs of disruption for maintenance and repair). The ESL for this assignment will be based on discussions with City staff, information from previous studies, and any additional information that might inform the ESL. In terms of determining the Remaining Service Life (RSL), the City used the installation date together with the ESL.

In reality, different assets will deteriorate at different rates and not necessarily linearly over time, however, it is important to keep in mind the level of effort required to predict failure compared with the asset value. More sophisticated deterioration modelling may be warranted for very high value assets, whilst the cost of deterioration modeling for low-value assets may very well exceed the replacement cost of the asset. The actual service life can vary significantly from the ESL. In some instances, a variation in expected vs. actual service life is evident due to the following factors:

- **Operating conditions and demands:** Some equipment is operated intermittently or even infrequently, or is being operated a lower demand than its design capacity, thus the actual operating "age" of the asset is reduced.
- **Environment:** Some equipment is exposed to very aggressive environmental conditions (e.g., corrosive chemicals), while other assets are in relatively benign conditions, thus the deterioration of assets is affected differently.
- **Maintenance:** Equipment is maintained through refurbishment or replacement of components, which prolongs the service life of the asset.
- **Technological Obsolescence:** Some assets can theoretically be maintained indefinitely, although considerations such as maintenance cost, energy inefficiency and new technologies are likely to render this approach uneconomical.

2.2 Current Asset Replacement Value

The estimated replacement value is the cost of replacing an existing asset in 2024 dollars, considering an inflation rate. These costs were developed based on the records of previous tenders and quotes, other municipalities similar in size to the City, and consultation with the City's staff. Where applicable, a CPI-based inflation rate was used to estimate the 2024 values.

2.2.1 Asset Inventory and Replacement Value

An extensive stormwater network of assets is operated and maintained by the City to manage stormwater. Valued at $2.44 Billion, the City's stormwater system is categorized into two asset categories: Stormwater Linear and Stormwater Natural Assets. The stormwater asset categories are further divided into 15 asset types ranging from stormwater mains to stormwater management ponds (see **Stormwater assets** encompass three related sewer system and technologies: stormwater (STM), clean water collectors (CWC), and foundation drain collectors (FDC). The CWC system has significant environmental benefits beyond groundwater infiltration, which is different from other groundwater recharge methods because it uses only relatively clean water from roof areas and provides means to modify its operation and a direct access for maintenance. The foundation drainage systems infiltrate runoff generated from pervious and impervious surfaces after providing a measure of water quality treatment to remove suspended solids and other contaminants.

Table 2-1 for a high-level asset breakdown).

The City's core services, including Water, Wastewater, Stormwater, and Transportation, are coordinated with each other to ensure cost efficiencies to maintain the desired level of service while minimizing the risks. The core service areas are considered as a whole when considering the infrastructure lifecycle needs.

Stormwater assets encompass three related sewer system and technologies: stormwater (STM), clean water collectors (CWC), and foundation drain collectors (FDC). The CWC system has significant environmental benefits beyond groundwater infiltration, which is different from other groundwater recharge methods because it uses only relatively clean water from roof areas and provides means to modify its operation and a direct access for maintenance. The foundation drainage systems infiltrate runoff generated from pervious and impervious surfaces after providing a measure of water quality treatment to remove suspended solids and other contaminants.

Table 2-1: Asset Inventory & Valuation

Asset Category	Asset Type	No.	Unit of Measure	Unit Replacement Cost ($/Unit)	Replacement Value
Stormwater Linear	STM Mains	1,196	km	$210,000 - $5,680,000	$1,214,843,000
	CWC Mains	5.6	km	$440,000 - $1,050,000	$3,555,000
	FDC Mains	88	km	$290,000 - $1,650,000	$42,393,000
	STM Laterals	240	km	$290,000 - $2,070,000	$340,709,000
	FDC Laterals	17	km	$290,000 - $630,000	$6,990,000
	STM Maintenance Holes	16,454	No.	$12,480 - $37,280	$233,643,000
	CWC Maintenance Holes	35	No.	$12,480	$437,000
	FDC Maintenance Holes	714	No.	$12,480 - $37,280	$9,035,000
	Catchbasins	22,790	No.	$12,410 - $37,210	$287,189,000
	Minor Culverts	365	No.	$400,000 - $16,030,000	$12,211,000
	Major Culverts	136	No.	$132,000,000 - $4,768,000,000	$129,278,000
	In/out Structures	856	No.	$8,450	$7,233,000
	Devices	489	No.	$10,350	$5,061,000
Stormwater Natural Assets	Ditches	88	km	$700,000	$61,803,000
	Stormwater Management Ponds	182	No.	$224,560 - $561,400	$89,038,000
***Total**					**$2,443,418,000**

NOTES:

- The replacement value for mains and laterals excludes the asphalt cost, which is accounted for in the road AMP.
- *Total replacement value of laterals includes estimation of missing lateral records in GIS.

Stormwater linear assets represent the largest component of the stormwater system inventory by replacement value, and include 1,290 kilometers of mains across the 3 systems, each with laterals and maintenance holes. The stormwater open conveyance linear system also includes catchbasins, culverts, in/out structures, devices, and ditches. The stormwater management facilities include 182 stormwater management ponds providing water quantity, quality and/or erosion control.

In order to maintain the assets in a desired service level, the City implements approximately 300 programs and initiatives including routine CCTV inspection of stormwater mains, catchbasin cleaning, annual inspection and stormwater management ponds and critical pond cleaning, prevention of erosion and degradation of natural creek system, and proactive improvement and preventive repair of stormwater infrastructure.

2.3 Asset Condition

2.3.1 Age-Based Condition Assessment

Two-parameter Weibull distribution function was used to assess the current condition and to project the future condition of the City's Stormwater Assets. The Weibull distribution has been used extensively in reliability studies and lifetime prediction models in industries ranging from the automotive to the oil and gas industries; it provides a suitable distribution for this type of analysis.

The Weibull probability distribution provides a left-skewed distribution that rises slowly and diminishes quickly as the population is consumed. The underlying premise of the Weibull-shaped deterioration is that while some assets fail prematurely due to severe conditions or improper installation, other assets are very long-lived and function well beyond their theoretical expected service life. In order to perform a high order network-level analysis, it was assumed that assets would fail (and require replacement) within a deterioration envelope / curve approximated by a Weibull probability distribution. The two-parameter Weibull cumulative distribution has two parameters for scale and shape, as set out in Equation [1]:

$$f(x;\alpha,\beta) = e^{-\left(\frac{x}{\beta}\right)^{\alpha}} \qquad [1]$$

Where: x = Age
α = Shape parameter
β = Scale parameter (or slope)

Table 2-2 presents the condition score ranges and the corresponding range of ESL and total life consumed.

Table 2-2: Age-Based Physical Condition Scale

Condition Score (minimum)	Condition Score (maximum)	Condition Rating	Range % of ESL Consumed	Range of % Operational Life Consumed
1.0	1.5	Very Good	0% – 71%	0% – 47%
1.5	2.2	Good	72% – 84%	48% – 56%
2.2	2.8	Fair	85% – 92%	57% – 60%
2.8	5.0	Poor	93% – 100%	61% – 100%

2.3.2 Age Summary

Figure 2-1 is a horizontal bar graph that shows the Stormwater average asset age and average remaining service life in years as a proportion of average expected service life (ESL) by asset types. Asset ages have been established using data from the City's GIS database and consultant reports. The expected service life is developed using the City's Tangible Capital Asset database and workshop discussions with City staff. It is shown for each asset type as a standalone number to the right of the graph.

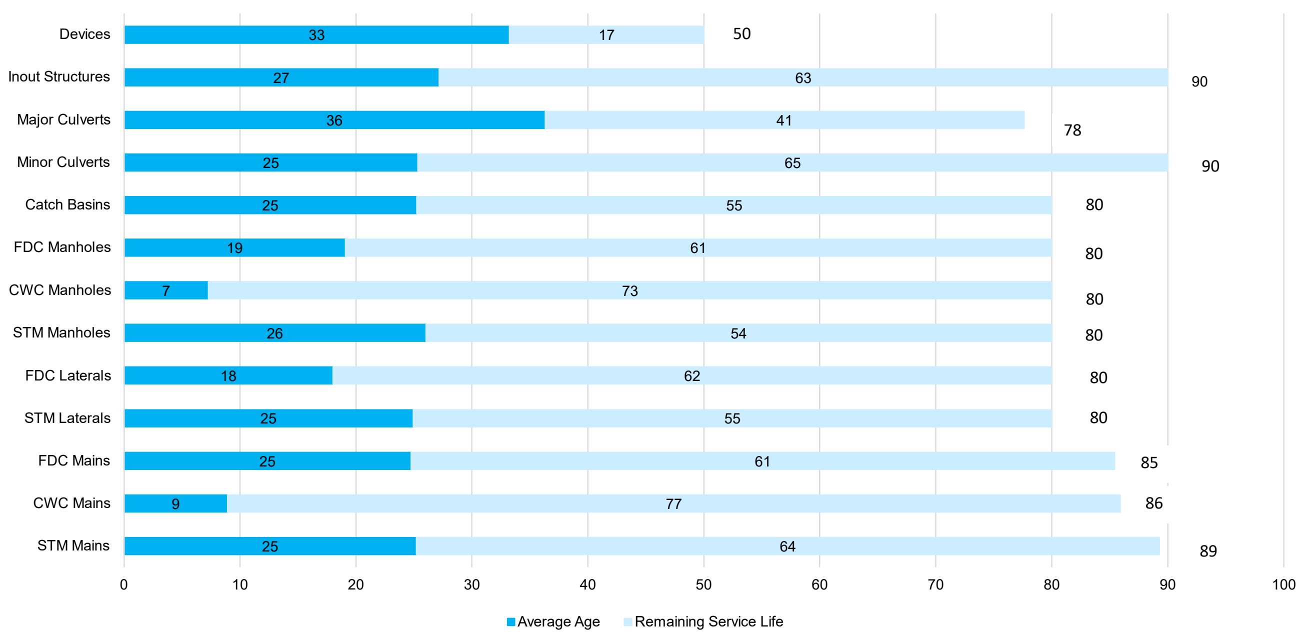


Figure 2-1: Average Asset Age as a Proportion of Average Expected Service Life

The stormwater management system is overall considered to be in the early stages of its life. The stormwater mains are approximately 28% through their expected service life. CWC mains are approximately only 10% through their expected useful life. FDC Mains are approximately 29% through their expected service life. The City's laterals and maintenance holes' age are similar to their adjacent mains.

The City's catchbasins are approximately 31% through the expected service life. The age of minor culverts indicates that the assets are approximately 28% through their service life. Major culverts are 46% through their expected service life, The in/out structures are approximately 30% through their expected service life. It is notable that the devices are 66% through their expected service life.

The ages of ditches and stormwater management ponds have not been systematically documented or the information is not readily available. Generally, stormwater management ponds, like many other natural assets, are considered to be non-traditional assets that are not necessarily to be replaced. There is no generally accepted accounting principles (GAAP) and some of them do not have an "end of life", assuming that these assets will essentially be maintained indefinitely. The operational expenditures made on stormwater management ponds (e.g. bathymetric surveys and sediment removal) are accounted for in **Section 5.1** and shown in **Figure 5-2.**

2.3.3 Condition Summaries

The City's Stormwater service assets are overall in very good condition with 98.4% of assets in very good condition (**Figure 2-2**) weighted by replacement value. There are only 0.3% of assets in poor condition meaning that they are approaching or exceeded the end of their expected service lives, indicating little to no need for investment in the short to medium term. The remaining 1.2% of assets are in good and fair condition indicating that they are meeting current needs, but some are aging and may require attention.

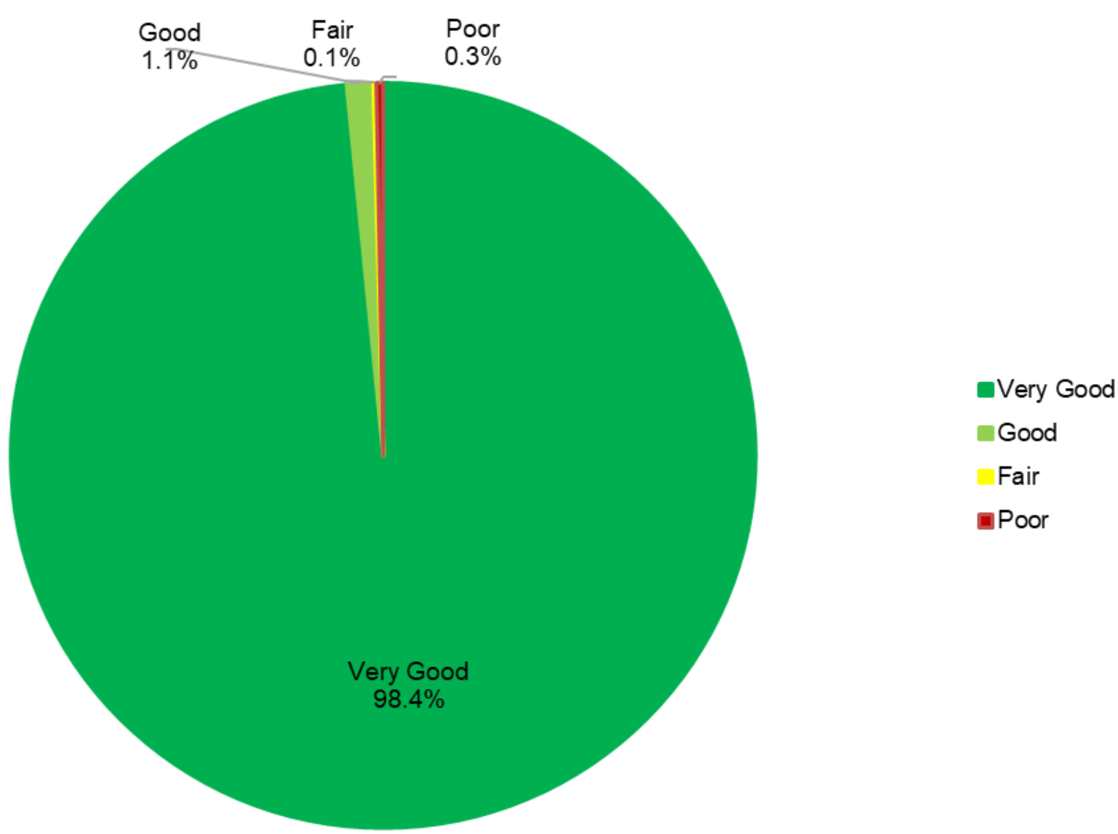


Figure 2-2: Asset Condition Summary

Asset conditions have been determined by using the data from the City' GIS database and consultant reports. The condition of stormwater mains, laterals, maintenance holes, catchbasins, culverts, in/out structures, and devices is based on the age and expected service life.

As shown in the detailed condition profile in **Figure 2-3**, most of the stormwater assets are in very good condition.

As the age information of natural assets such as stormwater management ponds, and ditches, is not readily available and the deterioration of these assets is hard to predict, the condition of these assets is not presented in the condition details. However, these assets are regularly inspected and maintained, as detailed in **Section 5.1** below.

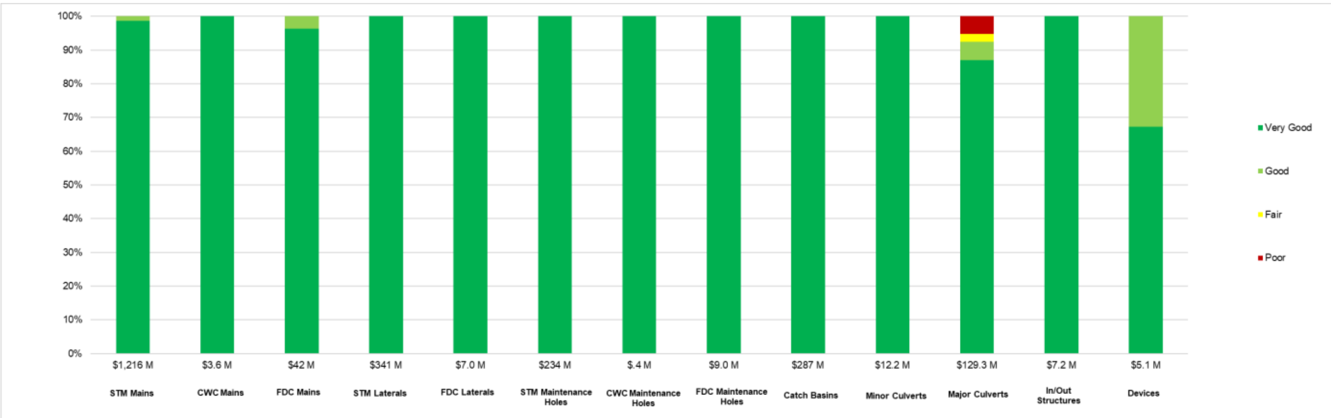


Figure 2-3: Distribution of Asset Condition by Replacement Value

3. Levels of Service

3.1 Purpose

Levels of Service (LoS) supports every aspect of the overall AM System as shown in **Figure 3-1**. The objective of establishing clearly defined service levels is to help the City meet stakeholder values, achieve its strategic goals, make informed risk-based decisions, and implement effective asset lifecycle activities.

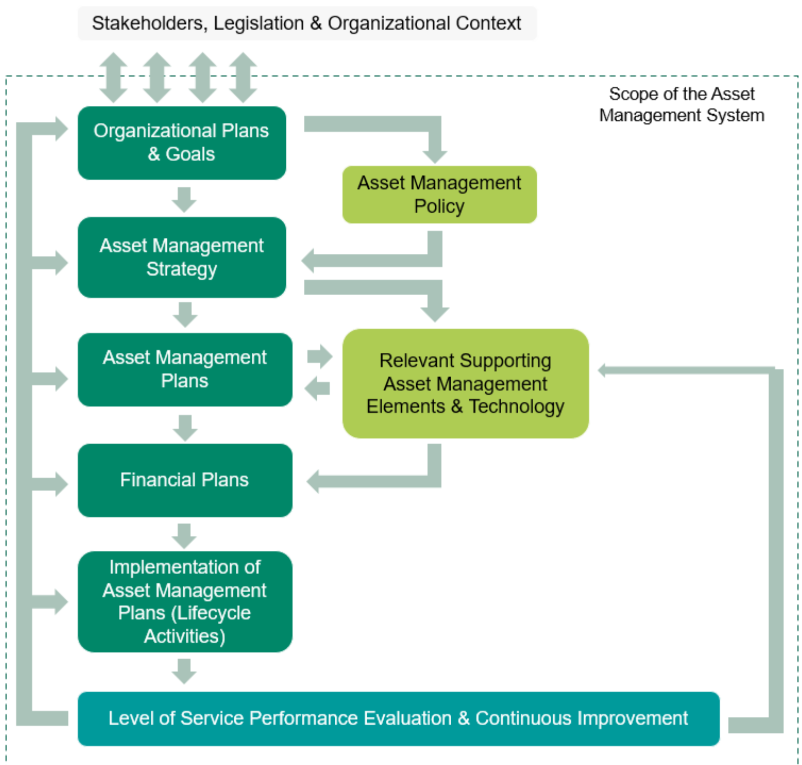


Figure 3-1: LoS within the AM System

In the City's experience, documenting LoS is a proven practice that will enable the City to:

- Link corporate strategic objectives to customer expectations and technical operations.
- Balance customer needs and expectations while evaluating the effectiveness of operations and whether the right LoS is being provided at the right cost.
- Transition from an "Asset Stewardship" approach that focuses on making decisions based on maintaining assets in an acceptable condition to a "Serviceability" approach that is geared towards making decisions based on balancing the costs, risks, and goals for the LoS being provided by the City's assets.
- Communicate the physical nature of infrastructure that the City owns and is financially responsible for while promoting the use of LoS to enable effective consultation with stakeholders regarding alternative funding options according to desired LoS outcomes.
- Make recommendations on strategies that the City can take now to minimize future renewal costs while ensuring that adequate LoS can be delivered without burdening future generations.
- Assess internal (e.g., program changes) and external (e.g., climate change) factors that have the potential to impact the City's ability to deliver services and how these factors may impact the LoS being provided.
- Implement a corporate continuous improvement program to further optimize AM across all service areas.

The O. Reg. 588/17 requires that all AMPs include information about the LoS that the City proposes to provide, the activities required to meet those service levels, and a strategy to fund those activities. The deadline for formalizing these LoS requirements is July 1, 2025 (see **Section 1.3**).

Successful AM programs aim to achieve targeted service levels through customer-based decision making. To achieve this, the City considered a customer-centric approach, where the customer is at the heart of every decision from development to implementation, consultation, and roll-out of the LoS Framework (**Figure 3-2**).

There are two types of LoS measures: Customer LoS (also called "Community" LoS) and Technical LoS. Customer LoS are recorded in a manner that attempts to describe the LoS in terms of what is actually being provided to the customer (i.e., the public) and how the customers experience the service. It is important to note that customers are not concerned with the specific operating requirements of the assets that provide the service, but rather the value they obtain from the operation of the assets. To achieve Customer LoS there needs to be line of sight between the value delivered and how that value is realized. This is the purpose of Technical LoS which attempts to describe how the City will provide and meet the expected Customer LoS.

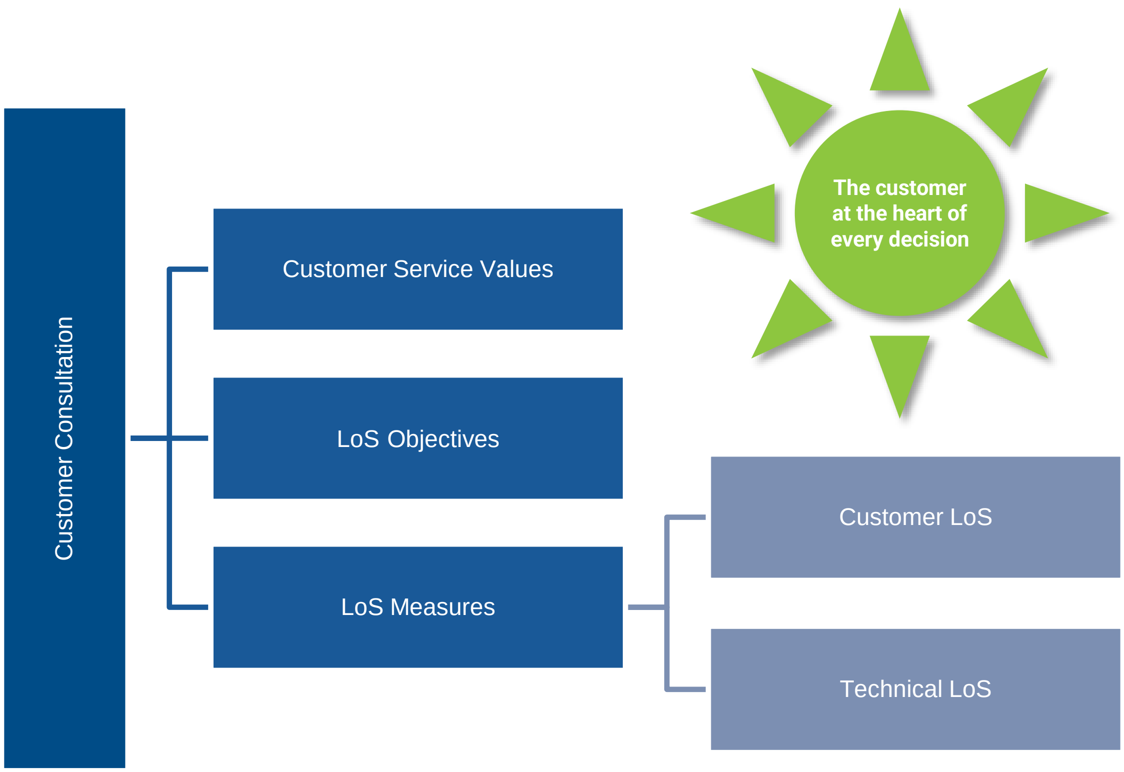


Figure 3-2: The LoS Framework Customer-Centric Approach

The LoS Framework was primarily conceived through a collaborative workshop process. In 2020, four workshops with City staff were conducted across each of the fourteen service areas.

The following outcomes were achieved during each service area workshop:

- Staff were oriented as to the purpose and importance of establishing a consistent LoS Framework;
- Stakeholders were identified, including their expectations, interests, and any regulatory requirements;
- Customer service values were established and reviewed;
- LoS objectives were established for each customer service value;
- Staff provided several performance measures that are currently being tracked as well as those that the City would like to track in the future;
- Where information was available, current performance, targets, and data sources were documented; and
- Growth and shifts in future demand were discussed across the City's service areas.

3.2 Objectives

Defining LoS objectives is important for drawing a line of sight between the City's corporate objectives and the tangible asset performance outcomes. To do so, the LoS objectives must take into consideration stakeholder interests to develop asset performance measures that aim to meet the needs and expectations of the community. By doing this, the City will ensure that their assets are striving towards optimal performance, not only operationally, but economically, socially, and sustainably as well.

Every stakeholder has certain interests in the service being provided and in general, these interests can be categorized into six universal stakeholder values, as shown in **Table 3-1**. Each universal stakeholder value is also assigned a corporate LoS objective.

Table 3-1: The City's Values and LoS Objectives

Customer Value	LoS Objective
Quality and Reliability	The service is delivered with a high standard of excellence and the service is available when needed.
Affordability	The cost of the service is delivered in a financially sustainable manner and does not burden customers.
Environmental Sustainability	The service is delivered in a manner that does not compromise the ability of future generations to meet their needs.
Access and Capacity	Customers can easily access the service with minimal inconvenience.
Health and Safety	The service is delivered with minimal health and safety impacts.
Responsiveness	Customer service requests are responded to efficiently and in a timely manner.

3.3 Stakeholders and Their Interests

A stakeholder is any person or organization that can affect, be affected by, or perceive themselves to be affected by a decision or an activity. Stakeholder analysis is the process of understanding stakeholder needs, expectations, and perceptions relative to the stakeholder's level-of-interest and level-of-influence over the organization. An organization typically engages with their stakeholders to:

- Establish which activities or services matter most to them.
- Understand their risk appetite and risk threshold.
- Understand their willingness to pay for services.

Stakeholders can take many forms and may be internal (i.e., staff, Council) or external (i.e., the public, regulatory agencies, suppliers, neighbouring municipalities, etc.) to the organization. Historically, only service recipients who pay for City services would be considered customers; however, today customers can take many forms and should include any entity that has a legitimate interest in the service being provided. In addition to service recipients (i.e., the public), this may include:

- **Regulatory Agencies** – Stakeholders that set standards, compliance regulations or other legislation that govern service delivery.
- **Special Interest Groups** – Stakeholders that are affected by or have an interest in activities within the City's right of ways.

3.4 Level of Service (LoS) Performance Measures

A documented suite of LoS performance measures enables a common understanding of the service delivery that the City's customers currently receive, and the associated cost of maintaining infrastructure assets to provide the service. Having these performance measures set at the appropriate levels within the City ensures alignment from the corporate vision, to asset investment decisions, and to day-to-day operational activities. When establishing LoS performance measures it is important to keep in mind the "SMART" acronym, as follows:

- **S**pecific, easily evaluated and understood.
- **M**easurable, quantifiable, and easily collectable to ensure ongoing data availability.

- **A**ttainable, so that they work to motivate as opposed to discourage.
- **R**elevant, in that they relate and align with a specific goal.
- **T**ime-Bound, measured over a specific period, which is typically annually for benchmarking.

There are two types of LoS performance measures: Community LoS and Technical LoS. Community LoS are recorded in a manner that attempts to describe the LoS in terms of what is being provided to the community (i.e., the public) and how the customer experiences the service. Community LoS are qualitative, non-technical, and are driven by the municipality's strategic AM objectives. Community LoS are not concerned with the specific operating requirements of the assets that provide the service, but rather the value they obtain from the operation of the assets. To achieve Community LoS, there needs to be line of sight between the value delivered and how that value is realized. This is the purpose of Technical LoS which attempts to describe, quantitively, how the City will provide and meet the expected Community LoS.

3.5 LoS Performance Results

Ontario O. Reg. 588 / 17 requires legislated community levels of service for core assets. Community levels of service use qualitative descriptions to describe the scope or quality of service delivered by an asset category. O. Reg. 588 / 17 also requires legislated technical levels of service for core assets. Technical levels of service use metrics to measure the scope or quality of service being delivered by an asset category. **Table 3-2** presents a summary of the City's stormwater service level for O. Reg 588 / 17 Metrics. References are provided to show where O. Reg 588/17 requirement has been attained.

A summary of the City's current and proposed community and technical service levels for Stormwater Assets are documented in **Table 3-2.**

Table 3-2: Community and Technical Service Levels

Level of Service	Current Performance	Current Service Level Target	Proposed Service Level Target
Percentage of properties in municipality resilient to a 100-year storm.	96.5%	96.5%	No Change
Percentage of the municipal stormwater management system resilient to a 5-year storm.	99.6%	99.6%	No Change
Description, which may include maps, of the user groups or areas of the municipality that are protected from flooding, including the extent of the protection provided by the municipal stormwater management system.	See **Figure 3-3** and **Figure 3-4**		No Change

Figure 3-3 shows a map that outlines the City's Stormwater connectivity.

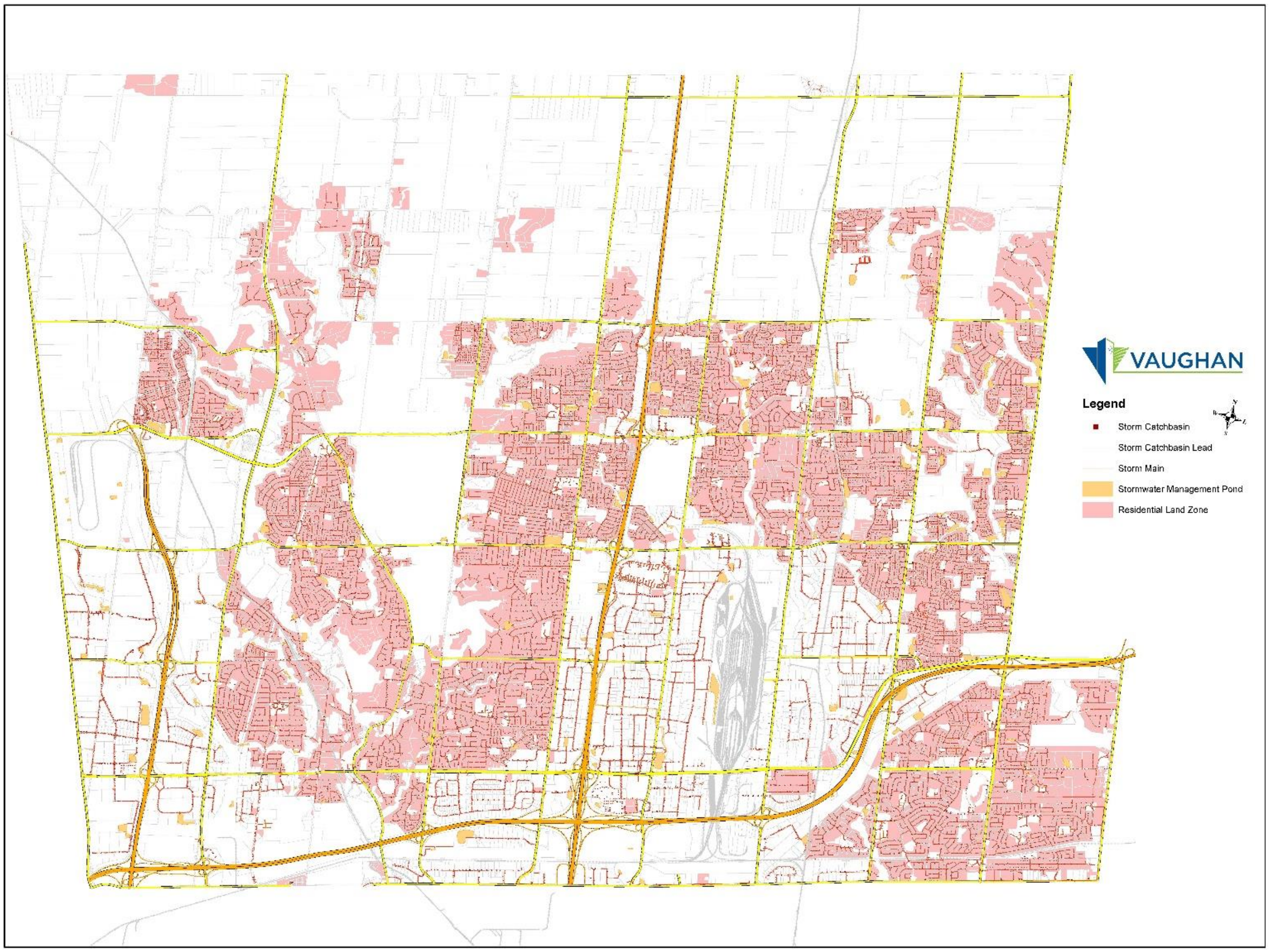


Figure 3-3: Map Outlining the City's Stormwater Connectivity

Figure 3-4: Map Outlining the City's Floodlines shows a map that outlines the City's floodlines.

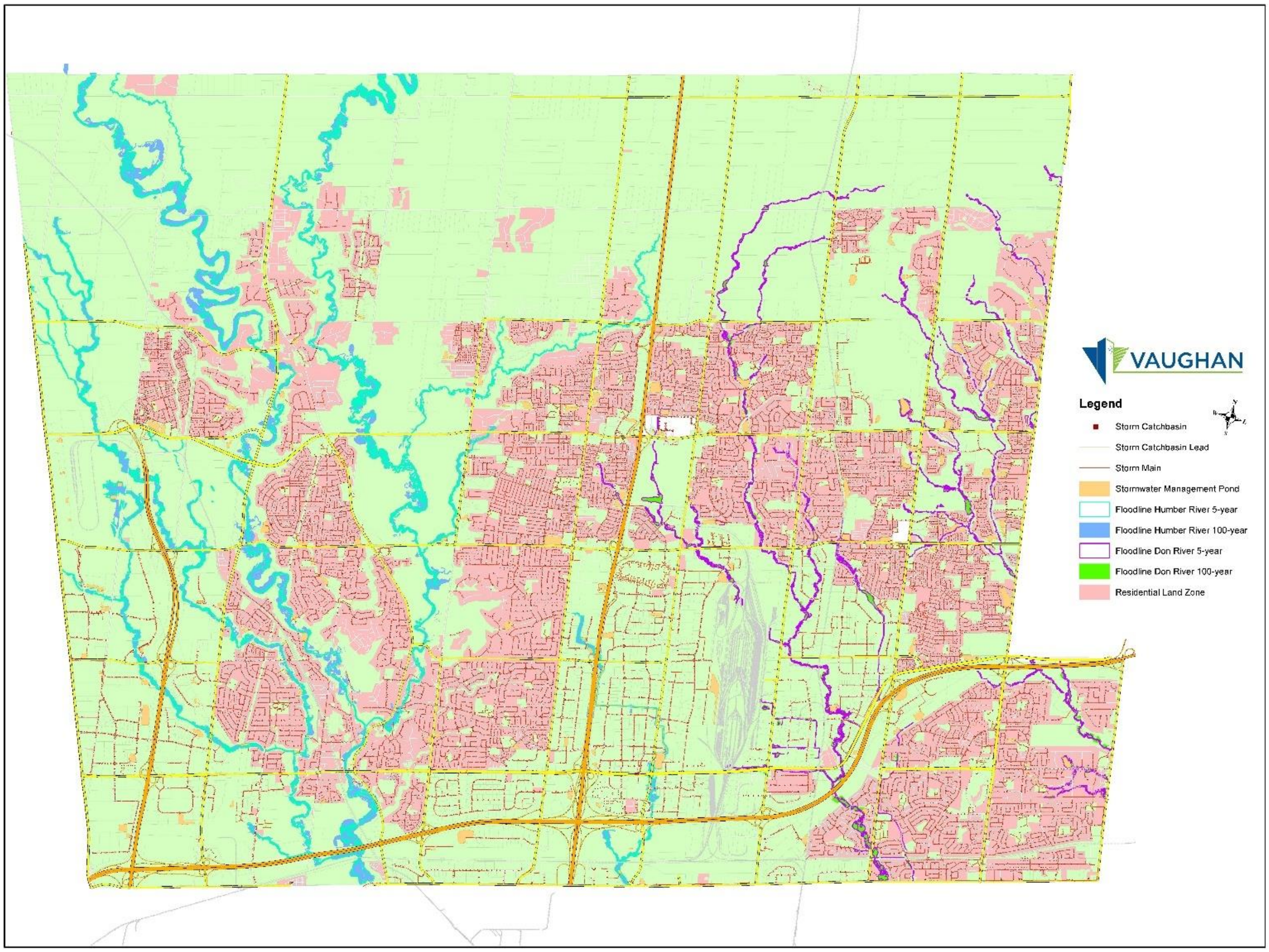


Figure 3-4: Map Outlining the City's Floodlines

3.6 LoS Performance Targets

Establishing LoS targets is an important part of continual improvement and performance management. Without targets, it is difficult to ascertain whether goals are being met, or the extent of the gap if they are not. Incorporating targets into the City's LoS Framework helps to ensure that targets are reasonable, aligned with customer expectations, and evaluated on an objective basis by considering cost-benefit trade-offs.

One of the key challenges in setting targets in a municipal environment is that they can often become biased and/or politically motivated. Therefore, it is important to review LoS targets with stakeholders. An important aspect of evaluating LoS targets is determining how willing the user is to pay for the service. Regulatory requirements are an exception; however, they only provide the minimum service standard. Cost is still an important parameter to consider when assessing the merits of service improvements.

To deal with the financial realities, it is necessary to:

- Calculate how much the service costs based on current LoS.
- Determine the cost associated with varying the LoS.
- Assess the customers' willingness to pay.

4. Asset Lifecycle Strategies

Asset lifecycle management focuses on the specific activities we must undertake during all phases of the asset lifecycle. By considering entire asset lifecycles the City can ensure sound decision making that consider present and future service delivery needs.

The overarching goal of life cycle management is to maximize the long-term benefits and services that our assets deliver while minimizing the associated costs and risks in the long run. Every asset has a life cycle cost, which is the total cost of all the activities undertaken throughout its service life. The following sections describe activities across the life cycle of assets.

4.1 Lifecycle Activities

Any responsible owner of assets such as the City has a desire to preserve the condition of their existing assets for as long as possible, by maintaining or even extending their design lives through routine activities such as maintenance and active intervention. The City is continually acquiring infrastructure assets, but these assets require increased funding for operation and maintenance as they age. The City is also responsible for the replacement of deteriorated assets as long as the service is required. While individual assets may have a useful life that can be predicted in years or decades, the service that the asset provides could be for a substantially longer duration (perhaps in perpetuity). Part of the purpose of the AM planning process is to fully understand and predict the long-range financial requirements for the City's infrastructure to facilitate planning and resource management in the most cost-effective manner possible. **Figure 4-1** illustrates how costs typically accumulate over an asset's life. It is worth noting that the accumulation of the ongoing operations and maintenance, refurbishment and disposal / replacement costs is many multiples of the initial acquisition costs. A key and important take-away from **Figure 4-1** is therefore for the City to fully understand the entire life cycle costs before proceeding with asset acquisition.

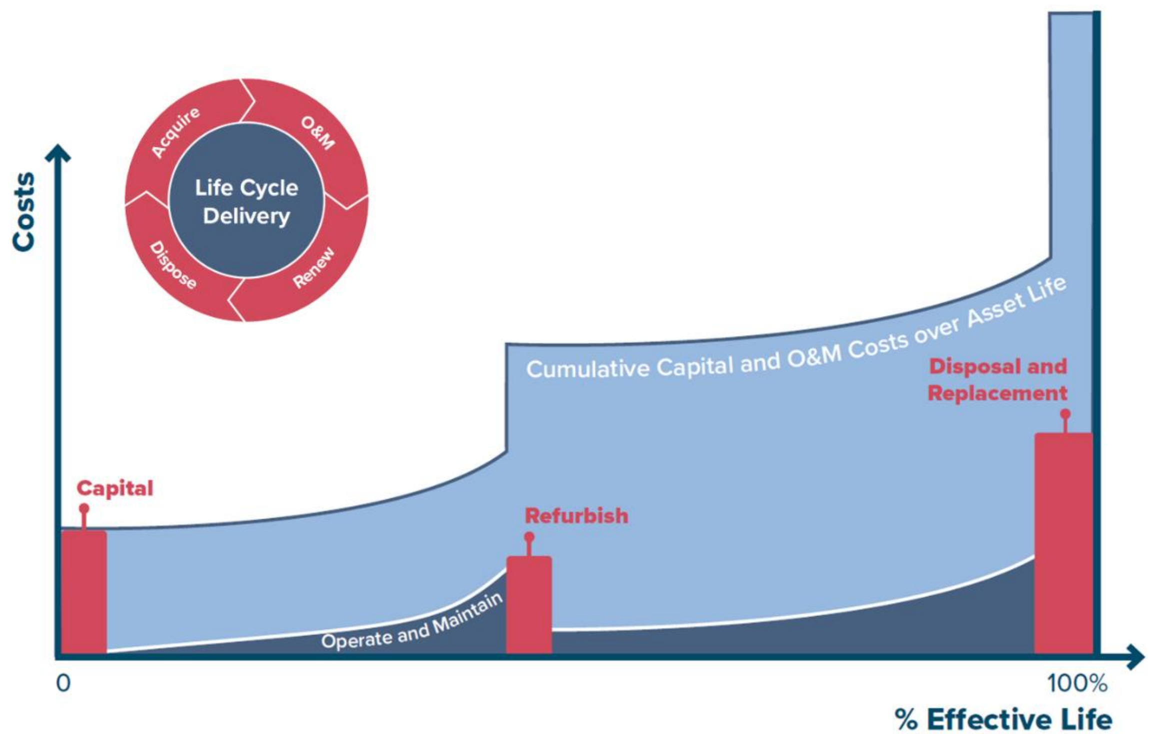
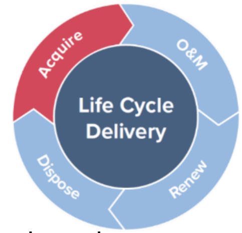


Figure 4-1: Life Cycle Cost Accumulation Over Asset Life

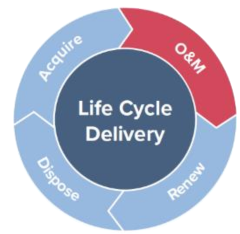
Expressed simply, full lifecycle cost of infrastructure can be accumulated under the following broad headings:

- **Asset Acquisition / Procurement / Construction**: The City has made significant investments in the design and acquisition of its municipal infrastructure assets. Added to City-purchased inventory is infrastructure that the City accepts (and takes immediate financial responsibility for) from developers as new neighborhoods are constructed. For example, as developers build new neighborhoods, the new local infrastructure (including local roads, water mains, sewer mains and storm mains) is paid for by the developer and then transferred to the City for operation, maintenance and ultimately replacement. The City's infrastructure inventory was therefore created over many decades through infrastructure paid for by the City or by developers Looking towards the future, when acquiring new assets, the City should evaluate credible alternative design solutions that consider how the asset is to be managed at each of its life cycle stages. Asset management and full life cycle considerations for the acquisition of new assets include, but are not limited to the following:

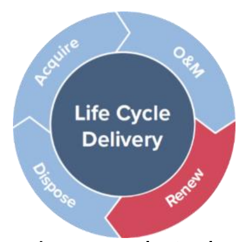


  - The asset's operability and maintainability;
  - Availability and management of spares;
  - Staff skill and availability to manage the asset;
  - The manner of the asset's eventual disposal.

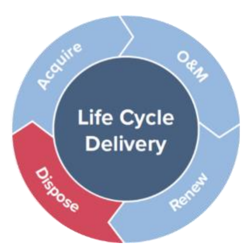
- **Asset Operations and Maintenance (O&M)**: As new infrastructure is commissioned, the City accepts the responsibility of operating and maintaining the infrastructure according to O&M standards to ensure that the infrastructure is safe and reliable. Operations staff provide the day-to-day support required to operate infrastructure. In few cases, operation costs are minor, but for most there are significant increases. For example, underground pipes require almost no operational support while a facility such as a pump station requires full-time staff to operate the facility safely and efficiently. Maintenance expenses include periodic preventive maintenance to ensure that the infrastructure can provide reliable service throughout the life of the asset and corrective maintenance that is required to repair defective assets as and when needed. Inadequate funding for O&M will have an adverse impact on the lifespan of assets. The amount of O&M resources required in any period is a function of the current inventory of infrastructure and total O&M needs required for each asset. As the inventory of infrastructure grows, total O&M requirements will also grow.



- **Renewal and Replacement:** The third portion of full life cycle costing relates to the renewal and replacement of infrastructure that has deteriorated to the point where it no longer provides the required service. Renewal cost is sometimes incurred during the life of an asset where an investment is made to improve the condition and / or functionality of the asset e.g., re-lining of a pipe or resurfacing of a road. Disposal and replacement costs are incurred at the end of an asset's life when it is disposed of and replaced by a fully new asset. Canadian municipalities, including City of Vaughan, have not traditionally factored renewal or replacement costs into future budget projections, except for assets that have a relatively short life such as computer equipment and vehicles. The main reason behind this is the fact that large portions of this infrastructure inventory can have a very long life e.g., from 75 to 100 years for underground pipes. For growing communities like the City, there has not been a historical need to forecast expenses that are not anticipated for decades. However, based on the experiences of more established Canadian cities (where vast inventories of old assets are now in dire need of renewal or replacement), it is vital that communities fully understand the looming obligations of infrastructure renewal or replacement and develop a strategy to respond in a manner that is fair and affordable.



- **Decommissioning and Disposal:** There will inevitably come a point in time when an asset must be removed from service and, depending on the type of asset, there may be significant costs associated with its decommissioning and disposal. Factors that may influence the decision to remove an asset from service include: changes to legislation that cause the asset to be in non-compliance, the inability of the asset to cope with increased service levels, technology advances that render the asset obsolete, the cost of retaining the asset is greater than the benefit gained, or the current risk associated with the asset's failure is not tolerable. Normally, major costs that may be incurred during disposal and decommissioning derive from the environmental impact of the disposal and, if required, the rehabilitation and decontamination of land. In some cases, there will be residual liabilities and risks to consider if a decision is made to partially abandon the asset as opposed to fully disposing of its components



(e.g., leaving a non-functioning pipe in the ground, or an inactive building standing). However, some cost savings may be achieved through the residual value of the asset or by exploring alternative uses for the asset. In all cases, it is important to consider disposal and decommissioning as the strategy employed has the potential to attract significant stakeholder attention. For that reason, the costs and risks associated with disposal and decommissioning should be equally considered in the City's capital investment decision-making process.

The infrastructure AMPs present the City's strategy for responding to the full lifecycle costs of all its infrastructure assets. Long-range estimates were prepared together with the AMPs, based on industry best practices to ensure the financial sustainability of the City's infrastructure assets over their full life cycle, as discussed in the next Chapters.

4.2 Acquisition / Procurement / Construction Strategies

Added to City-purchased inventory is stormwater infrastructure that the City accepts (and takes long-term financial responsibility for) from developers as new neighbourhoods are constructed. For example, as developers build new neighbourhoods, the new local infrastructure (including stormwater mains) is paid for by the developer and then transferred to the City for operation, maintenance, and ultimately replacement. The City's infrastructure inventory was therefore created over many decades through infrastructure paid for by the City or by developers.

4.3 Operations and Maintenance Strategies

Stormwater asset operations and maintenance (O&M) costs consist of three major components: pure stormwater O&M activities, overhead and street sweeping costs. **Table 4-1** presents the breakdown of activities and five-year average cost for the City's Stormwater assets. All values listed in this section are the average costs of the 5 years from 2019 to 2023.

The five-year average annual pure stormwater O&M activities cost is $2,433,000. The overhead cost is a little more than half of the pure stormwater O&M activities cost. It should be noted that street sweeping is partially funded by wastewater and stormwater service and performed by the Road Services department.

The pure stormwater O&M activities includes new development inspection, system inspections, main inspections, service investigations, maintenance hole inspections, catchbasin inspections, inlet/outlet inspections, ditch/watercourse inspections, ditch/watercourse inspections, sample/contamination inspection, cross connection investigation, storm sewer connect/disconnect, main repairs, lateral repairs, maintenance hole repairs, catchbasin repairs, inlet/outlet repairs, subsurface drain repairs, curb and gutter repair, drainage channel repairs, pond management, main replacement material disposal, flushing and cleaning, catchbasin cleaning, inlet/outlet cleaning, ditches / watercourse cleaning, spills and cleanup, storm flow monitoring, catchbasin grate cleaning, super catchbasin & oil/grit, storm pond sign installation, storm sewer CCTV program, etc.

Table 4-1: Stormwater O&M Activities and Five-year Average Costs

O&M Activities	Description	Five-year Average Cost
Overhead	All overhead cost (e.g., Stormwater Division - Admin., compliance and training, business support, street sweeping, etc.)	$4,631,000
Pure Stormwater O&M Activities	Storm sewer CCTV program, catchbasin activities, pond management, lateral activities, main activities, maintenance hole activities, inlet/outlet activities (stormwater management pond related), ditch/watercourse inspections (stormwater management pond related), storm flow monitoring, subsurface drain repairs, curb and gutter repair, and drainage channel repairs.	$2,433,000
Total		**$7,064,000**

4.4 Renewal and Replacement Strategies

4.4.1 Stormwater Pipes

Pipe renewal. The following renewal activities are planned for water, wastewater, and stormwater mains:

- Pipe Bursting. Pipe bursting can be applied to brittle materials, and pipe splitting to ductile materials. The old pipe is ruptured and pressed into the surrounding soil while a new pipe follows the cone-ended bursting tool to replace the old pipe. The bursting tool is hammered through the host pipe by pneumatic or hydraulic means. The benefit of pipe bursting is that it allows for trenchless upsizing of the original pipe. The typical length of pipe replaced by pipe bursting is approximately 110m, but greater lengths have been accomplished. Pipe depth, soil conditions, adjacent utilities and service connections will dictate whether pipe bursting is appropriate. Pipe bursting can be used on almost any type of existing pipe except ductile iron (DI) or heavily reinforced concrete.
- Cured-in-Place Pipe (CIPP) Liners. Cured-in-place pipe liners (CIPP; also known as "cast"-in-place liners) have been commercially available since 1971 and are used to seal and or structurally renew existing pipes without excavation of the pipe itself. The basic CIPP liner product is a tube, impregnated with a liquid thermoset resin, inserted into a pipeline, and cured. CIPP liners were developed as a modified coating system, delivering resins in a carrying tube (often described as a "sock") that could hold the desired coating in place until the resin had time to cure. CIPP liners are either inverted, pulled in place, or manually inserted into the host pipe. All expand radially or are otherwise conformed tightly against the host pipe. Various resins are utilized including epoxy, polyester, silicate, and vinylester, and the most commonly used resins are styrene-based. Resins are either ambient cured, thermally cured (utilizing either hot water or steam), or ultraviolet light (UV) cured.

  CIPP liners will be an option for main renewal where open-cut intervention is not possible due to accessibility, and in particular, where the existing pipe is located under the following assets or in close proximity to the following features:

  - Regional roads;
  - Easements;
  - Railways;
  - Pipelines;
  - Bridges;
  - Rivers;
  - Walkways.

The use of trenchless technologies for pipe renewal and replacement is increasing and is predicted to grow into the future, as these technologies provide many benefits over open-cut pipe replacement. In terms of indirect costs, traffic disruption as a result of an open-cut pipe trench appears to be the greatest social cost to the consumer. By using trenchless technologies, utilities can reduce the societal burden by keeping roads open and not blocking business and local traffic. Other benefits of trenchless projects include improved safety (i.e., by not having an open trench) and that trenchless work does not interfere with other utilities or underground obstacles. Trenchless work is generally more cost effective than open-cut e.g., WERF estimates that cured-in-place lining enables savings of at least 10% over open cut methods. Another benefit of trenchless work is the elimination of cuts and patches in pavement which leads to the accelerated deterioration of the road surface.

Pipe replacement. Pipe replacement through trench open-cut is still fairly common within most municipalities, although open-cut work is typically disruptive to the adjacent area and requires a great deal of traffic control if the trench is located in a roadway. It tends to be slower than trenchless methods and more dangerous as workers / residents risk cave-ins when in or near the trench. Finally, trench open-cut methods generally are more expensive than trenchless methods. However, trench-open could still be the best / only option when trenchless methods are not viable.

Open-cut replacement consists of the traditional method of pipe installation, where an excavation crew typically digs a trench along the existing trench line using a track excavator or backhoe. The new pipe is laid, bedded and the trench is backfilled, compacted and the surface is reinstated as necessary.

The unit cost of pipe replacement through open-cut excavation needs to include the cost of excavation, laying the new pipe, backfilling and reinstatement. Other factors impacting costs include the installation of appurtenances such as valves, maintenance holes, or catchbasin leads and whether and how many laterals need to be re-connected. The cost of the surface reinstatement could vary significantly based on whether the excavation needs to be returned to the level of e.g., a collector road or only a landscaped surface.

Capital planning analysis. The stormwater asset intervention process flow that governs the decision-making on when and how to intervene on the pipes in the analysis is presented in **Figure 4-2** and **Figure 4-3.**

The capital planning applied a conservative principle in estimating pipe and appurtenance replacement. The capital budgeting forecasts for pipes will reflect the cost of replacing or renewing pipes and its adjacent appurtenances, including laterals, maintenance holes, and catchbasins. Oftentimes, the adjacent appurtenances' condition are based on the linear asset condition, thus, the investment requirement timeline is similar.

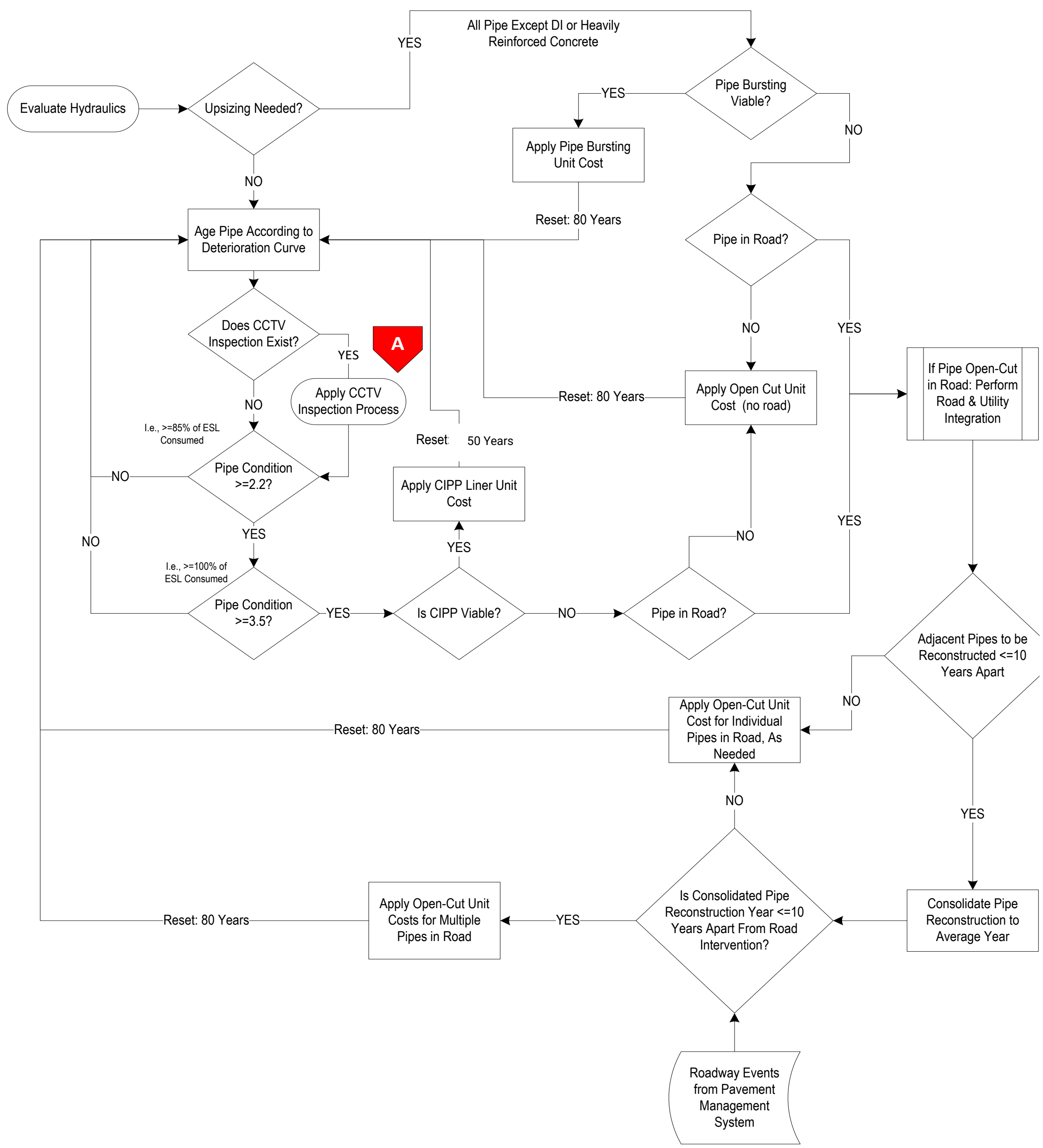
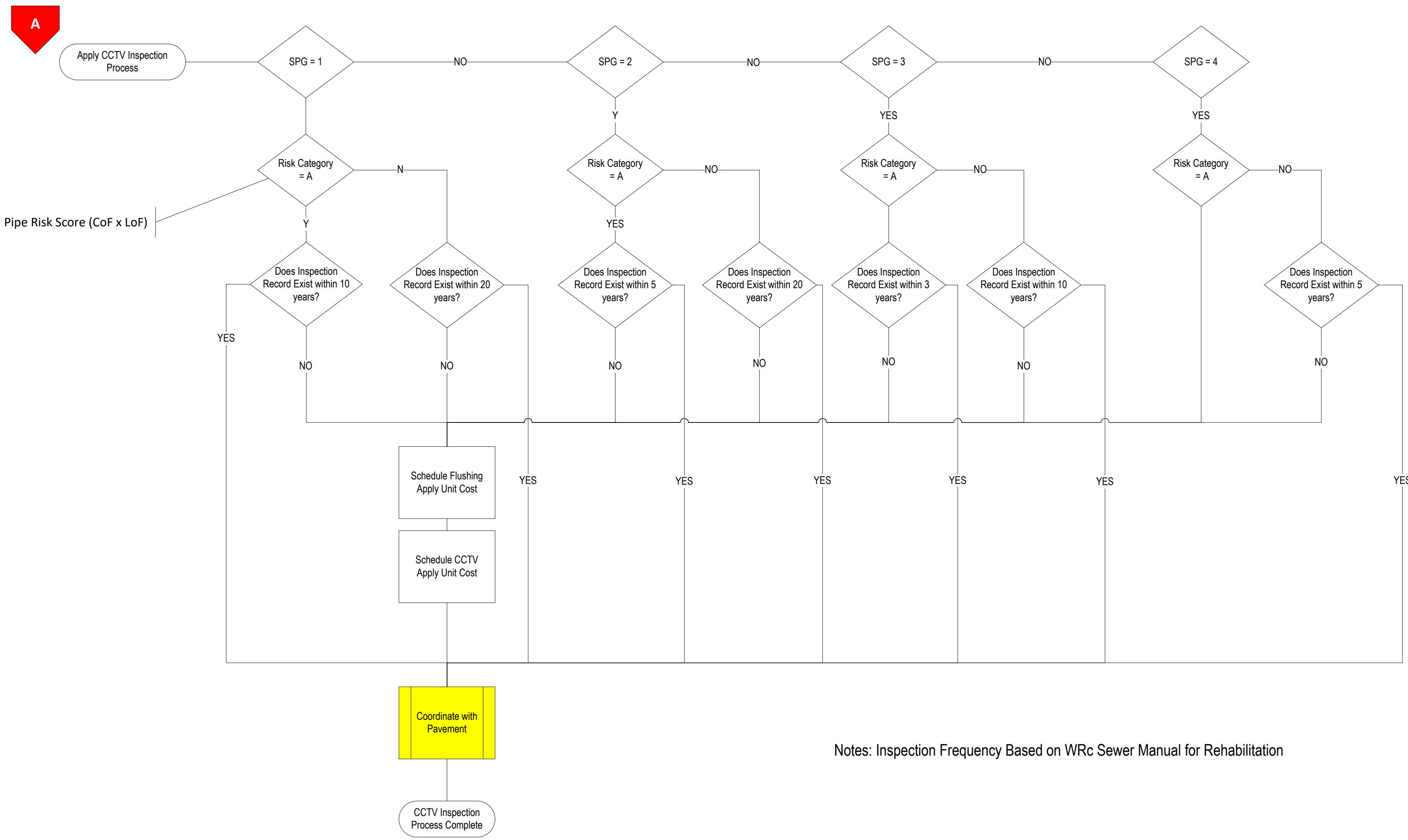


Figure 4-2: Stormwater Process Flow



Notes: Inspection Frequency Based on WRc Sewer Manual for Rehabilitation

Figure 4-3: CCTV Process Flow

CCTV data and resultant structural grade scores were not available and not incorporated in this report but could be incorporated in a future iteration of AM plans. Table 4-2 presents a summary of the key decision-points within the pipe intervention process flow, and an explanation of the asset management decision methodology.

Table 4-2: Pipe Intervention Process Decision Points & Explanations

Decision Point	Decision & Explanation
Upsizing Needed?	YES: If a hydraulic constraint is identified (from elsewhere e.g., the City's hydraulic model) and the pipe is required to be up sized to the required pipe diameter, the next step is to consider whether pipe bursting is viable. NO: If no hydraulic constraint is identified, no pipe upsizing is needed.
Pipe Bursting Viable?	YES: If pipe bursting is viable (i.e., viable for all pipes except for DI or heavily reinforced concrete pipes) then apply the pipe bursting unit cost to the length of pipe replaced. Reset pipe age to zero and apply an 80-year ESL to new pipe. NO: If pipe bursting is not viable (i.e., pipe is DI or heavily reinforced concrete), the next step is to consider whether the pipe is in a road.
Pipe Condition >= 2.2?	YES: If the pipe condition is equal or more than 2.2 (i.e., equal or more than 85% of the pipe ESL has been consumed), then trigger a pipe inspection and apply the inspection unit cost table. NO: If the pipe has not yet reached a condition of 2.2 then wait until it reaches a condition of 2.2 which will trigger an inspection.
Pipe Condition >= 3.5?	YES: If the pipe condition is equal to or greater than 3.5 (i.e., equal to or more than 100% of the pipe ESL has been consumed), then trigger a pipe renewal or replacement. The next step is to consider whether CIPP is a viable option for pipe renewal. NO: If the pipe has not yet reached a condition of 3.5 then wait until it reaches a condition of 3.5 which will trigger a pipe renewal or replacement.
Accessibility Issue?	YES: If the City flags the pipe as having an accessibility issue such as within / next to a Regional road, at a stream crossing, or where there is no space for an open cut intervention, then apply the CIPP unit cost to the length of pipe. Reset pipe age to zero and apply a 25-year ESL to the re-lined pipe. NO: If accessibility is not an issue (i.e., the pipe is not within / next to a Regional road, at a stream crossing, or where there is no space for an open cut intervention), the next step is to consider whether the pipe is in a road.
Is CIPP Viable?	YES: If CIPP is viable (i.e., the pipe has not yet been re-lined or reached a condition of 3.5 / is beyond its ESL), then apply the CIPP unit cost to the length of pipe. Reset pipe age to zero and apply a 25-year ESL to the re-lined pipe. NO: If CIPP is not viable (i.e., the pipe has been re-lined once already or has reached a condition of 3.5 / is beyond its ESL), the next step is to consider whether the pipe is in a road.
Pipe in Road?	YES: If an open-cut excavation pipe replacement is needed and the pipe is in a road, then the next step is to consider whether any adjacent pipes need to be replaced less than ten years apart. NO: If an open-cut excavation pipe replacement is needed but the pipe is not in a road, then apply the basic open-cut unit cost to the length of pipe to be replaced. Reset pipe age to zero and apply an 80-year ESL to new pipe.
Pipe => 450mm?	YES: If the pipe diameter in equal or greater than 450mm, then replace pipe with reinforced concrete pipe (RCP) and apply a 60-year ESL to the new pipe. NO: If the pipe diameter is less than 450mm, replace pipe with PVC pipe, and apply an 80-year ESL to the new pipe.
Adjacent Pipes to be Reconstructed <10 Ten Years Apart.	YES: If the years of open-cut reconstruction of two or more pipes in the same roadway are less than ten years apart, then calculate the average of the years and apply that as the year of reconstruction. Adjust the years of utility work to match the years of road work if it is within 10 years of one another. Apply the unit cost table for open-cut excavation in a roadway for two or three pipes, as needed, over the length of pipes reconstructed. Reset the pipes' age to zero and apply an 80-year ESL to new pipes. NO: If the years of open-cut reconstruction of two or more pipes in the same roadway are more ten years apart, do not adjust the reconstruction year. Adjust the years of utility work (one pipe) to match the year of road work if it is within 10 years of one another. Apply the unit cost table for open-cut exaction in a roadway for one pipe, over the length of pipe reconstructed. Reset the pipe age to zero and apply an 80-year ESL to new pipe.

Decision Point	Decision & Explanation
Gravity Sewer SPG (Structural Performance Grade) > = 4	YES: Align scheduled pipe rehabilitation with the Road program. Pipes with structural grades of 5 should be prioritized in the current planning year and pipes equal to 4 in the subsequent year NO: Pipe with a structural grade of 3 and the pipe does not have a high-risk profile, a CCTV inspection should be scheduled with the next 10 year otherwise schedule CCTV inspection within the next 5 years. Pipe with a structural grade of 2 and the pipe does not have a high risk profile, a CCTV inspection should be scheduled with the next 15-20 years otherwise schedule CCTV inspection within the next 10 years with a structural grade of 2 and the pipe does not have a high risk profile, a CCTV inspection should be scheduled with the next 20 years otherwise schedule CCTV inspection within the next 10 year. Note: Apply when structural grade available.
Risk Category = A	YES: Pipe asset deemed critical and asset inspection & renewal should be prioritized based on risk rating; NO: Assets are less critical, and repairs can be pushed out to align with pavement renewal program. Note: Use when prioritizing within budget constraints.

4.4.2 Stormwater Open Conveyance Assets

As mentioned in **Section 4.3**, the life cycle activities for ditches will only consist of O&M activities. Thus, there will be no renewal and replacement need identified for ditches in this report.

4.4.3 Stormwater Management Ponds

As mentioned in **Section 4.3**, the life cycle activities for stormwater management ponds will be only O&M activities. Thus, there will be no renewal and replacement need identified in this report.

4.5 Decommissioning and Disposal Activities Strategies

Asset decommissioning and disposal activities are performed to decommission and dispose of assets due to ageing or changes in performance and capacity requirements. This decision process includes the consideration of costs and benefits of rationalization using a whole life approach, the impact of asset rationalisation on other infrastructure and the processes for disposal of assets. More specifically, the following factors need to be evaluated when considering the decommission and disposal of assets:

- Assets not required for the delivery of services, either currently, or over the longer planning period.
- Assets that have become uneconomical to maintain or operate.
- Assets that are not suitable for service delivery.
- Assets that have a negative impact on service delivery, the environment, or community.
- Assets that no longer support the City's service objectives due to a change in type of service being delivered or the delivery method.
- Assets where their use has become uneconomical due to the limited availability of spares or the cost of their replacement parts.
- Assets where their technology has been outdated.
- Assets which can no longer be used for the purpose originally intended.

Considerations for the City's asset decommissioning and disposal activities include, but are not limited to:

- Updates to the City's Statement of Tangible Capital Assets. Considerations related to the determination of residual value and the disposal of assets include:
    - ➢ Residual value and the useful life of an asset should be reviewed, at the very least, at each financial year-end and, if expectations differ from previous estimates, any change should be accounted for prospectively as a change in estimate.
    - ➢ The depreciation method used should reflect the pattern in which the asset's economic benefits are consumed.
    - ➢ The depreciation method should be reviewed, at the very least, annually and, if the pattern of consumption of benefits has changed, the depreciation method should be changed prospectively as a change in estimate.

- Updates to asset databases such as the GIS and CMMS.
- Environmental impact of disposal and implications for land rehabilitation, where applicable.
- Continued service delivery while a new asset is being constructed / commissioned: overlap of the start-up of new assets / facilities and the decommissioning of existing assets / facilities being replaced.
- Cost of decommissioning and disposal.
- Disposing Asbestos Cement (AC) mains
    - In normal use, Asbestos fibres in drinking water will not affect public health since there is low concentration of asbestos in drinking water. However, when AC pipes are severely deteriorated, asbestos can be released into the water.
    - While the City does not have extensive AC pipelines in its stormwater collection system (approximately 1.2 km), additional health and safety measures should be taken into considerations when attempting to repair, remove, or dispose such a material. These types of activities, if not well managed, may release asbestos fibres into the air causing risks to the public health. Work associated with assets made of AC material should be in accordance with the City's specifications related to hazardous material management (i.e. asbestos management) and in accordance with O. Reg. 278 / 05, which is made under the Occupational Health and Safety Act.

4.6 Capital Planning

Capital investment is to address community growth or changes, or to renew existing assets to maintain service levels. For the actual funding needs assessment, please refer to **Section 5**.

- **Life Cycle Cost Analysis Approach**. The City's analysis enables optimized decision making and mathematical deterioration modelling of infrastructure assets and the development of short, medium and long-term forecasts of renewal and replacement costs of a number of decision criteria and the ability to compare different intervention options to find the optimal solution in terms of timing and the intervention option chosen.
- **Forecast Periods.** The City aims to develop Short- to Medium-Term and Long-Term capital plans. Typically, short to medium-term capital plan identifies the activities required to meet current and future demand, the cost of those activities and a financing approach. It is developed or renewed every three to five years and should coincide with regulations on short to medium-term expenditure planning. A long-term plan can serve as part of Strategic Asset Management Plan, which indicates what will be spent, by service areas, over a set period of time. Long-term plans tend to focus only on costs.

  Consistent with the approach of other asset management plans, the analysis periods for funding need assessments are 20 years. Given the longer expected service life of stormwater assets, a 100-year forecast was also modelled to provide a directional estimate of long-term costs.

4.7 Asset Prioritization

4.7.1 Risk Assessment

Infrastructure-related risk exposure is assessed based on the combined consideration of probability and consequences of an asset failure, which is used to drive the selection and prioritization of appropriate action, based on risk tolerance thresholds and funding availability. Understanding the risk exposure for a given set of assets allows the City to identify where they are most exposed to risk, and to target their investments to most effectively reduce that exposure.

In addressing risk for infrastructure assets, the first step in the analysis is to identify assets that are most critical to the business. Critical assets are those that will potentially have the greatest impact on service delivery should they fail. It should be noted that the parameters, criteria and weighting factors area starting point, and should be reviewed and modified to reflect the priorities of the City on an ongoing basis.

The fundamental principle of consequence (or criticality) models is that they evaluate the relative importance of assets based on select criteria. The approach to risk analysis within this project utilizes a triple-bottom-line assessment approach utilizing the following four criticality indices:

- **Economic** – influence of the asset's failure on monetary resources

- **Operational** – influence of the asset's failure on operational ability
- **Social** – influence of the asset's failure on society
- **Environmental** – influence of the asset's failure on the environment

By applying specific indices, the risk assessment framework generates a risk (or priority) score for each asset. The risk score is a rating of the asset based on the detailed assessment of the likelihood and consequence of failure based on a number of key parameters. All parameters are then equated using equation [2].

$$\textit{Risk} = \textit{Likelihood of Failure} \times \textit{Consequence of Failure} \qquad [2]$$

Based on this principal, the risk associated with a given asset's failure can be managed by limiting the likelihood of this occurring, or the impact realized, should it occur.

Consequence of Failure (CoF) reflects the relative "impact" of a given asset's failure. While traditionally these have been looked at as purely economic terms (i.e. repair cost, loss of revenue, etc.), the truth is that investment decisions are often driven by non-economic factors. Understanding both the economic and non-economic impacts associated with loss or limitation of service help in categorizing an asset's "criticality" and justifying infrastructure decisions in a consistent, defensible manner.

4.7.2 Risk Assessment Results

A detailed risk assessment was performed as part of a 2016 project for the City. A risk score was calculated for each stormwater main using its Likelihood of Failure (LoF) and Consequence of Failure (CoF) score. LoF for stormwater mains had two potential options based on whether Closed-Circuit Television (CCTV) condition data was available for the sewer segment or not. If a sewer segment was not visually inspected by CCTV, LoF was estimated using the Weibull age deterioration approach which determines where the stormwater main segment sits on a deterioration curve relative to age and its expected service life. If a sewer had undergone CCTV inspection and its structural condition score ranged between 2 and 5, its age was adjusted by selecting an appropriate age value that corresponded with the sewer's structural condition on a deterioration score chart.

For example, the age of a sewer with a structural condition score equal to 5 was adjusted so that its apparent age was increased to reflect greater ageing close to or beyond its expected service life. In this way, a sewer with a relatively low age but which is in a poor structural condition will be triggered for replacement in the immediate future. In addition, if a pipe is located within a "Hotspot" area, its LoF score was increased with the application of an adjustment factor. Based on the availability of the data, LoF was estimated using the Weibull age deterioration approach. The potential exists to incorporate CCTV condition data in the future assessment of LoF. The CoF for the new developed assets after 2016 were determined by a multi-regression method. Please refer to 2016 Risk Management Framework Report for more details.

A Risk Score was calculated for each stormwater main asset using its LoF and CoF scores. As the City's assets are relatively young with very low LoF scores, most of the stormwater mains fall in low-risk category. In this case, the City can prioritize stormwater work using the CoF (criticality) scores. **Figure 4-4** shows the criticality map for stormwater mains, indicating the location of the mains that are considered to be in the high, medium, and low criticality categories.

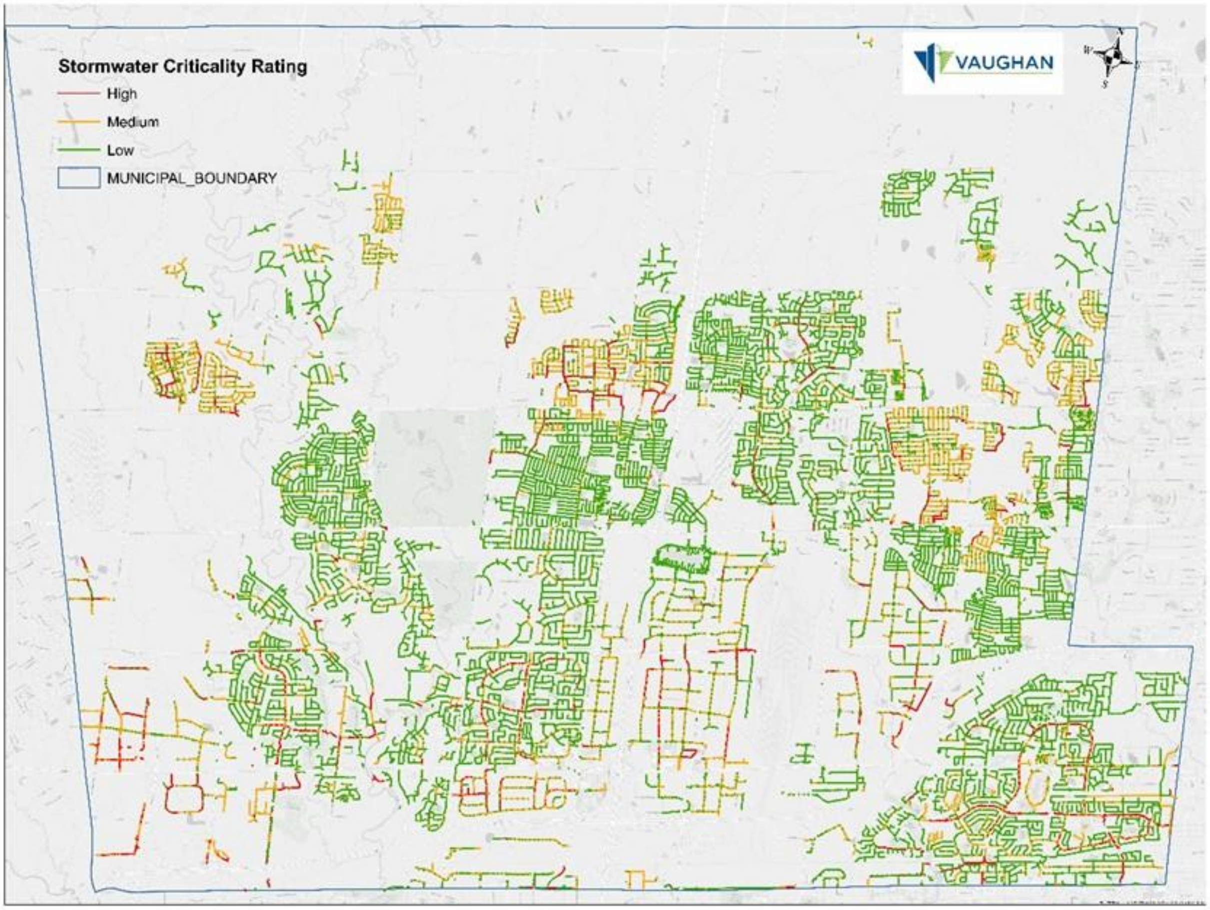


Figure 4-4: Stormwater Main Criticality Map

In addition to the risk assessment initiative, the City took the initiative to perform a Stormwater Management Vulnerability Study[1] in 2015 where maps were generated for visualizing vulnerability assessment results.

[1] Ontario Climate Consortium (2014): TRCA Stormwater Management Vulnerability Study report

4.7.3 Analytical Logic to Sequence Interventions

The asset criticality score can be used to prioritize projects within a funding constrained environment. Figure 4-5 illustrates this logic of carrying unfunded needs to the next year in the period where they receive a higher probability of receiving funds based on their criticality score.

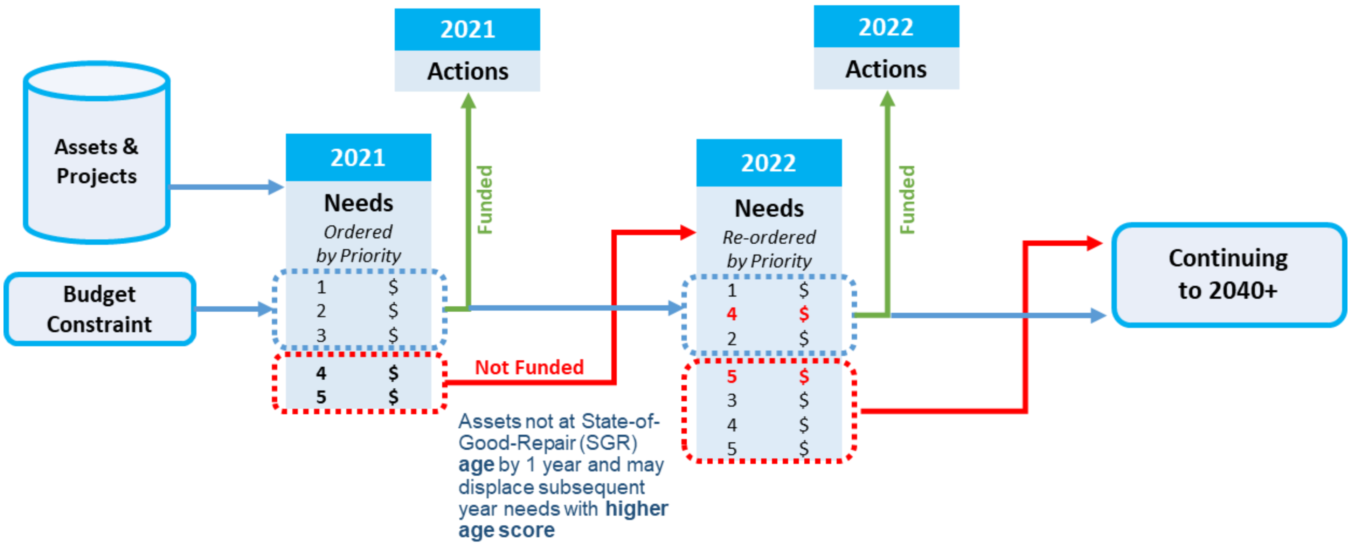


Figure 4-5: The Role of Criticality to Prioritize Projects Within A Funding Constrained Environment

4.8 Financial Planning

4.8.1 Financial Policies

The City has taken the initiative to establish financial asset management policies in 2018, which provides directions on how financial principles apply to assets to ensure that service goals are met. The policy aligns the business model of AM with the City's financial planning, financial reporting, cost management, treasury and taxation functions. The City will integrate findings from the AM Plans into its long-term financial planning and budgeting processes. Sound financial analysis will be encompassed in AM planning in order for the AM Plan to be a sought-after guide for employees in budgeting and financial planning.

4.8.2 Financial Analysis

Financial analysis activities for asset management are centered on two essential quantities: revenues and expenditures. Revenues can come from many sources. Through asset operations, the City generate its own source revenues from taxes, development charges, etc. Expenditures are all the direct and indirect costs associated with capital, operating and maintaining, and disposing of assets.

Assessing the financial implications support the decision-making when there are competing priorities and trade-offs between projects. Financial analysis provides a better picture of how to fund the capital plan and make critical decisions about service delivery while providing the greatest benefit for the community at the lowest cost.

4.8.3 Aligning the Financial and Non-Financial Functions of AM

ISO 55010[2] identifies the that the financial and non-financial functions of AM within organizations are generally inadequately aligned, as follows:

- **Financial Accounting Functions:** Focused on retrospective reporting of accounting / regulatory financial activities. However, there is a growing awareness in organizations of the need to focus on providing a managerial costing approach in order to support decision-making for the future.

[2] International Organization for Standardization (2019): ISO 55010 - Asset management — Guidance on the alignment of financial and non-financial functions in asset management

- **Non-Financial Functions:** Have a limited understanding of financial accounting functions but are recognizing the need to improve their understanding of the financial implications of their activities.

The lack of alignment between financial and non-financial functions can be attributed to silos in an organization, including reporting structures, functional / operational business processes, and related technical data. Silos generally bring forth the necessary level of specialization. However, with a lack a communication between the silos, organizations are at risk of inefficiencies and errors in AM results, or AM failures due to a lack of alignment between AM staff and senior management. Financial and non-financial alignment needs to work both "vertically" and "horizontally", as follows:

- **Vertical Alignment:** Financial and non-financial asset-related directives by management are informed by accurate upward information flows, effectively implemented across the appropriate levels of the organization.
- **Horizontal alignment:** Financial and non-financial information that flows between departments (conducting functions such as operations, engineering, maintenance, financial accounting and management) uses the same terminology and refers to the assets identified in the same way.

Figure 4-6 presents the key elements in a framework to address the need to achieve the alignment.

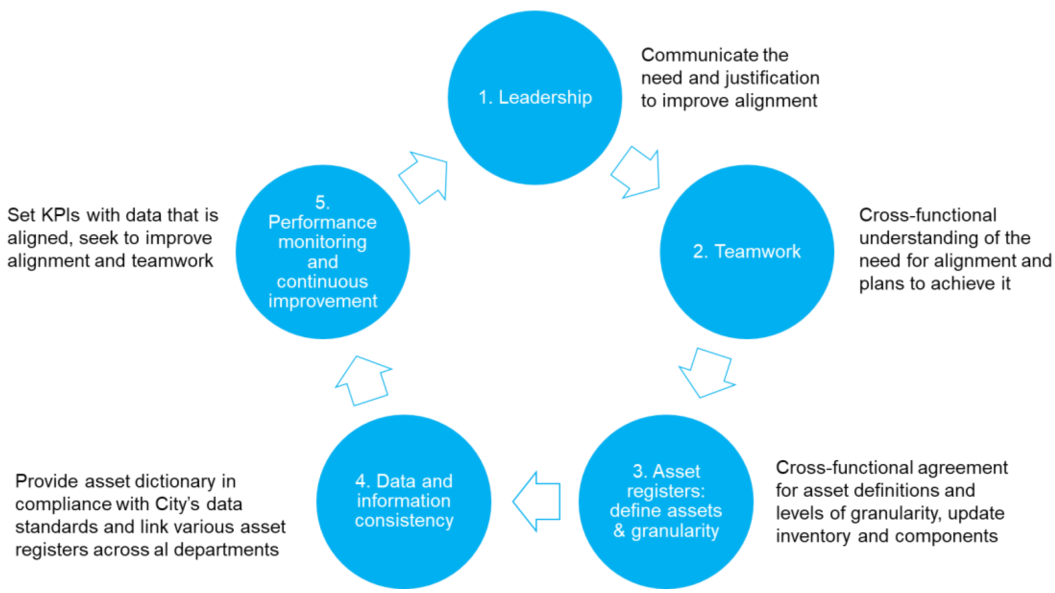


Figure 4-6: Key Elements of a Framework to Achieve Financial and Non-Financial Alignment

4.8.4 Long-Term Financial Planning

Strengthening the City's AM planning according to the recommendations in the Asset Management Strategy will improve the City's long-term financial planning, by accounting for whole life cycle costs as presented in **Section 4**. This includes all capital, annual operation and maintenance, and disposal costs over the planning timeframe, thereby aligning financial requirements with long-term level of service objectives.

The challenge is often one of agreeing on a timeframe for such planning, recognizing that the AM perspective is ideally focused on the asset life cycle, versus the political / election cycle that could be as short as a three to four-year Council term. Accordingly, financial and non-financial staff, as well as top management and politicians, should agree on a long enough timeframe to provide useful forward planning information that aligns the financial and non-financial perspectives, as presented in **Figure 4-7**.

Figure 4-7: AM Planning Alignment Across the Organization

The City should have an appropriate long-term financial planning process that achieves the following:

- Stimulates long-term strategic thinking and perspective for stakeholders and decision-makers.
- Can be used as a tool to prevent or predict future financial shocks and demonstrate financial sustainability.
- Demonstrates to internal and external stakeholders that the organization has a financial strategy in place to meet their demands, now and in the future.

The long-term financial planning process needs to involve financial and non-financial staff working together to combine the important elements of strategy development, asset management planning and financial forecasting (**Figure 4-6** and **Figure 4-7**).

5. Funding Need Analysis

5.1 Stormwater 20-Year Funding Need Analysis

The average annual reinvestment rate required to fund all replacement and rehabilitation activities for the City's water infrastructure assets over the next 20 years is $9.3M per year in 2024 dollars, as presented in **Figure 5-1**. This is equivalent to a total of $186M over the next 20-year period.

Given that the expected service life of stormwater assets can be close to 100 years, the City modelled a 100-year forecast to determine the average annual reinvestment rate over the next century. This results in an average annual reinvestment rate over the next century of $28M per year. This is equivalent to a total of approximately $2.8B over the next 100-year period.

Figure 5-1: Stormwater 20-Year Total Reinvestment Need

Figure 5-2 breaks down the 20-year reinvestment value into 3 sub-categories:

- **Mains and direct appurtenances** refer to all assets that might be replaced or rehabilitated at the same time as a main, including mains, maintenance holes, laterals, and catchbasins.
- **Non-linear assets** refer to all assets that would be replaced independently from a nearby main replacement. This category includes culverts, stormwater management facilities, in/out structures, devices, and low impact development assets (LID).
- **OpEx** refers to asset inspection and major repair/maintenance programs. This includes CCTV inspections, bathymetric surveys, pond sediment removal, ditches, and major culvert repairs.

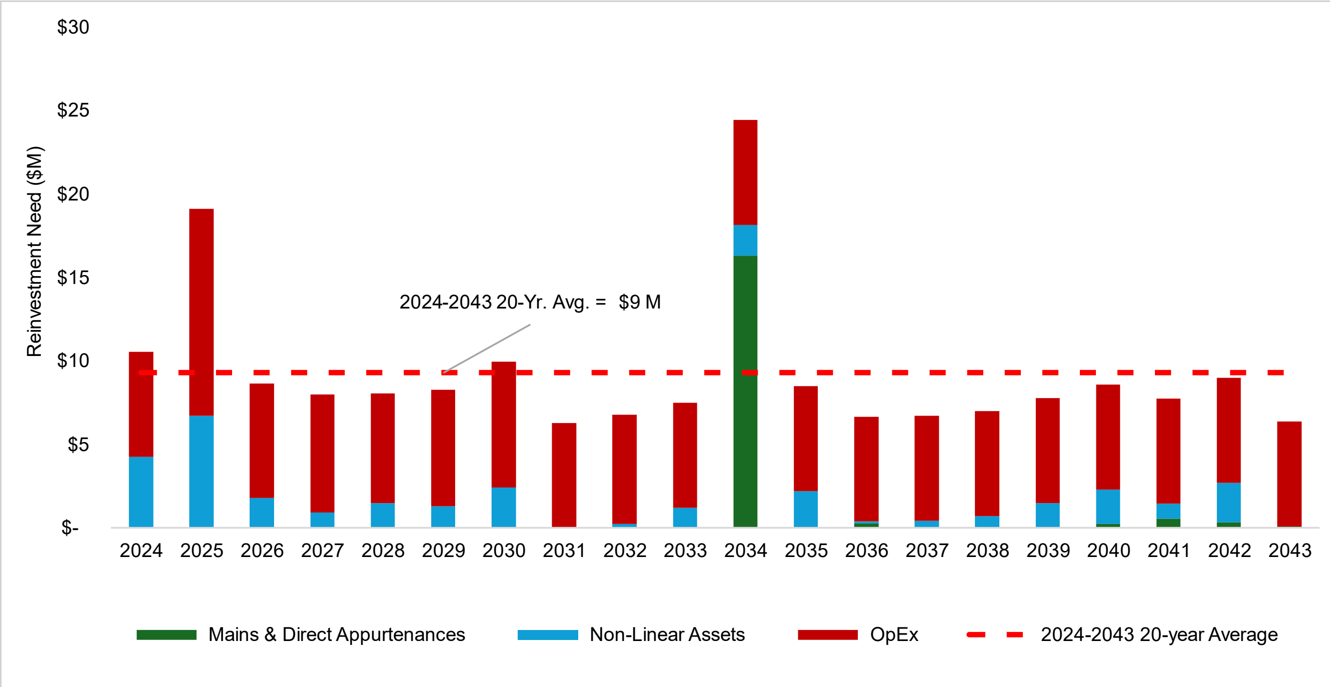


Figure 5-2: Stormwater 20-Year Reinvestment Need Details

As shown in **Figure 5-2** above and **Table 5-1** below, one tenth (10%) of expenditures over the next 20 years are for the renewal of mains and direct appurtenances. The non-linear assets, including the City's culverts and stormwater management facilities account for 17% of expenditures. The remaining approximately three quarters (73%) come from OpEx expenditures.

Looking at the next 100 years, these ratios change significantly. Seven tenths (70%) of expenditures over the next century are for the renewal of mains and direct appurtenances, while non-linear assets and OpEx represent 7% and 23%, respectively. The City should prepare for more reinvestment funding as the assets continue to age.

Table 5-1: 20-Year Total and Annual Average Reinvestment Need

	Mains & Direct Appurtenances	Non-Linear Assets	OpEx	Total
Annual Average Need	$ 894,000	$ 1,623,000	$ 6,785,000	$ 9,302,000
20-Year Total	$ 17,875,000	$ 32,460,000	$ 135,692,000	$ 186,027,000
% of Total Expenditures – 20-Year Forecast	10%	17%	73%	
% of Total Expenditures – 100-Year Forecast	70%	7%	23%	

5.2 Full Funding Need Profile

Figure 5-3 shows a full picture of the City's Stormwater Service funding need forecast over the next 20 years, which provides the City the full funding requirements in order to perform effective financial planning activities. The total annual reinvestment rate from **Figure 5-1** has been overlaid with the forecasted O&M annual budget.

Stormwater assets require approximately $141M in O&M funding over the next 20 years, equivalent to approximately $7.1M per year in 2024 dollars. As such, with the addition of O&M, the total average annual reinvestment rate for the City's stormwater assets increases to approximately $16.4M annually, for a total of $327M over the next 20-year period.

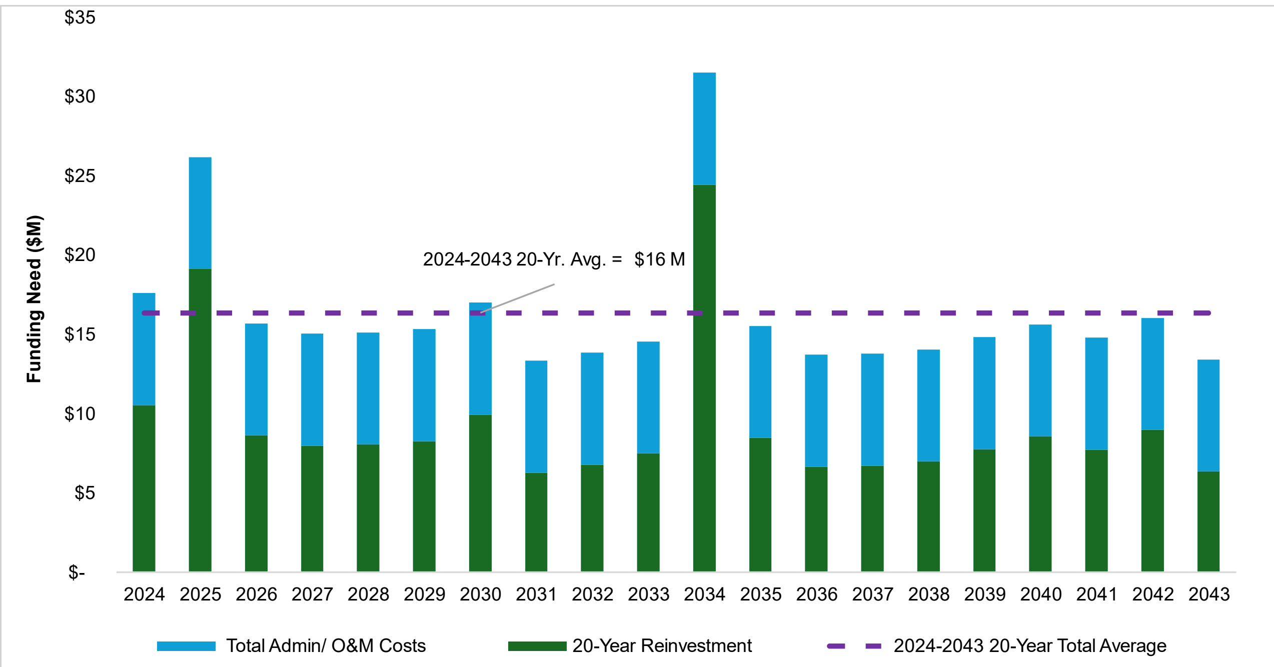


Figure 5-3: Stormwater Full Funding Need Profile

5.3 Infrastructure Reserves Funding Forecast

Reserve funds are important tools in the planning and management of the City's financial resources and provide a strong indicator of the City's overall financial health and are fundamental to the City's long-term financial sustainability. The City is committed to maintaining healthy reserve fund balances which are collected through various means (i.e., development charges, contributions, dedications, taxation, etc.).

There are specific infrastructure reserves for the rate-supported service areas of Water, Wastewater and Stormwater. These reserves contain funds set aside through annual contributions from ratepayers to help pay for the repair and replacement of infrastructure assets. Like many municipalities across Canada, Vaughan is facing increased costs associated with maintaining aging infrastructure. Corporate Asset Management Plans for both core and non-core assets suggest the City's infrastructure deficit is large and growing. The City has continued with robust strategies and plans by developing a comprehensive Long-Range Fiscal Plan and model, which was used to better inform the 2025 and future budgets by providing information about the financial requirements to sustain growth, delivery of services and the community's infrastructure needs.

Prudent financial planning requires ongoing contributions to water, wastewater, and stormwater reserves to fund the repair and replacement of infrastructure. Safe and reliable drinking water distribution, effective wastewater collection and efficient stormwater management are cornerstones of a sustainable and healthy community. To achieve this, continued operating and infrastructure investments are critical to ensure the City's water, wastewater and stormwater systems remain financially sustainable now and into the future. This objective is supported by continuing to build service area infrastructure reserves. The 2025 budgeted rates and charges will generate net total reserve contributions of $23.2 million to fund water, wastewater and stormwater-related programs and services. The City is committed to ensuring the financial sustainability of these systems and the ongoing protection of the environment in alignment with the Safe Drinking Water Act, Ontario Water Resources Act, the Environmental Protection Act and the Growth Plan for the Greater Golden Horseshoe.

The City's Asset Management Plans assess average reinvestment requirements over the next 20 years for the City's core assets, including water, wastewater and stormwater infrastructure. Annual reserve contributions should generally be in line with the asset reinvestment requirement to ensure sufficient funds are set aside for asset rehabilitation and replacement needs.

For the Stormwater service area, the forecasted 20-year average funding need is $9.3M. In comparison, the average annual funding forecasted over the next 10 years is estimated to be $4.3M representing a funding coverage of 46% as illustrated in Error! Reference source not found.. The funding sources in this forecast are limited to annual reserve contributions and the Canada Community-Building Fund (CCBF is provided from the Federal Government). Other available funding sources not included are debentures and non-CCBF grants, which would mitigate any infrastructure funding gaps.

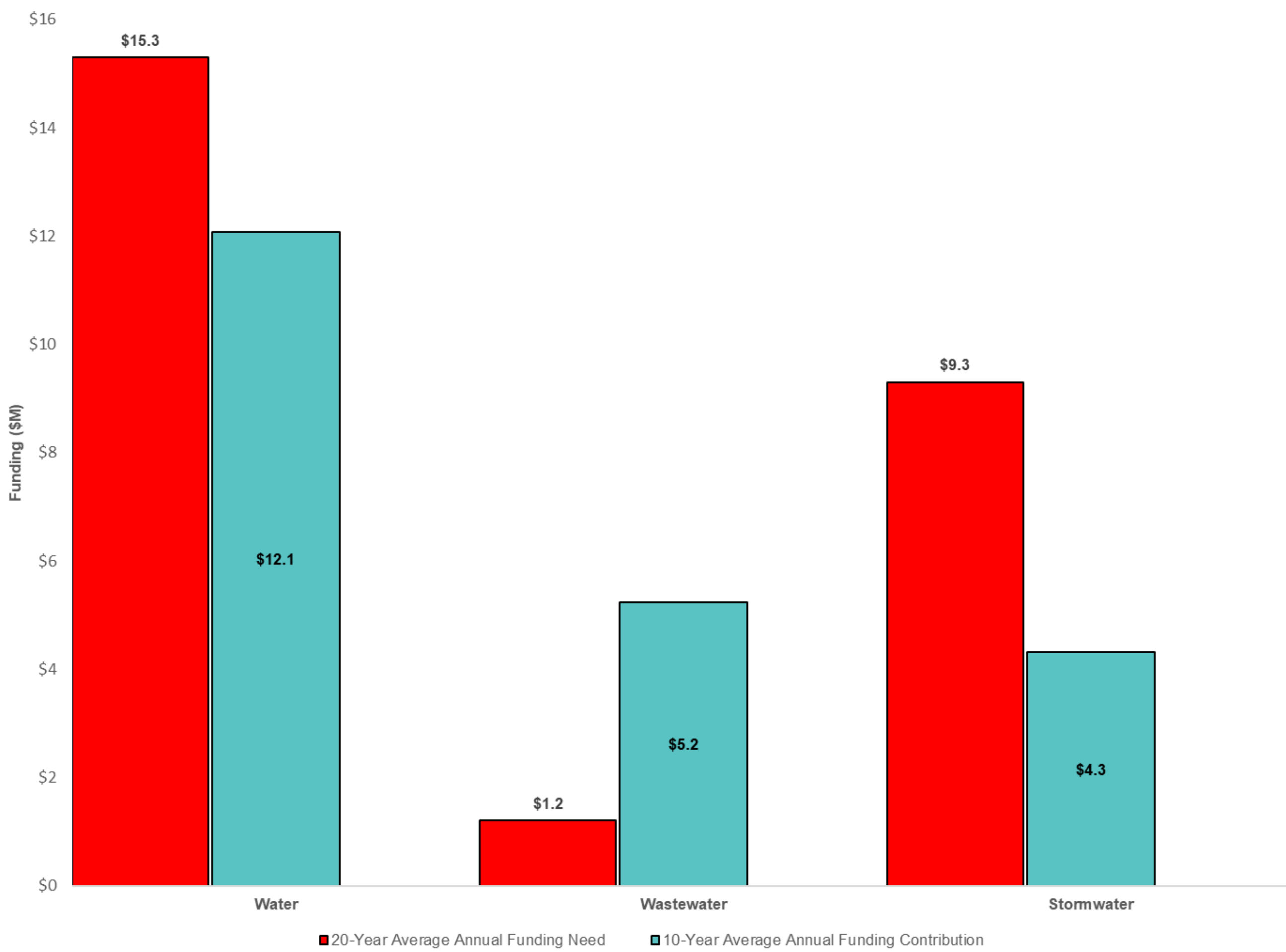


Figure 5-4: Coverage of Average Annual Funding Needs for Rate-Supported Service Areas

Revisiting the timing and scope of capital projects, optimizing the use of existing funding tools and revenue sources, such as debt and dedicated contributions to capital reserves, can help increase the City's capacity to begin to close an infrastructure funding gap.

5.4 Growth-related Assets Funding Need

The City completed the Integrated Urban Water Plan (IUWP) Master Plan Study in 2024. The objective of the study was to develop a plan to meet the water, wastewater and stormwater infrastructure needs as the City's communities continue to grow. This study analyzed the city-wide infrastructure needs to identify the required infrastructure that will meet future servicing demands. The study assessed the existing and future servicing needs and provides servicing recommendations to meet the City's growth plans. Based on the IUWP, the forecasted funding need estimates for the construction of new Stormwater assets out to 2051 is illustrated in Error! Reference source not found. with a primary funding source for these needs being Development Charges.

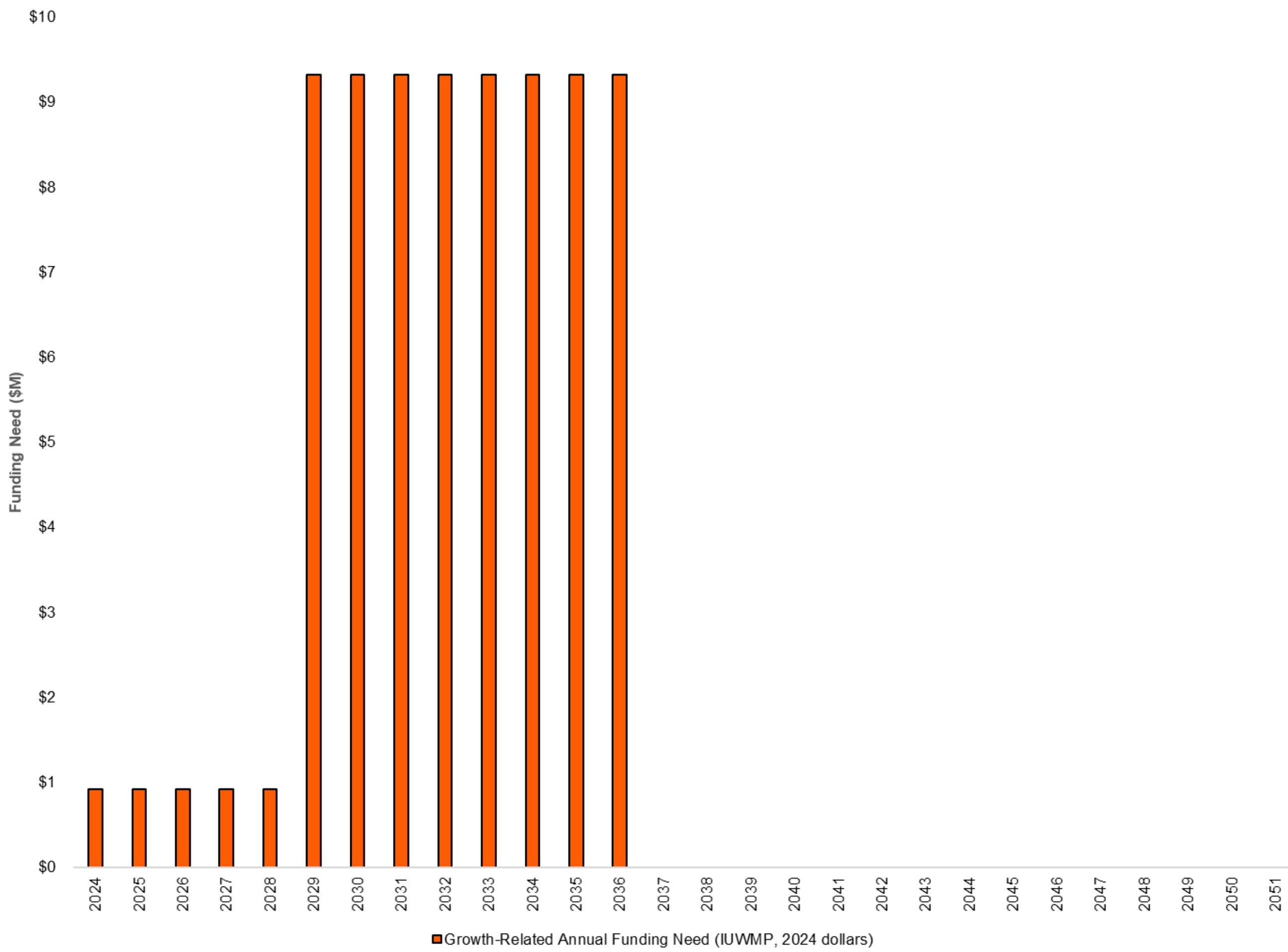


Figure 5-5: Forecasted Funding Needs for Construction of New Stormwater Assets

One of the next steps in the further development of the IUWMP is to apply added detail to the forecasted funding need estimates. This will provide a more refined forecast, which will serve to provide additional guidance for Asset Management planning in the future at the City of Vaughan.

Asset Management Plan

Core Assets
Roads

City of Vaughan
March 2025

Table of Contents

Figures

Tables

1. Introduction

The City of Vaughan (The City) has conducted a renewal of the City's Asset Management (AM) Plans for all its infrastructure assets, including Roads.

1.1 Background

The City is one of nine area municipalities located within the Regional Municipality of York. As a lower tier municipality, the City is responsible for providing services such as buildings, fire protection, public works, water distribution, wastewater collection, and parks and recreation.

The next 25 years will see the City transition from a growing suburban municipality to a fully urban space. This type of transition will require long-term thinking about how best to accommodate and make the most of new opportunities. Planning for the future through strategic planning will position the City to deal with the many pressing issues impacting the organization such as community safety, access to health facilities, environment, traffic congestion and issues related to growth and the quality of municipal services.

The City is one of Canada's fastest growing cities, with a population of over 320,000 according to the latest census from Statistics Canada. It is projected that the number of residents will increase to 415,000 by 2031. In addition to its rapidly growing population, the City is home to a well-diversified and expanding employment sector with over 7,800 businesses and 231,000 employees. The City has the largest supply of new employment lands in the Greater Toronto Area (GTA) and it is projected that the number of employees will increase to 271,000 by 2031.

1.2 Objectives

In 2018, by City Council approval, the Corporate Asset Management (AM) Policy for the City came into effect; and, in 2013, the City's first Corporate AM Strategy was published. As identified in the Corporate AM Strategy, the City's first set of AM Plans (AMPs) were developed in 2014.

In early 2021, the City updated its AM Strategy and core infrastructure AMPs, as per Ontario Regulation (O. Reg) 588/17. The purpose of this series of AMPs is to now update the infrastructure assets so as to provide the City with a comprehensive updated AM Plan.

The objective of this AMP is to deliver a financial and technical roadmap for the management of the City's roadway appurtenance assets, and to provide the means for the City to maximize value from its assets, at the lowest overall expense while, at the same time, providing enhanced service levels for its residents and promoting green initiatives.

Organizations that implement good AM practices will benefit from improved business and financial performance, effective investment decisions, and better risk management. Stakeholders can expect lower total asset life cycle costs, higher asset performance, and confidence in sustained future performance.

1.3 AM Provincial Requirements

The Ontario Regulation 588/17 (O. Reg. 588/17) came into effect in 2018 and stipulates specific AM requirements to be in place within Ontario municipalities by certain key dates (**Table 1-1**). The development of this AMP is one of the steps to guide the City towards meeting the July 1st, 2025 deadline.

Table 1-1: O. Reg. 588/17: AM Planning for Municipal Infrastructure

Description: A regulation made under the Infrastructure for Jobs and Prosperity Act, 2015, stating that every municipality shall prepare and update a Strategic AM Policy, and that every municipality shall prepare an AM Plan for its core infrastructure assets by July 1, 2022, and an AM Plan for all other infrastructure assets by July 1, 2024. The regulation outlines several requirements that each AM Plan must follow, such as including current and proposed level of service. Core municipal infrastructure assets include water, wastewater, stormwater, road, and bridge assets.	
Deadline Date	Regulatory Requirement
July 1st, 2019	All municipalities are required to prepare their first Strategic AM Policy.
July 1st, 2022	All municipalities are required to have an AM Plan for its entire core municipal infrastructure (i.e., water, sanitary, stormwater, and transportation).
July 1st, 2024	All municipalities are required to have an AM Plan for infrastructure assets not included under their core assets.
July 1st, 2025	All AM Plans must include information about the levels of service that the municipality proposes to provide, the activities required to meet those level of service, and a strategy to fund activities.

1.4 Scope

This AMP has been developed for the City's Roads categories, owned and maintained by the City, as shown in **Table 1-2**. The renewal of the City's AM Plans is consistent with the guidelines laid out in the City's Corporate AM Policy and Section 5 of O. Reg. 588 / 17.

Table 1-2: In-Scope Assets

Asset Category	Sub-Assets
Roads	Roads (the subject of this Asset Management Report)

The following elements are included within the scope of this AMP:

- A summary of the asset inventory, including the replacement cost of the assets, the average age of the assets, the condition of the assets, and the City's approach to assessing the condition of the assets.
- Current levels of service (LoS) based on performance measures.
- Asset lifecycle management strategies to maintain identified current LoS, minimize associated asset risks, and to optimize costs over the whole lifecycle of the asset.

1.5 Approach for Asset Management Plan

The approach used in the renewal of this AM Plan is presented in **Figure 1-1**, and has been selected to ensure that the City can have the confidence to make fact-based and defensible business decisions from reliable and robust information.

Figure 1-1: AM Plan Approach

2. State of Infrastructure

Defining the state of the infrastructure involves quantifying the assets owned, examining their age, replacement value, and condition. The City's approach to each of these asset characteristics is summarized below.

2.1 Expected Service Life and Remaining Service Life

The expected service life (ESL) is defined as the period over which an asset is available for use and able to provide the required level of service at an acceptable risk (i.e., without unforeseen costs of disruption for maintenance and repair). The ESL for this assignment will be based on discussions with City staff, information from previous studies, and any additional information that might inform the ESL. In terms of determining the Remaining Service Life (RSL), the City used the installation date together with the ESL.

In reality, different assets will deteriorate at different rates and not necessarily linearly over time, however, it is important to keep in mind the level of effort required to predict failure compared with the asset value. More sophisticated deterioration modelling may be warranted for very high value assets, whilst the cost of deterioration modeling for low-value assets may very well exceed the replacement cost of the asset. The actual service life can vary significantly from the ESL. In some instances, a variation in expected vs. actual service life is evident due to the following factors:

- **Operating conditions and demands:** Some equipment is operated intermittently or even infrequently, or is being operated a lower demand than its design capacity, thus the actual operating "age" of the asset is reduced.
- **Environment:** Some equipment is exposed to very aggressive environmental conditions (e.g., corrosive chemicals), while other assets are in relatively benign conditions, thus the deterioration of assets is affected differently.
- **Maintenance:** Equipment is maintained through refurbishment or replacement of components, which prolongs the service life of the asset.
- **Technological Obsolescence:** Some assets can theoretically be maintained indefinitely, although considerations such as maintenance cost, energy inefficiency and new technologies are likely to render this approach uneconomical.

2.2 Current Asset Replacement Value

The estimated replacement value is the cost of replacing an existing asset in 2024 dollars, considering an inflation rate. These costs were developed based on the records of previous tenders and quotes, other municipalities similar in size to the City, and consultation with the City's staff. Where applicable, a CPI-based inflation rate was used to estimate the 2024 values.

2.2.1 Asset Inventory and Replacement Value

The City's Roads are managed and maintained to meet provincially issued system and facility operating permits, as well as the City's technical targets for performance and reliability.

In the reinvestment need analysis for road assets, the replacement costs are calculated considering the equation [1] and [2]:

$$Unit\ Cost\ (all - inclusive) = \{unit\ rate, length\} \quad [1]$$

$$Total\ Replacement\ Value\ of\ Service\ Type\ (roads) = \sum Unit\ Cost\ (all - inclusive) * Length + \sum Others \quad [2]$$

Where $Others$ refers to asset types that are not measured in the all-inclusive unit rate and can vary depending on the service type.

Upon calculating the replacement costs, the values were rounded to the nearest thousand. **Table 2-1** shows that the City's Roads are valued at approximately $1.56B, with local roads and collector roads comprising approximately 96% of the total replacement value.

Table 2-1: Asset Inventory & Valuation

	Length (m)	Area (m2)	Lane km	Unit Replacement Cost ($ / unit)	Replacement Value
Local Road	663,000	5,550,000	1,335	$171 / m^2	$949,056,000
Collector Road	271,000	3,197,000	642	$171 / m^2	$546,619,000
Rural Road	51,000	333,000	103	$171 / m^2	$56,906,000
Laneway	8,000	46,000	16	$171 / m^2	$7,895,000
TOTALS	**992,000**	**9,126,000**	**2,095**		**$1,560,476,000**

2.3 Asset Condition

All assets are expected to deteriorate over their lifetime, and their assigned condition reflects the physical state of the asset. No on-site condition assessments were carried out for this project; therefore, physical condition of the assets is based on consultations with City staff who have experience in managing the assets, combined with any existing condition data, and information from past studies.

2.3.1 Age-Based Condition Assessment

Two-parameter Weibull distribution function was used to assess the current condition and to project the future condition of the City's Roads. The Weibull distribution has been used extensively in reliability studies and lifetime prediction models in industries ranging from the automotive to the oil and gas industries; it provides a suitable distribution for this type of analysis.

The Weibull probability distribution provides a left-skewed distribution that rises slowly and diminishes quickly as the population is consumed. The underlying premise of the Weibull-shaped deterioration is that while some assets fail prematurely due to severe conditions or improper installation, other assets are very long-lived and function well beyond their theoretical expected service life. In order to perform a high order network-level analysis, it was assumed that assets would fail (and require replacement) within a deterioration envelope / curve approximated by a Weibull probability distribution. The two-parameter Weibull cumulative distribution has two parameters for scale and shape, as set out in Equation [1]:

$$f(x;\alpha,\beta) = e^{-\left(\frac{x}{\beta}\right)^{\alpha}} \qquad [1]$$

Where: x = Age
α = Shape parameter
β = Scale parameter (or slope)

Table 2-2 presents the condition score ranges and the corresponding range of ESL and total life consumed.

Table 2-2: Age-Based Physical Condition Scale

Condition Score (minimum)	Condition Score (maximum)	Condition Rating	Range % of ESL Consumed	Range of % Operational Life Consumed
1.0	1.5	Very Good	0% – 71%	0% – 47%
1.5	2.2	Good	72% – 84%	48% – 56%
2.2	2.8	Fair	85% – 92%	57% – 60%
2.8	5.0	Poor	93% – 100%	61% – 100%

2.3.2 Age Summary

Figure 2-1 shows the average road asset age as a proportion of the average useful life by asset type. The average useful life for a road is assumed to be 60 years and represents the construction of all necessary granular and asphalt surface treatments that comprise a road structure. The average age for road assets was calculated using the construction date. The GIS database also includes records of major reconstructions which replaced the asphalt and granular layers. In such cases, the road age is considered reset at that year. The design life for most asphalt pavements is 15-20 years and should be rehabilitated or replaced two to three times in order for the roadway to last to its expected service life (ESL) of 60 years. By applying pavement preservation treatments (e.g. crack sealing) and pavement rehabilitation approaches (e.g., mill and overlay) at the appropriate intervals, the City can achieve and extend the expected service life of a road pavement. As shown in **Figure 2-1**, the average age of the City's local roads is 28 years, which means that there are many roads that are due for rehabilitation within the next few years.

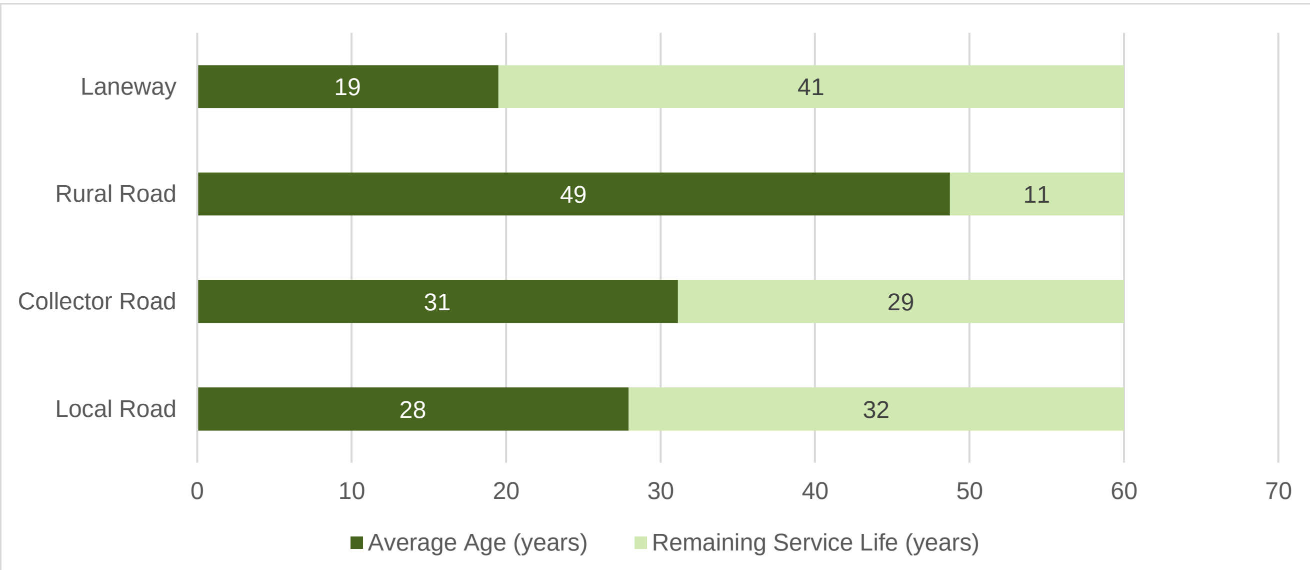


Figure 2-1: Average Asset Age as a Proportion of Average Expected Service Life

2.3.3 Condition Summaries

The Pavement Composite Index or PCI (0 - worst to 100 - best) was used as one of the indicators for optimizing pavement life cycle cost. The PCI is a function of the health of the network, the ability / service (capacity) of the network and the physical environment of the network. The City divides pavement conditions into four classes by PCI ranges: Very Good (80-100), Good (60-80), Fair (35-60), and Poor (0-35) (also refer to Figure 3-5). **Figure 2-2** presents the summary of current road network condition. The road service has 95% of assets in Very Good condition, which indicates the City's road network is very young and meets the current need. Attention may be required as they are aging in the future years.

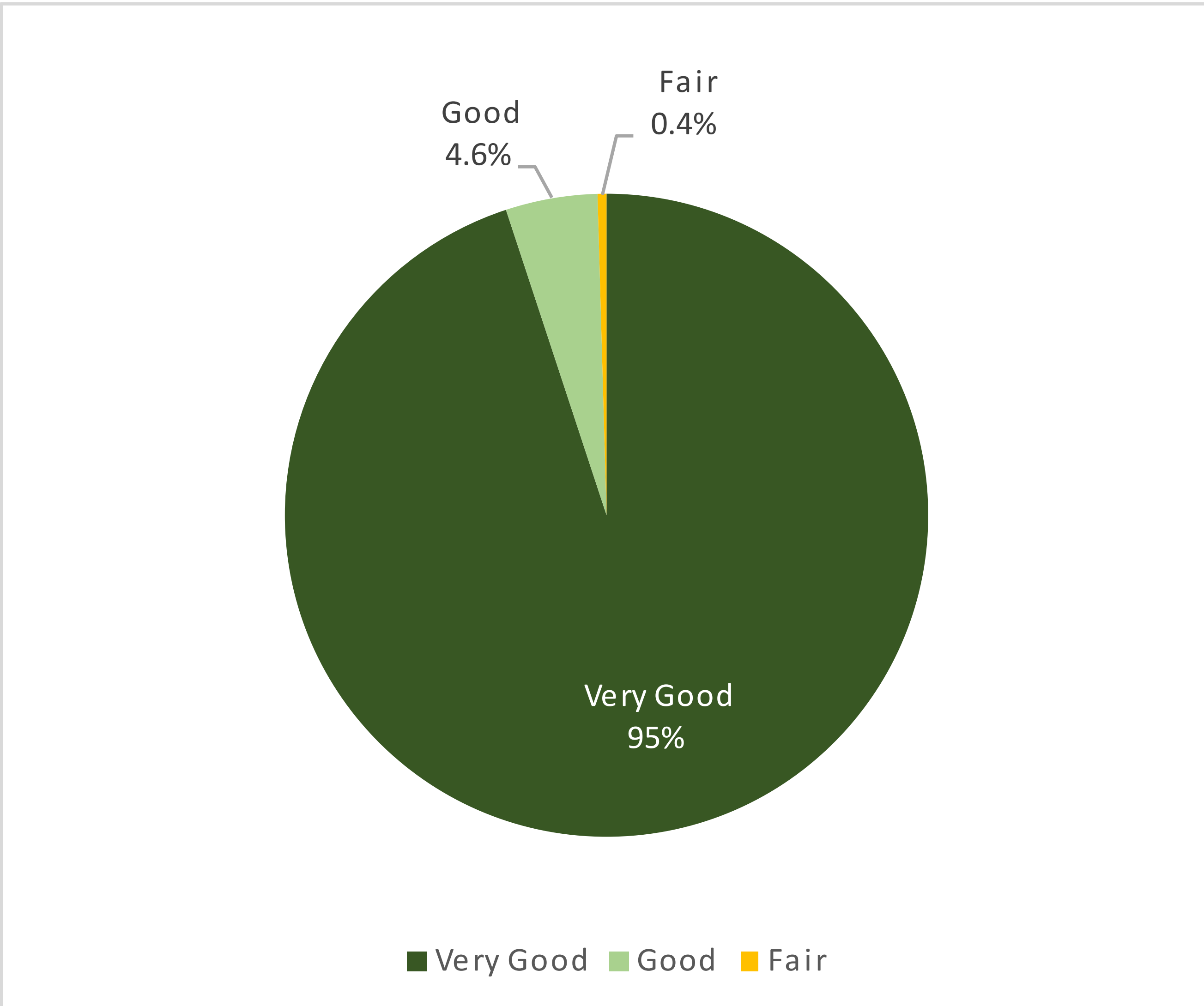


Figure 2-2: Asset Condition Summary

Local roads, collector roads, rural roads and laneways are overall rated in Good to Very Good condition (**Figure 2-3**).

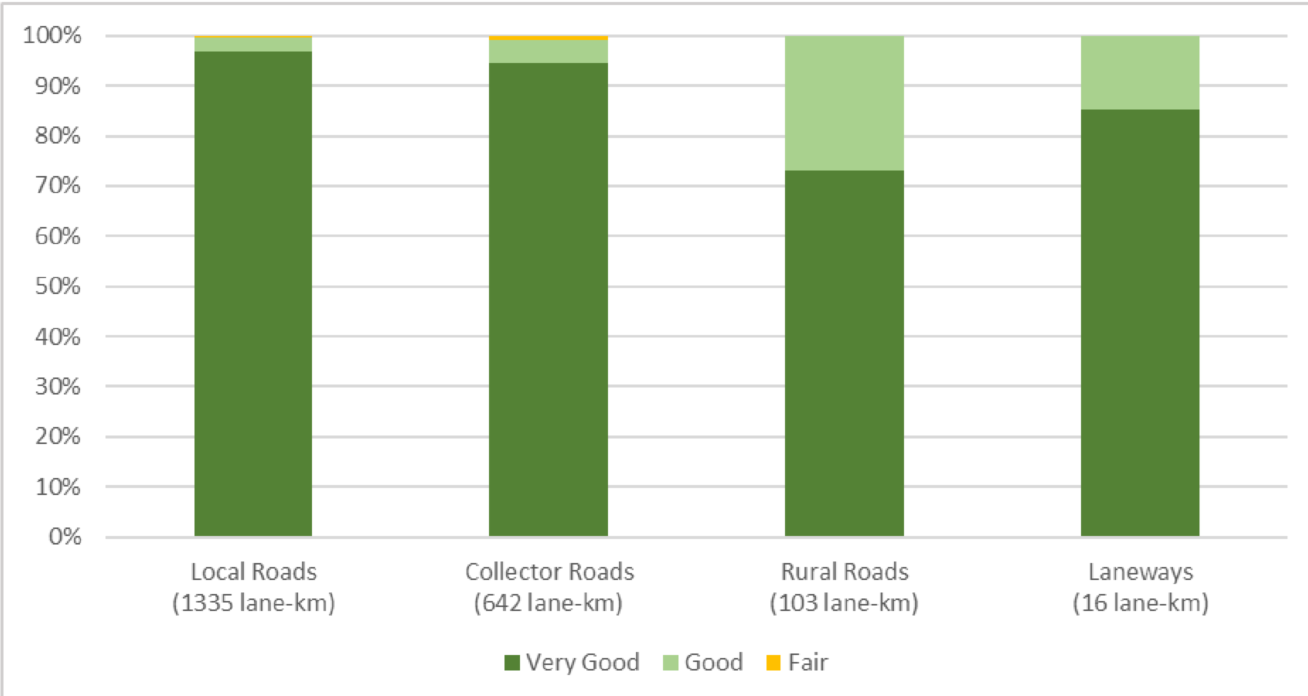


Figure 2-3: Distribution of Asset Condition by Replacement Value

3. Levels of Service

3.1 Purpose

LoS supports every aspect of the overall AM System as shown in **Figure 3-1**. The objective of establishing clearly defined service levels is to help the City meet stakeholder values, achieve its strategic goals, make informed risk-based decisions, and implement effective asset lifecycle activities.

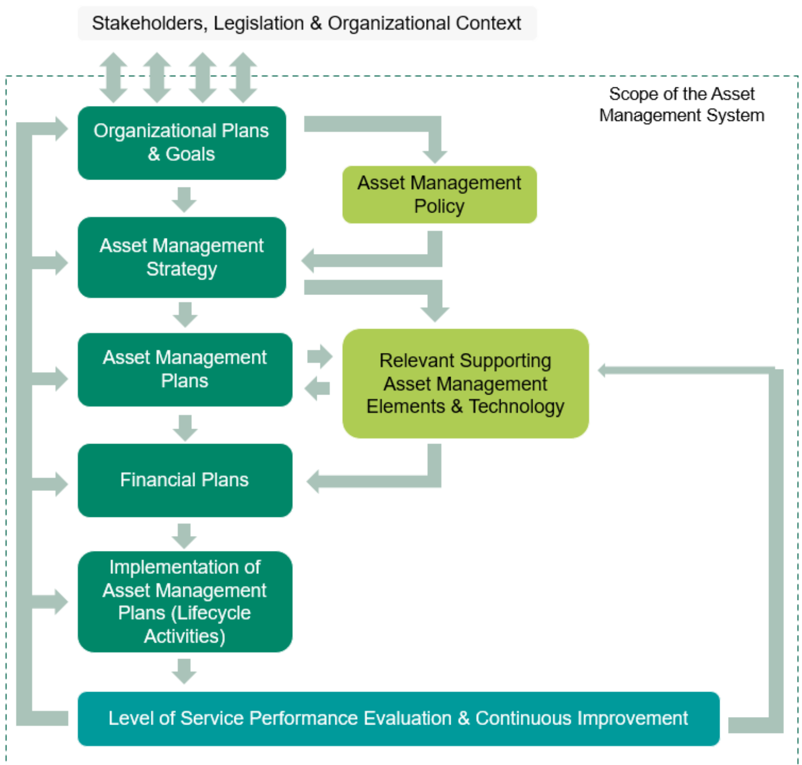


Figure 3-1: LoS within the AM System

In the City's experience, documenting LoS is a proven practice that will enable the City to:

- Link corporate strategic objectives to customer expectations and technical operations.
- Balance customer needs and expectations while evaluating the effectiveness of operations and whether the right LoS is being provided at the right cost.
- Transition from an "Asset Stewardship" approach that focuses on making decisions based on maintaining assets in an acceptable condition to a "Serviceability" approach that is geared towards making decisions based on balancing the costs, risks, and goals for the LoS being provided by the City's assets.
- Communicate the physical nature of infrastructure that the City owns and is financially responsible for while promoting the use of LoS to enable effective consultation with stakeholders regarding alternative funding options according to desired LoS outcomes.
- Make recommendations on strategies that the City can take now to minimize future renewal costs while ensuring that adequate LoS can be delivered without burdening future generations.
- Assess internal (e.g., program changes) and external (e.g., climate change) factors that have the potential to impact the City's ability to deliver services and how these factors may impact the LoS being provided.
- Implement a corporate continuous improvement program to further optimize AM across all service areas.

The O. Reg. 588/17 requires that all AMPs include information about the LoS that the City proposes to provide, the activities required to meet those service levels, and a strategy to fund those activities. The deadline for formalizing these LoS requirements is July 1, 2025 (see **Section 1.3**).

Successful AM programs aim to achieve targeted service levels through customer-based decision making. To achieve this, the City considered a customer-centric approach, where the customer is at the heart of every decision from development to implementation, consultation, and roll-out of the LoS Framework (**Figure 3-2**).

There are two types of LoS measures: Customer LoS (also called “Community” LoS) and Technical LoS. Customer LoS are recorded in a manner that attempts to describe the LoS in terms of what is actually being provided to the customer (i.e., the public) and how the customers experience the service. It is important to note that customers are not concerned with the specific operating requirements of the assets that provide the service, but rather the value they obtain from the operation of the assets. To achieve Customer LoS there needs to be line of sight between the value delivered and how that value is realized. This is the purpose of Technical LoS which attempts to describe how the City will provide and meet the expected Customer LoS.

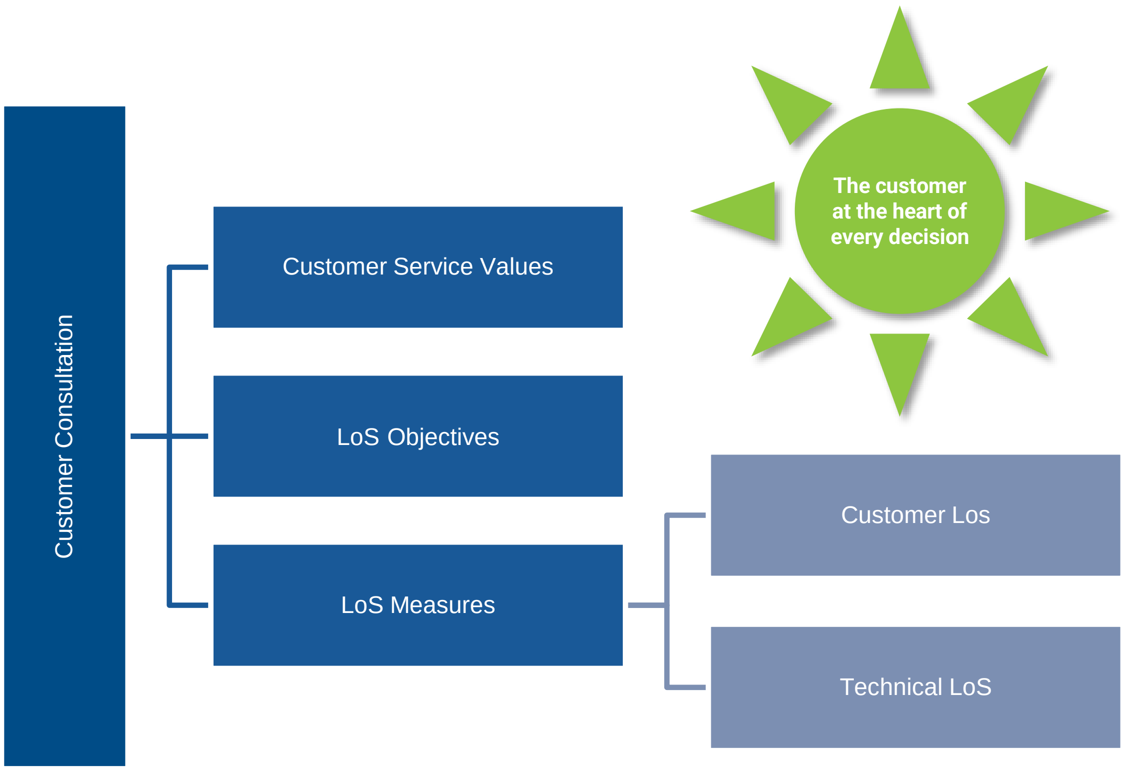


Figure 3-2: The LoS Framework Customer-Centric Approach

The LoS Framework was primarily conceived through a collaborative workshop process. In 2020, four workshops with City staff were conducted across each of the fourteen service areas.

The following outcomes were achieved during each service area workshop:

- Staff were oriented as to the purpose and importance of establishing a consistent LoS Framework;
- Stakeholders were identified, including their expectations, interests, and any regulatory requirements;
- Customer service values were established and reviewed;
- LoS objectives were established for each customer service value;
- Staff provided several performance measures that are currently being tracked as well as those that the City would like to track in the future;
- Where information was available, current performance, targets, and data sources were documented; and
- Growth and shifts in future demand were discussed across the City’s service areas.

3.2 Objectives

Defining LoS objectives is important for drawing a line of sight between the City's corporate objectives and the tangible asset performance outcomes. To do so, the LoS objectives must take into consideration stakeholder interests to develop asset performance measures that aim to meet the needs and expectations of the community. By doing this, the City will ensure that their assets are striving towards optimal performance, not only operationally, but economically, socially, and sustainably as well.

Every stakeholder has certain interests in the service being provided and in general, these interests can be categorized into six universal stakeholder values, as shown in **Table 3-1**. Each universal stakeholder value is also assigned a corporate LoS objective.

Table 3-1: The City's Values and LoS Objectives

Customer Value	LoS Objective
Quality and Reliability	The service is delivered with a high standard of excellence and the service is available when needed.
Affordability	The cost of the service is delivered in a financially sustainable manner and does not burden customers.
Environmental Sustainability	The service is delivered in a manner that does not compromise the ability of future generations to meet their needs.
Access and Capacity	Customers can easily access the service with minimal inconvenience.
Health and Safety	The service is delivered with minimal health and safety impacts.
Responsiveness	Customer service requests are responded to efficiently and in a timely manner.

3.3 Stakeholders and Their Interests

A stakeholder is any person or organization that can affect, be affected by, or perceive themselves to be affected by a decision or an activity. Stakeholder analysis is the process of understanding stakeholder needs, expectations, and perceptions relative to the stakeholder's level-of-interest and level-of-influence over the organization. An organization typically engages with their stakeholders to:

- Establish which activities or services matter most to them.
- Understand their risk appetite and risk threshold.
- Understand their willingness to pay for services.

Stakeholders can take many forms and may be internal (i.e., staff, Council) or external (i.e., the public, regulatory agencies, suppliers, neighbouring municipalities, etc.) to the organization. Historically, only service recipients who pay for City services would be considered customers; however, today customers can take many forms and should include any entity that has a legitimate interest in the service being provided. In addition to service recipients (i.e., the public), this may include:

- **Regulatory Agencies** – Stakeholders that set standards, compliance regulations or other legislation that govern service delivery.
- **Special Interest Groups** – Stakeholders that are affected by or have an interest in the City's roadway services.

3.4 Level of Service (LoS) Performance Measures

A documented suite of LoS performance measures enables a common understanding of the service delivery that the City's customers currently receive, and the associated cost of maintaining infrastructure assets to provide the service. Having these performance measures set at the appropriate levels within the City ensures alignment from the corporate vision, to asset investment decisions, and to day-to-day operational activities. When establishing LoS performance measures it is important to keep in mind the "SMART" acronym, as follows:

- **S**pecific, easily evaluated and understood.
- **M**easurable, quantifiable, and easily collectable to ensure ongoing data availability.
- **A**ttainable, so that they work to motivate as opposed to discourage.
- **R**elevant, in that they relate and align with a specific goal.
- **T**ime-Bound, measured over a specific period, which is typically annually for benchmarking.

There are two types of LoS performance measures: Community LoS and Technical LoS. Community LoS are recorded in a manner that attempts to describe the LoS in terms of what is being provided to the community (i.e., the public) and how the customer experiences the service. Community LoS are qualitative, non-technical, and are driven by the municipality's strategic AM objectives. Community LoS are not concerned with the specific operating requirements of the assets that provide the service, but rather the value they obtain from the operation of the assets. To achieve Community LoS, there needs to be line of sight between the value delivered and how that value is realized. This is the purpose of Technical LoS which attempts to describe, quantitively, how the City will provide and meet the expected Community LoS.

3.5 LoS Performance Results

Ontario O. Reg. 588 / 17 requires legislated community levels of service for core assets. Community levels of service use qualitative descriptions to describe the scope or quality of service delivered by an asset category. O. Reg. 588 / 17 also requires legislated technical levels of service for core assets. Technical levels of service use metrics to measure the scope or quality of service being delivered by an asset category. **Table 3-2** lists the performance measures that are included in the O. Reg 588/17 requirements for road assets. References are provided to indicate where O. Reg 588/17 requirements have been attained.

A summary of the City's current and proposed community and technical service levels for Roads are documented in **Table 3-2**. Note that the service levels for Bridges, Stormwater assets (including culverts) and Fleet assets are presented in their respective asset management plans (AMPs).

Table 3-2: Community and Technical Service Levels

Level of Service	Current Performance	Current Service Level Target	Proposed Service Level Target
Average PCI rating for Local Roads.	92	70	No Change
Average PCI rating for Collector Roads.	91	70	No Change
Average PCI rating for Rural Roads.	89	70	No Change
Average PCI rating for Laneways.	88	70	No Change
Lane kilometres per square kilometre of the City's land area for Local Roads.	4.84 lane km/km²	4.84 lane km/km²	No Change
Lane kilometres per square kilometre of the City's land area for Collector Roads.	2.33 lane km/km²	2.33 lane km/km²	No Change
Lane kilometres per square kilometre of the City's land area for Rural Roads.	0.37 lane km/km²	0.37 lane km/km²	No Change
Lane kilometres per square kilometre of the City's land area for Laneways.	0.06 lane km/km²	0.06 lane km/km²	No Change
Description, which may include maps, of the road network in the municipality and its level of connectivity.	See **Figure 3-3**		No Change
Description or images that illustrate the different levels of road class pavement condition.	See **Figure 3-4**		No Change

Figure 3-3 shows a map that outlines the City's road network connectivity.

Figure 3-3: Map Outlining the City's Road Network Connectivity

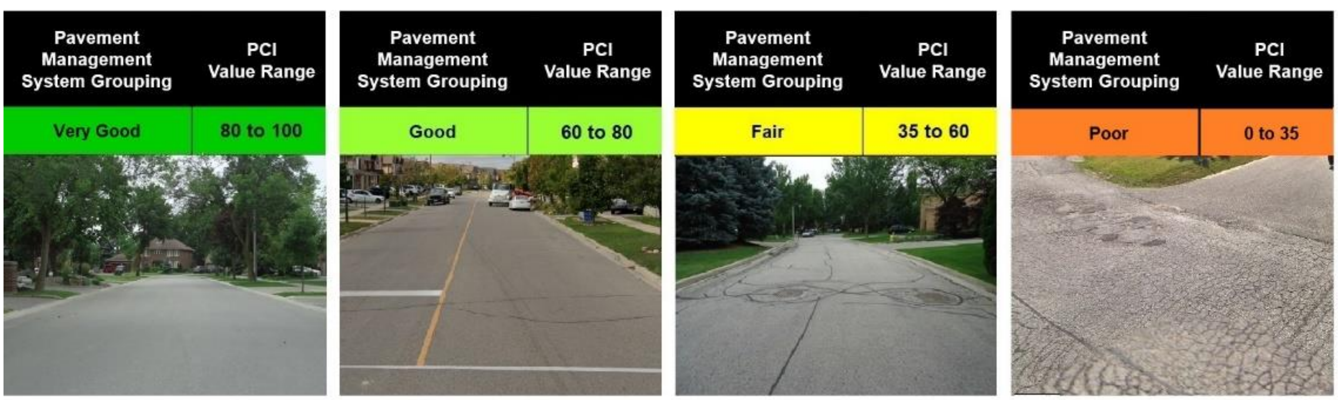


Figure 3-4: Images of Pavement Inspections Compared to Asset Management Condition Rating

3.6 LoS Performance Targets

Establishing LoS targets is an important part of continual improvement and performance management. Without targets, it is difficult to ascertain whether goals are being met, or the extent of the gap if they are not. Incorporating targets into the City's LoS Framework helps to ensure that targets are reasonable, aligned with customer expectations, and evaluated on an objective basis by considering cost-benefit trade-offs.

One of the key challenges in setting targets in a municipal environment is that they can often become biased and/or politically motivated. Therefore, it is important to review LoS targets with stakeholders. An important aspect of evaluating LoS targets is determining how willing the user is to pay for the service. Regulatory requirements are an exception; however, they only provide the minimum service standard. Cost is still an important parameter to consider when assessing the merits of service improvements.

To deal with the financial realities, it is necessary to:

- Calculate how much the service costs based on current LoS.
- Determine the cost associated with varying the LoS.
- Assess the customers' willingness to pay.

4. Asset Lifecycle Strategies

Asset lifecycle management focuses on the specific activities we must undertake during all phases of the asset lifecycle. By considering entire asset lifecycles the City can ensure sound decision making that consider present and future service delivery needs.

The overarching goal of life cycle management is to maximize the long-term benefits and services that our assets deliver while minimizing the associated costs and risks in the long run. Every asset has a life cycle cost, which is the total cost of all the activities undertaken throughout its service life. The following sections describe activities across the life cycle of assets.

4.1 Lifecycle Activities

Any responsible owner of assets such as the City has a desire to preserve the condition of their existing assets for as long as possible, by maintaining or even extending their design lives through routine activities such as maintenance and active intervention. The City is continually acquiring infrastructure assets, but these assets require increased funding for operation and maintenance as they age. The City is also responsible for the replacement of deteriorated assets as long as the service is required. While individual assets may have a useful life that can be predicted in years or decades, the service that the asset provides could be for a substantially longer duration (perhaps in perpetuity). Part of the purpose of the AM planning process is to fully understand and predict the long-range financial requirements for the City's infrastructure to facilitate planning and resource management in the most cost-effective manner possible. **Figure 4-1** illustrates how costs typically accumulate over an asset's life. It is worth noting that the accumulation of the ongoing operations and maintenance, refurbishment and disposal / replacement costs is many multiples of the initial acquisition costs. A key and important take-away from **Figure 4-1** is therefore for the City to fully understand the entire life cycle costs before proceeding with asset acquisition.

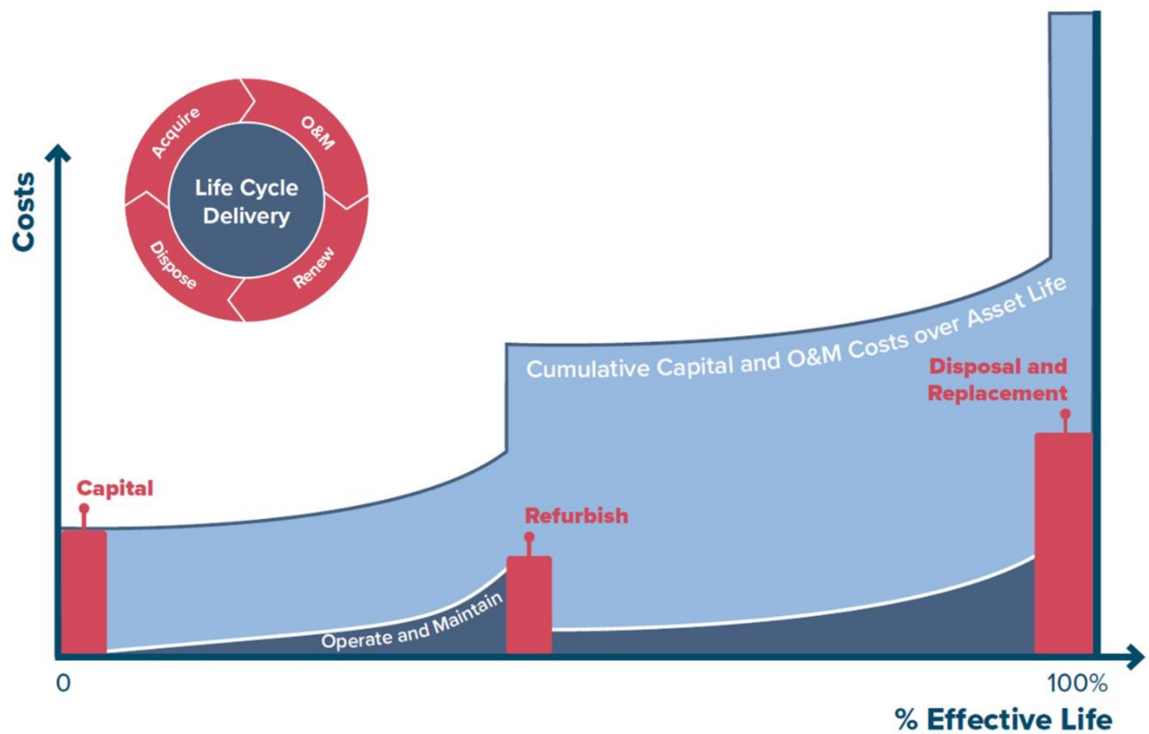
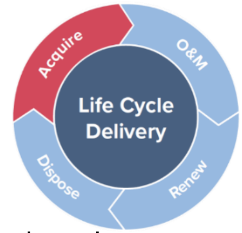
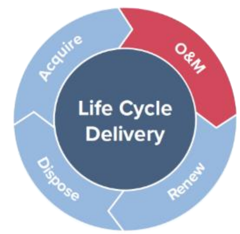


Figure 4-1: Life Cycle Cost Accumulation Over Asset Life

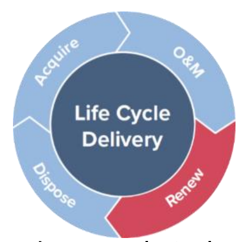
Expressed simply, full lifecycle cost of infrastructure can be accumulated under the following broad headings:



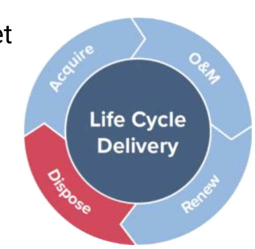
- **Asset Acquisition / Procurement / Construction**: The City has made significant investments in the design and acquisition of its municipal infrastructure assets. Added to City-purchased inventory is infrastructure that the City accepts (and takes immediate financial responsibility for) from developers as new neighborhoods are constructed. For example, as developers build new neighborhoods, the new local infrastructure (including local roads, water mains, sewer mains and storm mains) is paid for by the developer and then transferred to the City for operation, maintenance and ultimately replacement. The City's infrastructure inventory was therefore created over many decades through infrastructure paid for by the City or by developers Looking towards the future, when acquiring new assets, the City should evaluate credible alternative design solutions that consider how the asset is to be managed at each of its life cycle stages. Asset management and full life cycle considerations for the acquisition of new assets include, but are not limited to the following:
  - The asset's operability and maintainability;
  - Availability and management of spares;
  - Staff skill and availability to manage the asset;
  - The manner of the asset's eventual disposal.



- **Asset Operations and Maintenance (O&M)**: As new infrastructure is commissioned, the City accepts the responsibility of operating and maintaining the infrastructure according to O&M standards to ensure that the infrastructure is safe and reliable. Operations staff provide the day-to-day support required to operate infrastructure. In few cases, operation costs are minor, but for most there are significant increases. For example, underground pipes require almost no operational support while a facility such as a pump station requires full-time staff to operate the facility safely and efficiently. Maintenance expenses include periodic preventive maintenance to ensure that the infrastructure can provide reliable service throughout the life of the asset and corrective maintenance that is required to repair defective assets as and when needed. Inadequate funding for O&M will have an adverse impact on the lifespan of assets. The amount of O&M resources required in any period is a function of the current inventory of infrastructure and total O&M needs required for each asset. As the inventory of infrastructure grows, total O&M requirements will also grow.



- **Renewal and Replacement:** The third portion of full life cycle costing relates to the renewal and replacement of infrastructure that has deteriorated to the point where it no longer provides the required service. Renewal cost is sometimes incurred during the life of an asset where an investment is made to improve the condition and / or functionality of the asset e.g., re-lining of a pipe or resurfacing of a road. Disposal and replacement costs are incurred at the end of an asset's life when it is disposed of and replaced by a fully new asset. Canadian municipalities, including City of Vaughan, have not traditionally factored renewal or replacement costs into future budget projections, except for assets that have a relatively short life such as computer equipment and vehicles. The main reason behind this is the fact that large portions of this infrastructure inventory can have a very long life e.g., from 75 to 100 years for underground pipes. For growing communities like the City, there has not been a historical need to forecast expenses that are not anticipated for decades. However, based on the experiences of more established Canadian cities (where vast inventories of old assets are now in dire need of renewal or replacement), it is vital that communities fully understand the looming obligations of infrastructure renewal or replacement and develop a strategy to respond in a manner that is fair and affordable.



- **Decommissioning and Disposal:** There will inevitably come a point in time when an asset must be removed from service and, depending on the type of asset, there may be significant costs associated with its decommissioning and disposal. Factors that may influence the decision to remove an asset from service include: changes to legislation that cause the asset to be in non-compliance, the inability of the asset to cope with increased service levels, technology advances that render the asset obsolete, the cost of retaining the asset is greater than the benefit gained, or the current risk associated with the asset's failure is not tolerable. Normally, major costs that may be incurred during disposal and decommissioning derive from the environmental impact of the disposal and, if required, the rehabilitation and decontamination of land. In some cases, there will be residual liabilities and risks to consider if a decision is made to partially abandon the asset as opposed to fully disposing of its components

(e.g., leaving a non-functioning pipe in the ground, or an inactive building standing). However, some cost savings may be achieved through the residual value of the asset or by exploring alternative uses for the asset. In all cases, it is important to consider disposal and decommissioning as the strategy employed has the potential to attract significant stakeholder attention. For that reason, the costs and risks associated with disposal and decommissioning should be equally considered in the City's capital investment decision-making process.

The infrastructure AMPs present the City's strategy for responding to the full lifecycle costs of all its infrastructure assets. Long-range estimates were prepared together with the AMPs, based on industry best practices to ensure the financial sustainability of the City's infrastructure assets over their full life cycle, as discussed in the next Chapters.

4.2 Acquisition / Procurement / Construction Strategies

When the City acquires new transportation core assets, they are typically transferred from developers, in a process called assumption. In some cases, the City can also purchase privately owned roads and assume control and responsibility for them. In rare cases, the City may download roads from York Region, or upload roads to the Region.

The City accepts roads from developers (and takes immediate financial responsibility for) as new neighborhoods are constructed. For example, as developers build new neighborhoods, the new local infrastructure (including roads, bridges, sewers, watermains, etc.) are paid for by the developer and then transferred to the City for operations, maintenance and eventual replacement. The City's transportation infrastructure inventory was therefore created over many decades through infrastructure paid for by the City or by developers.

For roads that are downloaded from the Region, the roads are normally in a state of good repair before the transfer. There is a development cost (DC) budgeted for the roads downloaded but the City will need to assume the life cycle costs for the downloaded roads.

A situation could also occur where the City uploads roads to the Region, and the Region takes responsibility for them. The upload and download activity are determined by transportation planning. There are criteria established between the Region and the City e.g., what type of road should be classified as a regional road or local road? As traffic patterns change, or roads are realigned, a regional road could become a local road, and vise versa. Generally, there is a candidate list for road upload and download based on discussions between the City and the Region, and DCs can be shifted based on whether a road is uploaded or downloaded.

With regards to the transportation asset assumption process, Development Engineering is involved in the subdivision plans and approving plans from developers. Inspectors from Development Engineering perform inspections to make sure transportation assets are up to standard for transportation operations. The entire road GIS database at the City was transferred from the Region, and the City will make changes when there is a technical memorandum provided by Development Engineering specifying changes.

4.3 Operations and Maintenance Strategies

Road operations and maintenance cost consists of three major components: pure winter control activities, pure roads O&M activities (exclude winter control activities), and overhead. **Table 4-1** presents the breakdown activities and five-year average cost for the City's road assets. The O&M strategies for bridges are included in its own AMP and the culverts O&M Strategies for culverts are included in the Stormwater AMP.

The City's road O&M costs are largely comprised of winter control costs and overhead costs. The five-year average winter control activities cost is $12,072,000.. The five-year annual average O&M cost for other pure roads costs totals $1,543,000. The overhead cost is $2,721,000.

The City's winter control activities include winter equipment fueling, truck plowing, grader plowing, spot plowing, ice removal, snow removal, winter drainage, windrow snow clearing, snow fencing, salting and sanding, winter road patrol, stockpiling, sand purchase, salt purchase, and winter control standby activities. It is noticeable that there are significant costs for winter control standby ($6.9M), salt purchasing ($2.7M), and salting and sanding ($1.3M).

Other than winter control, the pure road and bridges O&M activities includes pavement marking, street sweeping, roadside vegetation maintenance, culvert installation maintenance, road platform maintenance, washout repairs, rural road maintenance, curb cut, boulevard interlock repair, sign install/maintenance, graffiti removal, guiderail maintenance, and railway crossing maintenance.

Table 4-1: Roads O&M Activities and Five-year Average Costs

O&M Activities	Description	Five-year Average Cost
Pure Winter Control Activities	Winter road patrol, sand and salt purchase, salting and sanding, winter equipment fuelling, plowing, ice and snow removal / cleaning, drainage, snow fencing, and winter control standby.	$12,072,000
Pure O&M Activities (exclude winter control activities)	road, pavement marking, street sweeping, curb cut, boulevard interlock repair, sign install/maintenance, graffiti removal, guiderail maintenance, railway crossing maintenance (excluded street sweeping amount recovered by wastewater service)	$1,543,000
Overhead	All overhead cost (e.g., Vehicle Maintenance, Staff Training, Yard Operations, etc.)	$2,721,000
Total		$16,336,000

It should be noted that street sweeping is performed by the road service and partially recovered by environmental services (wastewater and stormwater services). Other costs recovered by environmental services include debris clean up, rural grass cutting, rural vegetation, and culverts and so on. Thus, in **Table 4-1**, costs recovered from other service areas are excluded and accounted for in other related service areas.

4.4 Renewal and Replacement Strategies

The City's primary road renewal and replacement activities are full asphalt replacement (remove and replace) and partial depth asphalt replacement (mill and overlay) and full reconstruction. On rural roads (i.e. roads without curbs), other rehabilitation methods may also be feasible, such as pulverize and overlay, and other methods of in-place pavement recycling. Although specific rehabilitation techniques may be planned for in advance, it should be noted that the City employs site-specific road rehabilitation methods recommended by a geotechnical engineer's investigation. These engineers examine the pavement structure and recommend the most cost-effective treatment for rehabilitation. The detailed pavement renewal and replacement treatment approaches for the City is presented in **Table 4-2.**

Table 4-2: Pavement Renewal and Replacement Activities

Primary Renewal and Replacement Activities	Treatment Method	Description
Reconstruction	Complete pavement reconstruction	Reconstruction involves removing the existing pavement layers and underlying granular layers, replacing the entire pavement structure.
Remove and Replace	Replace asphalt pavement layer	Remove and replace involves removing the entire existing asphalt layers and rebuilding them to replace the equivalent pavement thickness.
Mill and Overlay	Partial depth asphalt replacement	Mill and overlay is a process where the top layer of asphalt is removed and replaced, in order to remove the distressed surface and prolong the life of the bottom asphalt layer and full pavement structure used to address distresses and other deficiencies in the pavement
Crack Sealing	Sealing pavement cracks	Although technically not a pavement renewal or replacement, crack sealing is one of the most important, cost-effective techniques used to prevent pavement cracks from causing premature road failure. Road cracks are filled with a rubberized asphalt compound, preventing repeated freeze-thaw cycles from expanding into potholes
Rehabilitation	Drainage ancillary treatment	Adequate drainage is very important to pavement performance. Drainage ancillary treatment can include ditching and installing subdrains, and cleaning of outlets, culverts and subdrains.

Primary Renewal and Replacement Activities	Treatment Method	Description
	Low class bituminous (LCB) surface treatment *Note: Vaughan only has 1.5km of LCB roads*	LCB treatment refers to thin surface treatment of liquid asphalt covered with an aggregate on surface treated roads, which often applied to pavements with lower traffic volumes.
	LCB upgrade to high class bituminous (HCB)	HCB refer to paved road with high class bituminous; upgrade road with LCB to HCB can accommodate increasing traffic demand
	Microsurfacing	Microsurfacing is a process where a mixture of fine aggregate, liquid asphalt and other additives are applied to the road to correct surface distresses such as raveling to prolong pavement life
	Pulverize and overlay	Pulverize and overlay involves grinding up existing asphalt layers in-place, blending it with existing sub-layers, and paving over them with new asphalt.
Gravel Road Upgrade *Note: Vaughan only has 3.2km of gravel roads*	Gravel to HCB	Upgrade rural gravel road to high class bituminous
	Gravel to LCB	Upgrade rural gravel road to low class bituminous

The City uses specialized software which models pavement analysis for performing life cycle cost optimization considering various budget scenarios. A number of treatment strategies are generated for the analysis period, and present value costs and benefits for the budget scenarios are calculated. The optimization then selects the "best" economic strategy out of the list of probable treatment strategies, for a specified budget scenario. The output of the analysis provides the recommended optimized maintenance and construction program. Maintenance programs are also output from the analysis as part of the life cycle cost optimization.

4.5 Decommissioning and Disposal Activities Strategies

Asset decommissioning and disposal activities are performed to decommission and dispose of assets due to ageing or changes in performance and capacity requirements. This decision process includes the consideration of costs and benefits of rationalization using a whole life approach, the impact of asset rationalisation on other infrastructure and the processes for disposal of assets.

More specifically, the following factors need to be evaluated when considering the decommission and disposal of assets:

- Assets not required for the delivery of services, either currently, or over the longer planning period.
- Assets that have become uneconomical to maintain or operate. (e.g., roads with excessively high maintenance costs.)
- Assets that are not suitable for service delivery.
- Assets that have a negative impact on service delivery, the environment, or community. (e.g., roads which have persistent erosion problems, often located in areas of extremely erodible soils.)
- Assets that no longer support the City's service objectives due to a change in type of service being delivered or the delivery method.
- Assets which can no longer be used for the purpose originally intended. (e.g., roads and bridges constructed for temporary access such as designated temporary roads).

Considerations for the City's asset decommissioning and disposal activities include, but are not limited to:

- Updates to the City's Statement of Tangible Capital Assets. Considerations related to the determination of residual value and the disposal of assets include:
  - Residual value and the useful life of an asset should be reviewed, at the very least, at each financial year-end and, if expectations differ from previous estimates, any change should be accounted for prospectively as a change in estimate.

- Residual value or salvage value for pavement can be significant because it involves the remaining value of significant expenditures not fully consumed at the end of the analysis period. The residual value of a pavement material depends on several factors: location, volume, recycling / re-use policies, age, anticipated use the end of the design life, etc. The last preservation or rehabilitation treatment in the analysis is often used to estimate the end of life residual value.
- The depreciation method used should reflect the pattern in which the asset's economic benefits are consumed.
- The depreciation method should be reviewed, at the very least, annually and, if the pattern of consumption of benefits has changed, the depreciation method should be changed prospectively as a change in estimate.

- Updates to asset databases such as the GIS and CMMS.
- Environmental impact of disposal and implications for land rehabilitation, where applicable.
- Continued service delivery while a new road asset is being constructed / commissioned.
- Cost of decommissioning and disposal.

4.6 Capital Planning

Capital investment is to address community growth or changes, or to renew existing assets to maintain service levels. For the actual funding needs assessment, please refer to **Section 5**

- **Life Cycle Cost Analysis Approach**. The City's analysis enables optimized decision making and mathematical deterioration modelling of infrastructure assets and the development of short, medium and long-term forecasts of renewal and replacement costs of a number of decision criteria and the ability to compare different intervention options to find the optimal solution in terms of timing and the intervention option chosen.
- **Forecast Periods.** The City aims to develop Short- to Medium-Term and Long-Term capital plans. Typically, short to medium-term capital plan identifies the activities required to meet current and future demand, the cost of those activities and a financing approach. It is developed or renewed every three to five years and should coincide with regulations on short to medium-term expenditure planning. A long-term plan can serve as part of Strategic Asset Management Plan, which indicates what will be spent, by service areas, over a set period of time. Long-term plans tend to focus only on costs.

  Consistent with the approach of other asset management plans, the analysis periods for funding need assessments are 20 years.

4.7 Asset Prioritization

4.7.1 Risk Assessment

Infrastructure-related risk exposure is assessed based on the combined consideration of probability and consequences of an asset failure, which is used to drive the selection and prioritization of appropriate action, based on risk tolerance thresholds and funding availability. Understanding the risk exposure for a given set of assets allows the City to identify where they are most exposed to risk, and to target their investments to most effectively reduce that exposure.

In addressing risk for infrastructure assets, the first step in the analysis is to identify assets that are most critical to the business. Critical assets are those that will potentially have the greatest impact on service delivery should they fail. It should be noted that the parameters, criteria and weighting factors area starting point, and should be reviewed and modified to reflect the priorities of the City on an ongoing basis.

The fundamental principle of consequence (or criticality) models is that they evaluate the relative importance of assets based on select criteria. The approach to risk analysis within this project utilizes a triple-bottom-line assessment approach utilizing the following four criticality indices:

- **Economic** – influence of the asset's failure on monetary resources
- **Operational** – influence of the asset's failure on operational ability
- **Social** – influence of the asset's failure on society
- **Environmental** – influence of the asset's failure on the environment

By applying specific indices, the risk assessment framework generates a risk (or priority) score for each asset. The risk score is a rating of the asset based on the detailed assessment of the likelihood and consequence of failure based on a number of key parameters. All parameters are then equated using equation [4].

$$Risk = Likelihood\ of\ Failure \times Consequence\ of\ Failure \qquad [4]$$

Based on this principal, the risk associated with a given asset's failure can be managed by limiting the likelihood of this occurring, or the impact realized, should it occur.

Consequences of Failure (CoF) reflect the relative "impact" of a given asset's failure. While traditionally these have been looked at as purely economic terms (i.e. repair cost, loss of revenue, etc.), the truth is that investment decisions are often driven by non-economic factors. Understanding both the economic and non-economic impacts associated with loss or limitation of service help in categorizing an asset's "criticality" and justifying infrastructure decisions in a consistent, defensible manner.

Risk score can be calculated for each road segment by using its Probability of Failure (PoF) and Consequence of Failure (CoF) score. For the City's roads, PoF can be estimated using the City's four-point PCI rating system (Very Good, Good, Fair, and Poor) by assigning a score of 1 (Very Good) to 4 (Poor) for each road segment.

The CoF or criticality rating considers evaluation of the relative importance of assets based on select criteria. With a comprehensive criticality rating, the following factors could be incorporated:

- Economic: Impact of the asset's failure on monetary resources e.g., replacement cost and the economic impact on commercial areas should the asset fail.
- Operational: Impact of the asset's failure on operational ability e.g., road functional classes, AADT, underlaying water, wastewater, and stormwater systems.
- Social: Impact of the asset's failure on society e.g., residential areas and commercial areas.
- Environmental: Impact of the asset's failure on the environment e.g., environmental sensitive areas.

It is recommended that the City perform a risk assessment to prioritize resources if there are budget constraints.

4.7.2 Analytical Logic to Sequence Interventions

The asset criticality score can be used to prioritize projects within a funding constrained environment. **Figure 4-2** illustrates this logic of carrying unfunded needs to the next year in the period where they receive a higher probability of receiving funds based on their criticality score.

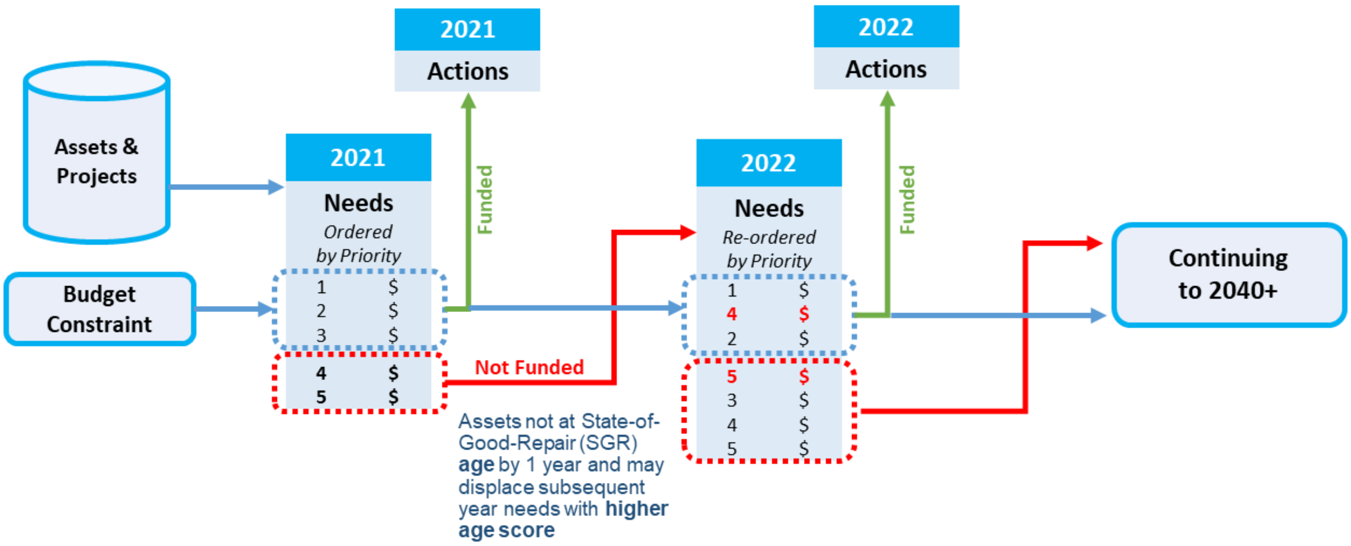


Figure 4-2: The Role of Criticality to Prioritize Projects Within A Funding Constrained Environment

4.8 Financial Planning

4.8.1 Financial Policies

The City has taken the initiative to establish financial asset management policies in 2018, which provides directions on how financial principles apply to assets to ensure that service goals are met. The policy aligns the business model of AM with the City's financial planning, financial reporting, cost management, treasury and taxation functions. The City will integrate findings from the AM Plans into its long-term financial planning and budgeting processes. Sound financial analysis will be encompassed in AM planning in order for the AM Plan to be a sought-after guide for employees in budgeting and financial planning.

4.8.2 Financial Analysis

Financial analysis activities for asset management is centered on two essential quantities: revenues and expenditures. Revenues can come from many sources. Through asset operations, the City generate its own source revenues from taxes, development charges, etc. Expenditures are all the direct and indirect costs associated with capital, operating and maintaining, and disposing of assets.

Assessing the financial implications supports in the decision-making when there are competing priorities and trade-offs between projects. Financial analysis provides a better picture of how to fund the capital plan and make critical decisions about service delivery while providing the greatest benefit for the community at the lowest cost.

4.8.3 Aligning the Financial and Non-Financial Functions of AM

ISO 55010[1] identifies the that the financial and non-financial functions of AM within organizations are generally inadequately aligned, as follows:

- **Financial Accounting Functions:** Focused on retrospective reporting of accounting / regulatory financial activities. However, there is a growing awareness in organizations of the need to focus on providing a managerial costing approach in order to support decision-making for the future.

[1] International Organization for Standardization (2019): ISO 55010 - Asset management — Guidance on the alignment of financial and non-financial functions in asset management

- **Non-Financial Functions:** Have a limited understanding of financial accounting functions but are recognizing the need to improve their understanding of the financial implications of their activities.

The lack of alignment between financial and non-financial functions can be attributed to silos in an organization, including reporting structures, functional / operational business processes, and related technical data. Silos generally bring forth the necessary level of specialization. However, with a lack a communication between the silos, organizations are at risk of inefficiencies and errors in AM results, or AM failures due to a lack of alignment between AM staff and senior management. Financial and non-financial alignment needs to work both "vertically" and "horizontally", as follows:

- **Vertical Alignment:** Financial and non-financial asset-related directives by management are informed by accurate upward information flows, effectively implemented across the appropriate levels of the organization.
- **Horizontal alignment:** Financial and non-financial information that flows between departments (conducting functions such as operations, engineering, maintenance, financial accounting and management) uses the same terminology and refers to the assets identified in the same way.

Figure 4-3 presents the key elements in a framework to address the need to achieve the alignment.

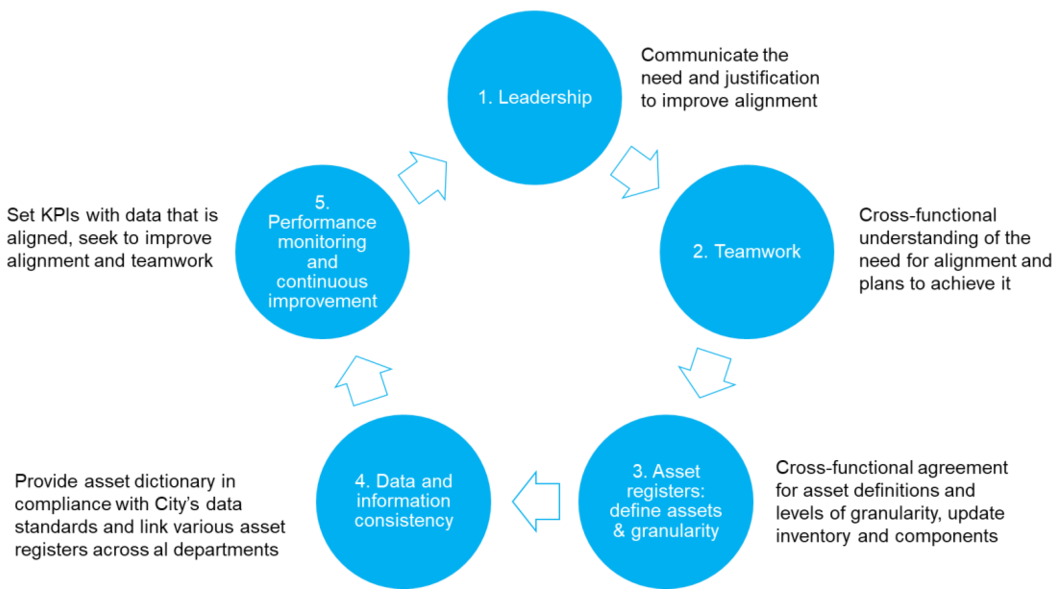


Figure 4-3: Key Elements of a Framework to Achieve Financial and Non-Financial Alignment

4.8.4 Long-Term Financial Planning

Strengthening the City's AM planning according to the recommendations in Asset Management Strategy will improve the City's long-term financial planning, by accounting for whole life cycle costs as presented in **Section 4**. This includes all capital, annual operation and maintenance, and disposal costs over the planning timeframe, thereby aligning financial requirements with long-term level of service objectives.

The challenge is often one of agreeing on a timeframe for such planning, recognizing that the AM perspective is ideally focused on the asset life cycle, versus the political / election cycle that could be as short as a three to four-year Council term. Accordingly, financial and non-financial staff, as well as top management and politicians, should agree on a long enough timeframe to provide useful forward planning information that aligns the financial and non-financial perspectives, as presented in **Figure 4-4**.

Figure 4-4: AM Planning Alignment Across the Organization

The City should have an appropriate long-term financial planning process that achieves the following:

- Stimulates long-term strategic thinking and perspective for stakeholders and decision-makers.
- Can be used as a tool to prevent or predict future financial shocks and demonstrate financial sustainability.
- Demonstrates to internal and external stakeholders that the organization has a financial strategy in place to meet their demands, now and in the future.

The long-term financial planning process needs to involve financial and non-financial staff working together to combine the important elements of strategy development, asset management planning and financial forecasting (**Figure 4-3** and **Figure 4-4**).

5. Funding Need Analysis

5.1 Roads 20-Year Funding Need Analysis

The average annual reinvestment rate for the City's entire road network is equivalent to $9.5M over the next 20 years in 2024 dollars. This is equivalent to a total of approximately $190.8M over the next 20-year period, as presented in **Figure 5-1**.

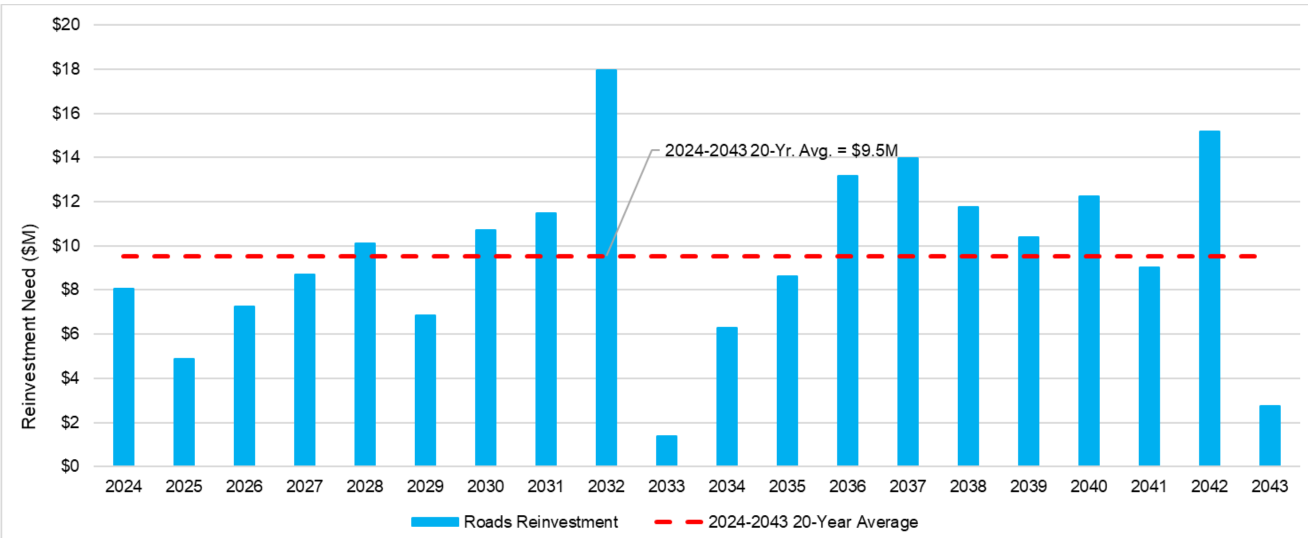


Figure 5-1: Roads 20-Year Reinvestment Need

It is important to note, there is significant reinvestment required for rehabilitation program as shown in **Figure 5-2**, Looking ahead to the decade between 2032 and 2042, the City should prepare for more reinvestment as roads continue to age and deteriorate.

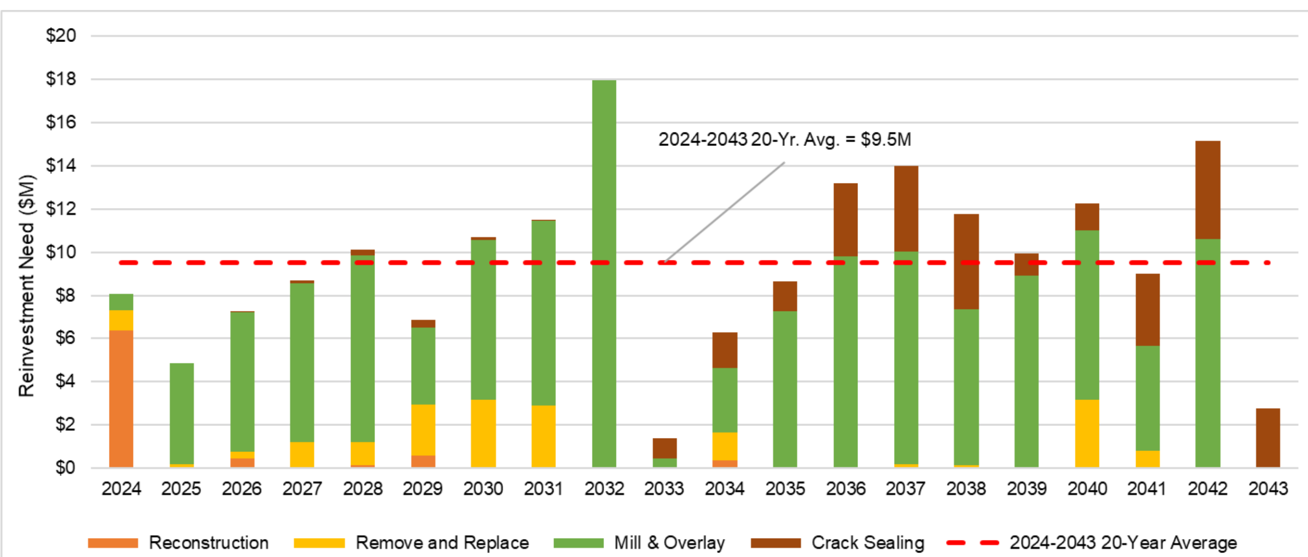


Figure 5-2: Roads 20-Year Reinvestment Need Details

The detailed reinvestment needs in 2024 dollars for Reconstruction, Remove and Replace, Rehabilitation, Rural Road Upgrade are presented in **Table 5-1**.

Table 5-1: 20-Year Total and Annual Average Reinvestment Need

	Reconstruction	Remove and Replace	Mill and Overlay	Crack Sealing	Total
Annual Average Need	$394,000	$894,000	$6,752,000	$1,479,000	$9,519,000
20-Year Total	$7,880,000	$17,880,000	$135,040,000	$29,580,000	$190,380,000

The total annual reinvestment rate from **Figure 5-1** has been overlaid with an idealised / target O&M annual budget (based on 5 year historical values, 2024 dollars), as presented in **Figure 5-3**.

The City's road assets require approximately $31M O&M funding over the next 20 years, equivalent to $1.5M per year in 2024 dollars. As such, with the addition of Reinvestment, O&M, the total average annual reinvestment rate for the City's road assets increases to approximately $11.1M annually, for a total of $225M over the next 20-year period.

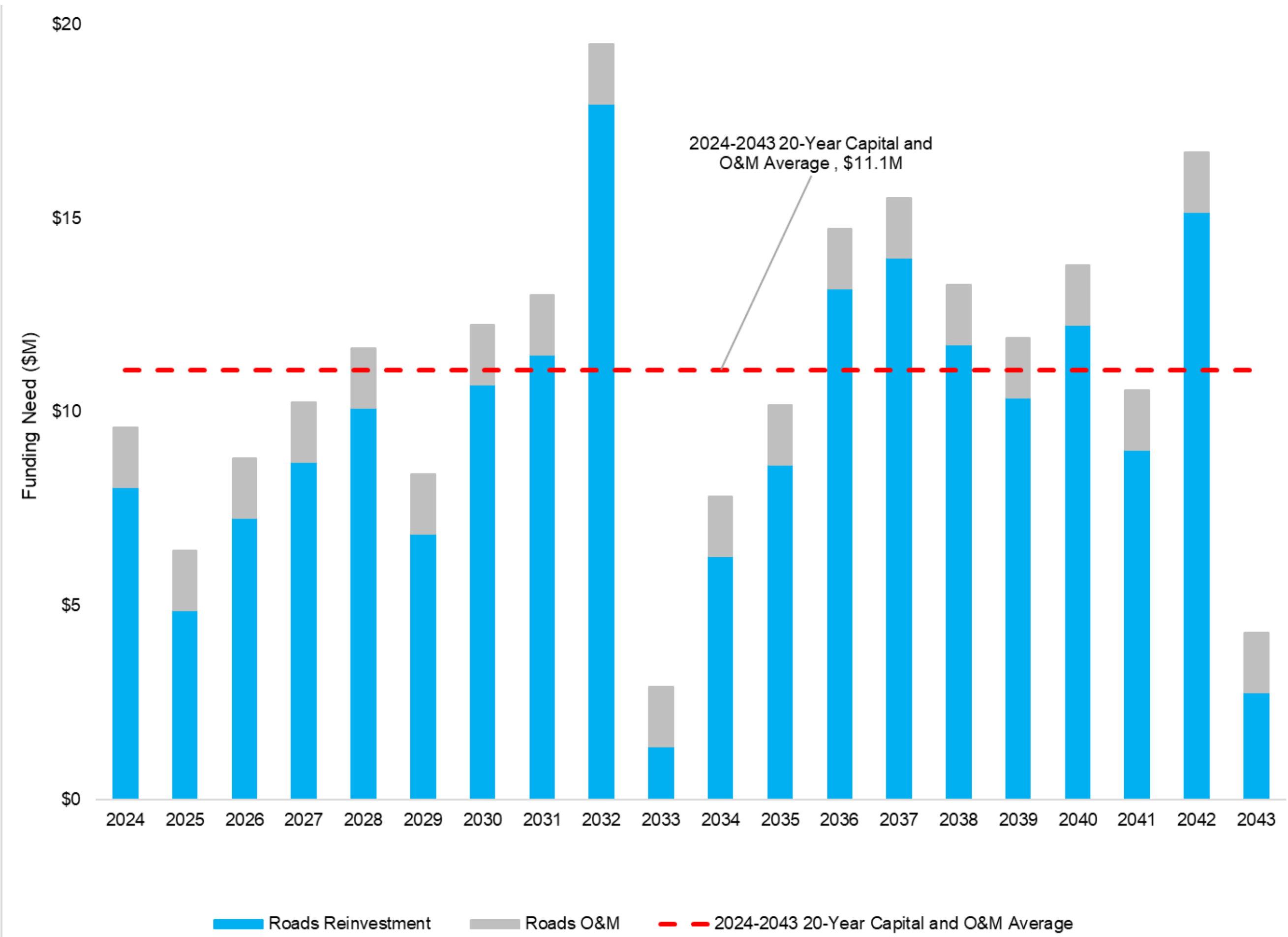


Figure 5-3: Roads 20-Year Capital Investment and O&M Cost Forecast

5.2 Full Funding Need Profile

Figure 5-4 shows a full picture of the City's road assets funding needs forecast over the next 20 years, which provides the City the full funding requirements for performing effective financial planning activities. The total annual reinvestment rate from **Figure 5-1** and **Figure 5-2** was overlaid with the City's roads O&M cost, five-year annual average winter control activities costs, and road overhead costs.

The City's road full funding requirement amounts to approximately $517.5M over the next 20 years with the additional funding requirement of overhead, winter control and O&M, equivalent to $25.9M per year in 2024 dollars. It is noticeable that the funding requirement for winter control is significant compared to capital reinvestment and O&M requirement, as presented in **Figure 5-4**.

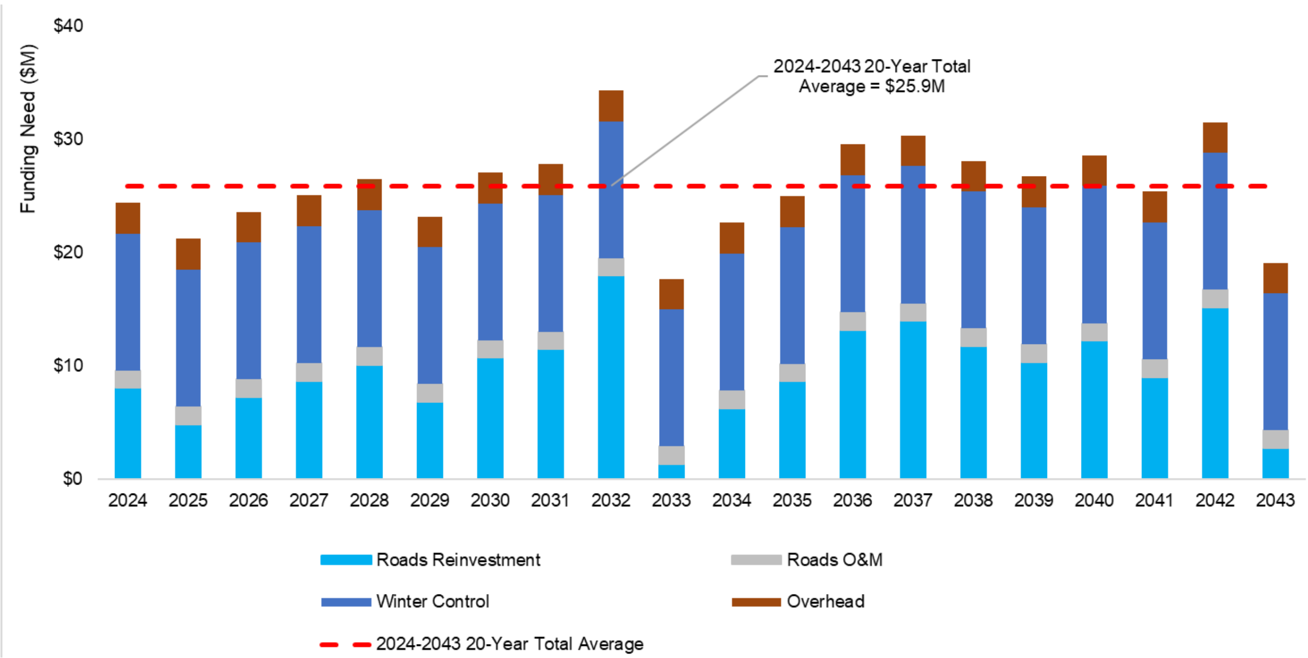


Figure 5-4: Roads Full Funding Need Profile

5.3 Infrastructure Reserves Funding Forecast

Reserve funds are important tools in the planning and management of the City's financial resources and provide a strong indicator of the City's overall financial health and are fundamental to the City's long-term financial sustainability. The City is committed to maintaining healthy reserve fund balances which are collected through various means (i.e., development charges, contributions, dedications, taxation, etc.).

There are specific infrastructure reserves for the tax-supported service areas of Roads, Facilities, Parks, Fleet and Fire. These reserves contain funds set aside through annual contributions from taxation to help pay for the repair and replacement of infrastructure assets. Like many municipalities across Canada, Vaughan is facing increased costs associated with maintaining aging infrastructure. Corporate Asset Management Plans for both core and non-core assets suggest the City's infrastructure deficit is large and growing. The City has continued with robust strategies and plans by developing a comprehensive Long-Range Fiscal Plan and model, which was used to better inform the 2025 and future budgets by providing information about the financial requirements to sustain growth, delivery of services and the community's infrastructure needs.

Prudent financial planning requires ongoing contributions to Roads reserves to fund the repair and replacement of infrastructure. To achieve this, continued operating and infrastructure investments are critical to ensure the City's Roads assets remain financially sustainable now and into the future. This objective is supported by continuing to build service area infrastructure reserves. The 2024 reserve contribution for Roads reserves totalled $2.0M with the City being committed to ensuring the financial sustainability of its Roads assets.

The City's Asset Management Plans assess average reinvestment requirements over the next 20 years for the City's assets, including Roads infrastructure. Annual reserve contributions should generally be in line with the asset reinvestment requirement to ensure sufficient funds are set aside for asset rehabilitation and replacement needs.

For the Roads service area, the forecasted 20-year average funding need is $23.1M. In comparison, the average annual funding forecasted over the next 10 years is estimated to be $8.7M representing a funding coverage of 38% as illustrated in Error! Reference source not found.. The funding sources in this forecast are limited to annual reserve contributions, capital from taxation and the Canada Community-Building Fund (CCBF is provided from the Federal Government). Other available funding sources not included are debentures and non-CCBF grants, which would mitigate any infrastructure funding gaps.

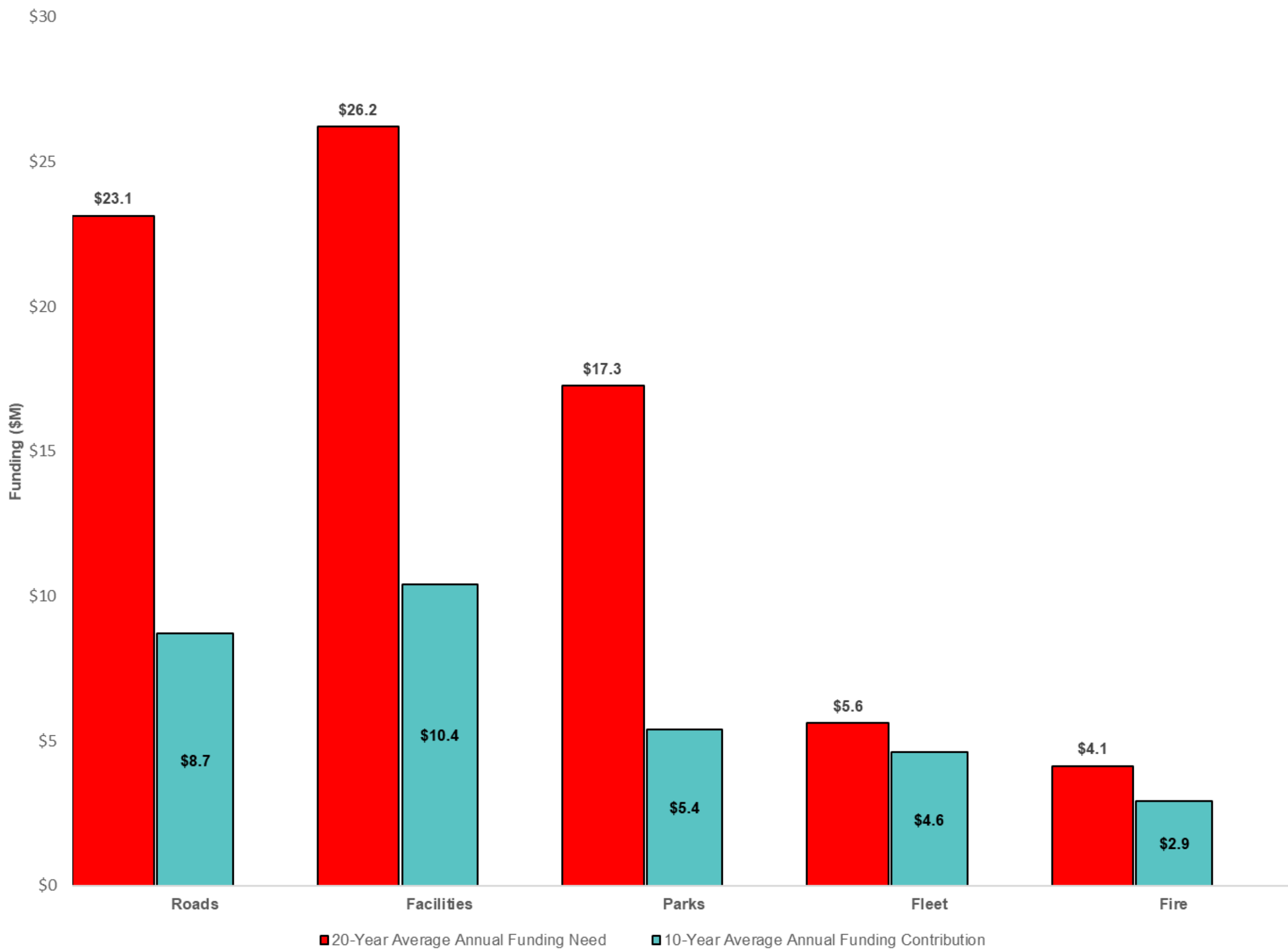


Figure 5-5: Coverage of Average Annual Funding Needs for Tax-Supported Service Areas

Revisiting the timing and scope of capital projects, optimizing the use of existing funding tools and revenue sources, such as debt and dedicated contributions to capital reserves, can help increase the City's capacity to begin to close an infrastructure funding gap.

5.4 Growth-related Assets Funding Need

The City completed the Vaughan Transportation Plan (VTP) study in 2023. The objective of the study was to develop a plan to meet the transportation infrastructure needs as the City's communities continue to grow. This study analyzed the city-wide infrastructure needs to identify the required infrastructure that will meet future servicing demands. The study assessed the existing and future servicing needs and provides servicing recommendations to meet the City's growth plans. Based on the model, the forecasted funding need estimates for the construction of new Roads assets out to 2033 is illustrated in Error! Reference source not found. with a primary funding source for these needs being Development Charges.

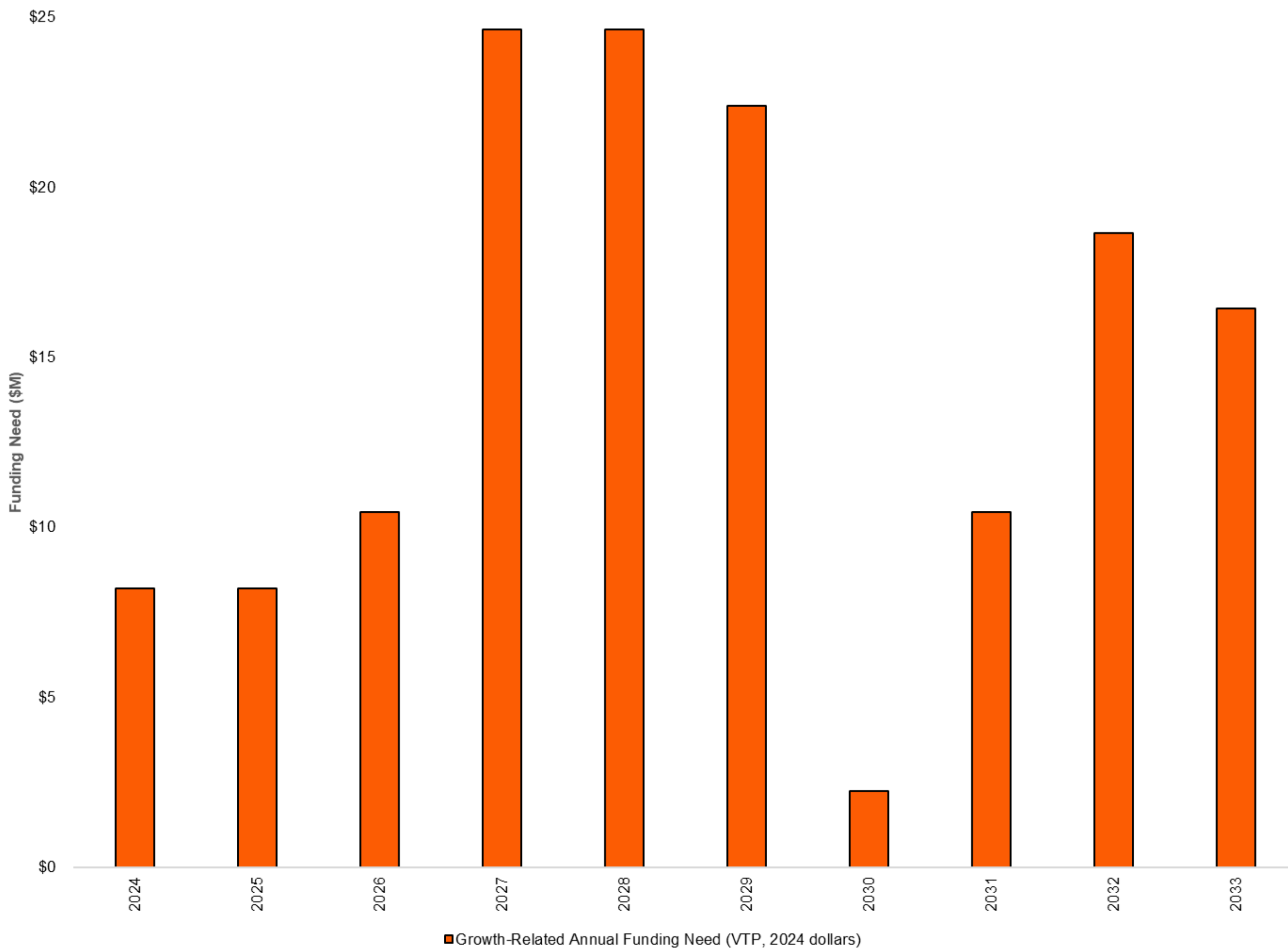


Figure 5-6: Forecasted Funding Needs for Construction of New Roads Assets

One of the next steps in the further development of the VTP is to apply added detail to the forecasted funding need estimates. This will provide a more refined forecast, which will serve to provide additional guidance for Asset Management planning in the future at the City of Vaughan.

Asset Management Plan

Core Assets
Bridges

City of Vaughan
March 2025

Table of Contents

Figures

Tables

1. Introduction

The City of Vaughan (The City) has conducted a renewal of the City's Asset Management (AM) Plans for all its infrastructure assets, including Bridges.

1.1 Background

The City is one of nine area municipalities located within the Regional Municipality of York. As a lower tier municipality, the City is responsible for providing services such as buildings, fire protection, public works, water distribution, wastewater collection, and parks and recreation.

The next 25 years will see the City transition from a growing suburban municipality to a fully urban space. This type of transition will require long-term thinking about how best to accommodate and make the most of new opportunities. Planning for the future through strategic planning will position the City to deal with the many pressing issues impacting the organization such as community safety, access to health facilities, environment, traffic congestion and issues related to growth and the quality of municipal services.

The City is one of Canada's fastest growing cities, with a population of over 320,000 according to the latest census from Statistics Canada. It is projected that the number of residents will increase to 415,000 by 2031. In addition to its rapidly growing population, the City is home to a well-diversified and expanding employment sector with over 7,800 businesses and 231,000 employees. The City has the largest supply of new employment lands in the Greater Toronto Area (GTA) and it is projected that the number of employees will increase to 271,000 by 2031.

1.2 Objectives

In 2018, by City Council approval, the Corporate Asset Management (AM) Policy for the City came into effect; and, in 2013, the City's first Corporate AM Strategy was published. As identified in the Corporate AM Strategy, the City's first set of AM Plans (AMPs) were developed in 2014.

In early 2021, the City updated its AM Strategy and core infrastructure AMPs, as per Ontario Regulation (O. Reg) 588/17. The purpose of this series of AMPs is to now update the infrastructure assets so as to provide the City with a comprehensive updated AM Plan.

The objective of this AMP is to deliver a financial and technical roadmap for the management of the City's roadway appurtenance assets, and to provide the means for the City to maximize value from its assets, at the lowest overall expense while, at the same time, providing enhanced service levels for its residents and promoting green initiatives.

Organizations that implement good AM practices will benefit from improved business and financial performance, effective investment decisions, and better risk management. Stakeholders can expect lower total asset life cycle costs, higher asset performance, and confidence in sustained future performance.

1.3 AM Provincial Requirements

The Ontario Regulation 588/17 (O. Reg. 588/17) came into effect in 2018 and stipulates specific AM requirements to be in place within Ontario municipalities by certain key dates (**Table 1-1**). The development of this AMP is one of the steps to guide the City towards meeting the July 1st, 2025 deadline.

Table 1-1: O. Reg. 588/17: AM Planning for Municipal Infrastructure

Description: A regulation made under the Infrastructure for Jobs and Prosperity Act, 2015, stating that every municipality shall prepare and update a Strategic AM Policy, and that every municipality shall prepare an AM Plan for its core infrastructure assets by July 1, 2022, and an AM Plan for all other infrastructure assets by July 1, 2024. The regulation outlines several requirements that each AM Plan must follow, such as including current and proposed level of service. Core municipal infrastructure assets include water, wastewater, stormwater, road, and bridge assets.	
Deadline Date	Regulatory Requirement
July 1st, 2019	All municipalities are required to prepare their first Strategic AM Policy.
July 1st, 2022	All municipalities are required to have an AM Plan for its entire core municipal infrastructure (i.e., water, sanitary, stormwater, and transportation).
July 1st, 2024	All municipalities are required to have an AM Plan for infrastructure assets not included under their core assets.
July 1st, 2025	All AM Plans must include information about the levels of service that the municipality proposes to provide, the activities required to meet those level of service, and a strategy to fund activities.

1.4 Scope

This AMP has been developed for the bridges owned and maintained by the City, as shown in **Table 1-2**. The renewal of the City's AM Plans is consistent with the guidelines laid out in the City's Corporate AM Policy and Section 5 of O. Reg. 588 / 17.

Table 1-2: In-Scope Assets

Asset Category	Sub-Assets
Bridges	Vehicular Bridges (i.e. carrying roads or train tracks)

The following elements are included within the scope of this AMP:

- A summary of the asset inventory, including the replacement cost of the assets, the average age of the assets, the condition of the assets, and the City's approach to assessing the condition of the assets.
- Current levels of service (LoS) based on performance measures.
- Asset lifecycle management strategies to maintain identified current LoS, minimize associated asset risks, and to optimize costs over the whole lifecycle of the asset.

1.5 Approach for Asset Management Plan

The approach used in the renewal of this AM Plan is presented in **Figure 1-1**, and has been selected to ensure that the City can have the confidence to make fact-based and defensible business decisions from reliable and robust information.

Figure 1-1: AM Plan Approach

2. State of Infrastructure

Defining the state of the infrastructure involves quantifying the assets owned, examining their age, replacement value, and condition. The City's approach to each of these asset characteristics is summarized below.

2.1 Expected Service Life and Remaining Service Life

The expected service life (ESL) is defined as the period over which an asset is available for use and able to provide the required level of service at an acceptable risk (i.e., without unforeseen costs of disruption for maintenance and repair). The ESL for this assignment will be based on discussions with City staff, information from previous studies, and any additional information that might inform the ESL. In terms of determining the Remaining Service Life (RSL), the City used the installation date together with the ESL.

In reality, different assets will deteriorate at different rates and not necessarily linearly over time, however, it is important to keep in mind the level of effort required to predict failure compared with the asset value. More sophisticated deterioration modelling may be warranted for very high value assets, whilst the cost of deterioration modeling for low-value assets may very well exceed the replacement cost of the asset. The actual service life can vary significantly from the ESL. In some instances, a variation in expected vs. actual service life is evident due to the following factors:

- **Operating conditions and demands:** Some equipment is operated intermittently or even infrequently, or is being operated a lower demand than its design capacity, thus the actual operating "age" of the asset is reduced.
- **Environment:** Some equipment is exposed to very aggressive environmental conditions (e.g., corrosive chemicals), while other assets are in relatively benign conditions, thus the deterioration of assets is affected differently.
- **Maintenance:** Equipment is maintained through refurbishment or replacement of components, which prolongs the service life of the asset.
- **Technological Obsolescence:** Some assets can theoretically be maintained indefinitely, although considerations such as maintenance cost, energy inefficiency and new technologies are likely to render this approach uneconomical.

2.2 Current Asset Replacement Value

The estimated replacement value is the cost of replacing an existing asset in 2024 dollars. These costs are collected from the City's GIS record. Where applicable, a CPI-based inflation rate was used to estimate the 2024 values.

2.2.1 Asset Inventory and Replacement Value

The City's Bridges are managed and maintained to meet provincially issued system and facility operating permits, as well as the City's technical targets for performance and reliability.

Bridge replacement costs are estimated by specialized bridge engineers, hired by the City to conduct on-site biennial condition assessments, as required by provincial regulations.

The City has a total of 79 bridges, currently valued at approximately $184 Million. Bridge assets are divided into Vehicular Bridges and Pedestrian Bridges.

Table 2-1: Asset Inventory & Valuation

Asset Category	Asset Type	No.	Unit of Measure	Unit Replacement Cost	Replacement Value
Bridges	Vehicular Bridges	26	Each	$452,000 - $19,206,000	$163,100,000
	Pedestrian Bridges	53	Each	$40,000 - $2,210,000	$20,865,000
	Sub-Total	**79**	Each	**$171,000 - $19,172,000**	**$183,965,000**

2.3 Asset Condition

All assets are expected to deteriorate over their lifetime, and their assigned condition reflects the physical state of the asset. On-site condition assessments were carried out for this project, combined with any existing condition data, and information from past studies.

2.3.1 Age-Based Condition Assessment

Two-parameter Weibull distribution function was used to assess the current condition and to project the future condition of the City's Bridges. The Weibull distribution has been used extensively in reliability studies and lifetime prediction models in industries ranging from the automotive to the oil and gas industries; it provides a suitable distribution for this type of analysis.

The Weibull probability distribution provides a left-skewed distribution that rises slowly and diminishes quickly as the population is consumed. The underlying premise of the Weibull-shaped deterioration is that while some assets fail prematurely due to severe conditions or improper installation, other assets are very long-lived and function well beyond their theoretical expected service life. In order to perform a high order network-level analysis, it was assumed that assets would fail (and require replacement) within a deterioration envelope / curve approximated by a Weibull probability distribution. The two-parameter Weibull cumulative distribution has two parameters for scale and shape, as set out in Equation [1]:

$$f(x;\alpha,\beta) = e^{-\left(\frac{x}{\beta}\right)^{\alpha}} \qquad [1]$$

Where: x = Age
α = Shape parameter
β = Scale parameter (or slope)

Table 2-2 presents the condition score ranges and the corresponding range of ESL and total life consumed.

Table 2-2: Age-Based Physical Condition Scale

Condition Score (minimum)	Condition Score (maximum)	Condition Rating	Range % of ESL Consumed	Range of % Operational Life Consumed
1.0	1.5	Very Good	0% – 71%	0% – 47%
1.5	2.2	Good	72% – 84%	48% – 56%
2.2	2.8	Fair	85% – 92%	57% – 60%
2.8	5.0	Poor	93% – 100%	61% – 100%

2.3.2 Age Summary

Figure 2-1 shows the average asset age as a proportion of the average expected service life for bridges. The average assumed Expected Service Life (ESL) for the main types of bridges are shown in **Table 2-3**.

Table 2-3: Average ESL for the Main Bridge Types

Structure Type	Expected Service Life
Vehicular Bridge	100 years
Pedestrian Bridge	40 years

Similar to roads, bridges require periodic maintenance and rehabilitation in order to achieve their expected service life. Vehicular bridges typically undergo two to three rehabilitations over their lifetime for the bridge to last the full term of its expected service life. Major rehabilitations may even prolong their expected service life. Pedestrian bridges may undergo rehabilitation, depending on the nature of their deterioration. In most cases, a pedestrian bridge is replaced with another prefabricated bridge, placed on the existing foundations.

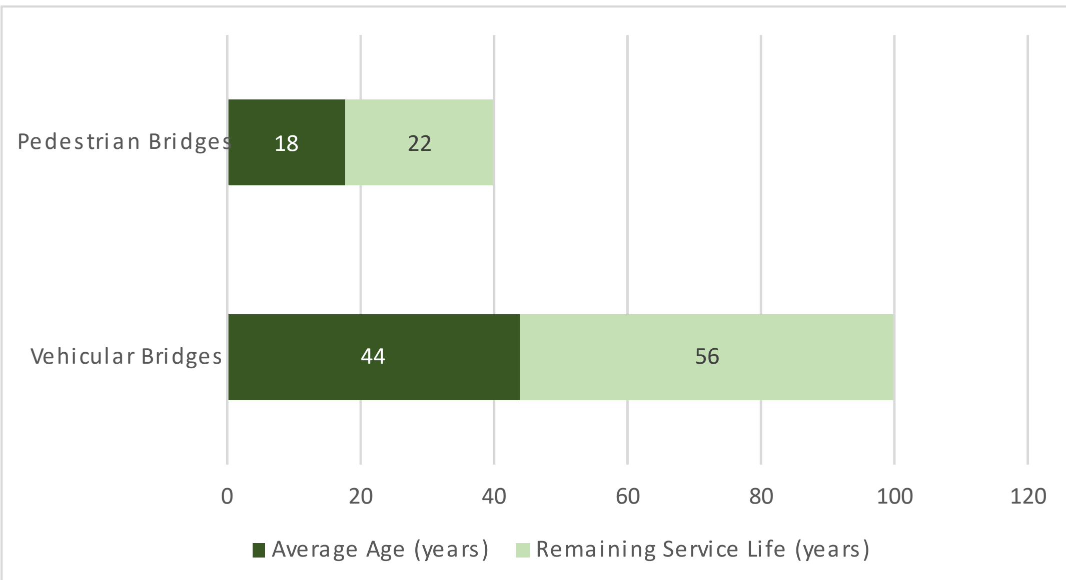


Figure 2-1: Average Asset Age as a Proportion of Average Expected Service Life

As shown in **Figure 2-1**, the average age of the City's vehicular bridges and pedestrian bridges are 44 years and 18 years, respectively. The average age of both bridge types is slightly less than halfway through their lifespan. This means that there might be many bridges that are due for major rehabilitation in the next few years, particularly pedestrian bridges, due to their shorter lifespan. Major rehabilitations bring the existing structure up to the current design code requirements, and with good planning, can extend the expected service life of a structure beyond the average expected service life.

2.3.3 Condition Summaries

The City-owned bridges are managed in accordance with Provincial bridge legislation and guidelines. Assets are managed based on biennial field inspections by structural engineers to identify structural issues and concerns following the Ontario Structure Inspection Manual (OSIM). Inspection results are documented, and prioritized capital needs are identified in consultant reports. To have a consistent condition rating system across the City's service areas, the bridge conditions are divided into four classes by Bridge Condition Index (BCI) ranges: Very Good (80-100), Good (60-80), Fair (35-60), and Poor (0-35) (also refer to **Figure 2-2** and **Figure 2-3**). The BCI scoring tool is an industry standard method of assessing and rating each individual component of a bridge or culvert structure and compiling the data to obtain an amalgamated score which helps determine its overall condition and value. Whether a specific structure actually requires repair or replacement and when is determined by the opinion of the structural engineers. For the purpose of the asset management plan, the BCI rating is the most appropriate tool to gauge the overall condition of the City's bridges.

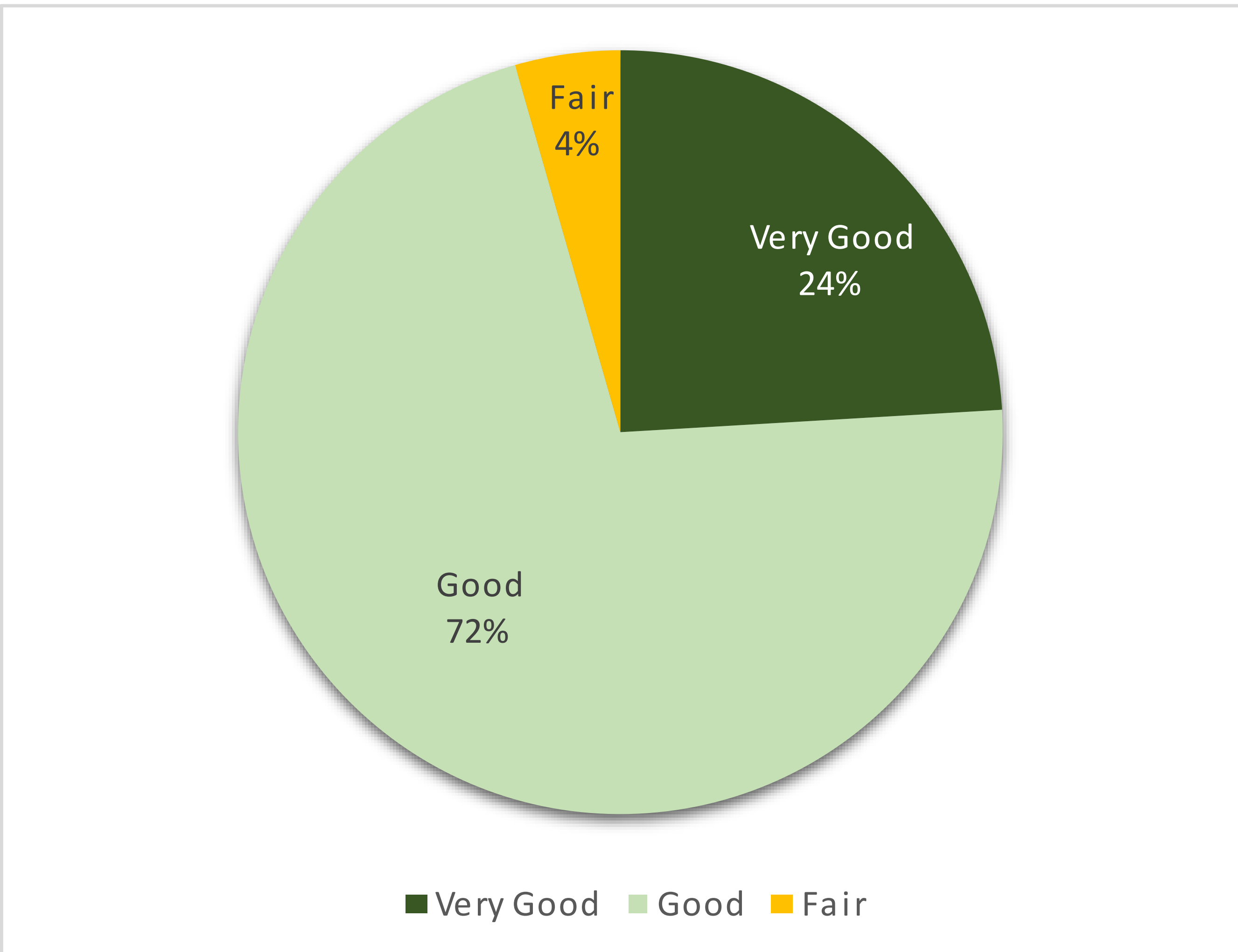


Figure 2-2: Asset Condition Summary

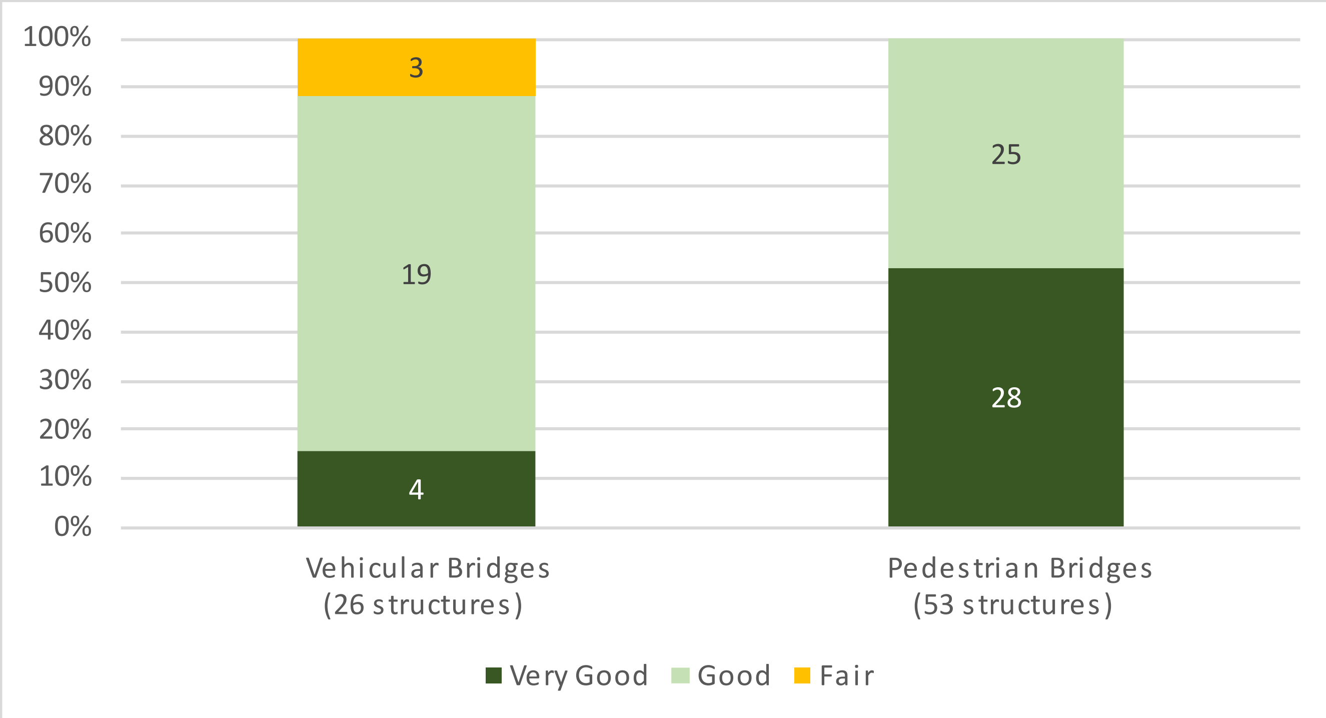


Figure 2-3: Distribution of Bridge Asset Condition

The detailed condition information for bridges are available in the “2024 Biennial Bridge & Large Culvert Inspections – City of Vaughan” report conducted by Keystone Bridge Management Corp. Both vehicular and pedestrian bridges are nearly all in Good or Very Good condition. It is observed that 3 vehicular bridges and 5 pedestrian bridges have exceeded their average expected service life specified in **Figure 2-1**.

3. Levels of Service

3.1 Purpose

LoS supports every aspect of the overall AM System as shown in **Figure 3-1**. The objective of establishing clearly defined service levels is to help the City meet stakeholder values, achieve its strategic goals, make informed risk-based decisions, and implement effective asset lifecycle activities.

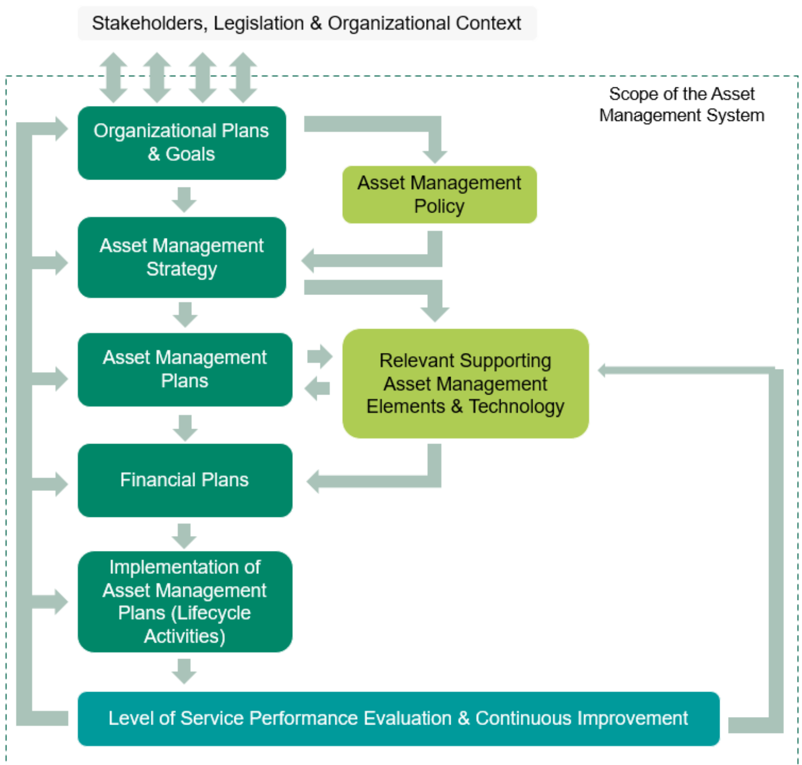


Figure 3-1: LoS within the AM System

In the City's experience, documenting LoS is a proven practice that will enable the City to:

- Link corporate strategic objectives to customer expectations and technical operations.
- Balance customer needs and expectations while evaluating the effectiveness of operations and whether the right LoS is being provided at the right cost.
- Transition from an "Asset Stewardship" approach that focuses on making decisions based on maintaining assets in an acceptable condition to a "Serviceability" approach that is geared towards making decisions based on balancing the costs, risks, and goals for the LoS being provided by the City's assets.
- Communicate the physical nature of infrastructure that the City owns and is financially responsible for while promoting the use of LoS to enable effective consultation with stakeholders regarding alternative funding options according to desired LoS outcomes.
- Make recommendations on strategies that the City can take now to minimize future renewal costs while ensuring that adequate LoS can be delivered without burdening future generations.
- Assess internal (e.g., program changes) and external (e.g., climate change) factors that have the potential to impact the City's ability to deliver services and how these factors may impact the LoS being provided.
- Implement a corporate continuous improvement program to further optimize AM across all service areas.

The O. Reg. 588/17 requires that all AMPs include information about the LoS that the City proposes to provide, the activities required to meet those service levels, and a strategy to fund those activities. The deadline for formalizing these LoS requirements is July 1, 2025 (see **Section 1.3**).

Successful AM programs aim to achieve targeted service levels through customer-based decision making. To achieve this, the City considered a customer-centric approach, where the customer is at the heart of every decision from development to implementation, consultation, and roll-out of the LoS Framework (**Figure 3-2**).

There are two types of LoS measures: Customer LoS (also called "Community" LoS) and Technical LoS. Customer LoS are recorded in a manner that attempts to describe the LoS in terms of what is actually being provided to the customer (i.e., the public) and how the customers experience the service. It is important to note that customers are not concerned with the specific operating requirements of the assets that provide the service, but rather the value they obtain from the operation of the assets. To achieve Customer LoS there needs to be line of sight between the value delivered and how that value is realized. This is the purpose of Technical LoS which attempts to describe how the City will provide and meet the expected Customer LoS.

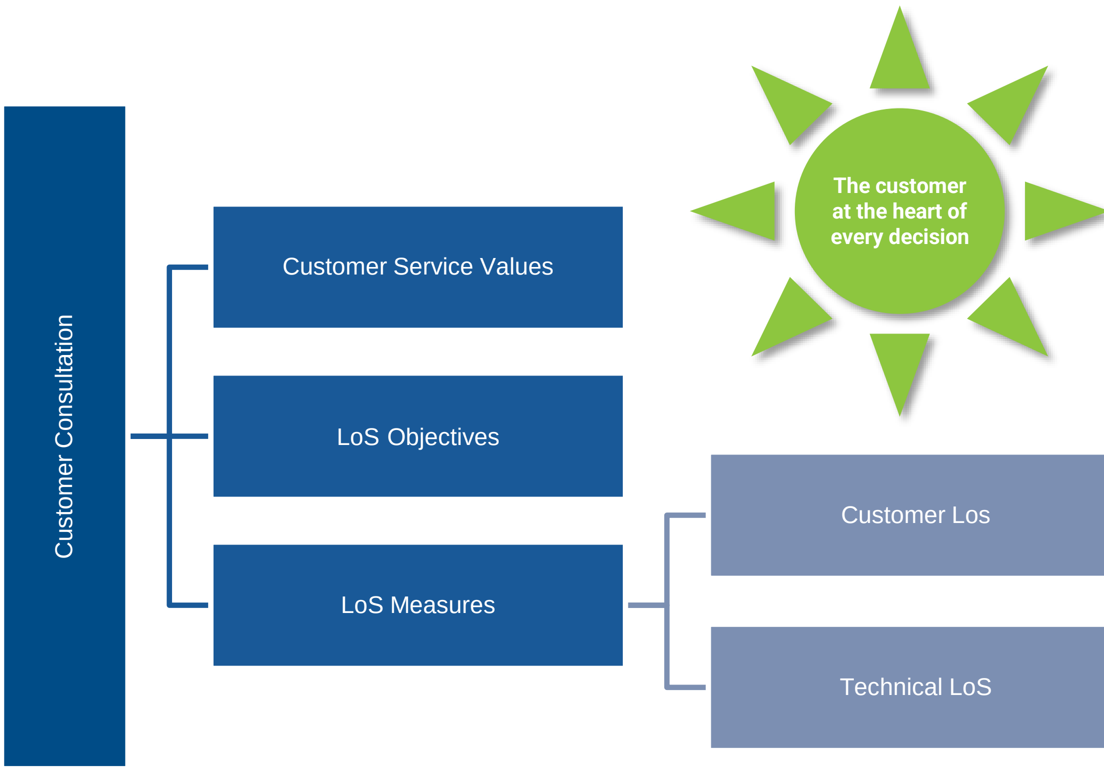


Figure 3-2: The LoS Framework Customer-Centric Approach

The LoS Framework was primarily conceived through a collaborative workshop process. In 2020, four workshops with City staff were conducted across each of the fourteen service areas.

The following outcomes were achieved during each service area workshop:

- Staff were oriented as to the purpose and importance of establishing a consistent LoS Framework;
- Stakeholders were identified, including their expectations, interests, and any regulatory requirements;
- Customer service values were established and reviewed;
- LoS objectives were established for each customer service value;
- Staff provided several performance measures that are currently being tracked as well as those that the City would like to track in the future;
- Where information was available, current performance, targets, and data sources were documented; and
- Growth and shifts in future demand were discussed across the City's service areas.

3.2 Objectives

Defining LoS objectives is important for drawing a line of sight between the City's corporate objectives and the tangible asset performance outcomes. To do so, the LoS objectives must take into consideration stakeholder interests to develop asset performance measures that aim to meet the needs and expectations of the community. By doing this, the City will ensure that their assets are striving towards optimal performance, not only operationally, but economically, socially, and sustainably as well.

Every stakeholder has certain interests in the service being provided and in general, these interests can be categorized into six universal stakeholder values, as shown in **Table 3-1**. Each universal stakeholder value is also assigned a corporate LoS objective.

Table 3-1: The City's Values and LoS Objectives

Customer Value	LoS Objective
Quality and Reliability	The service is delivered with a high standard of excellence and the service is available when needed.
Affordability	The cost of the service is delivered in a financially sustainable manner and does not burden customers.
Environmental Sustainability	The service is delivered in a manner that does not compromise the ability of future generations to meet their needs.
Access and Capacity	Customers can easily access the service with minimal inconvenience.
Health and Safety	The service is delivered with minimal health and safety impacts.
Responsiveness	Customer service requests are responded to efficiently and in a timely manner.

3.3 Stakeholders and Their Interests

A stakeholder is any person or organization that can affect, be affected by, or perceive themselves to be affected by a decision or an activity. Stakeholder analysis is the process of understanding stakeholder needs, expectations, and perceptions relative to the stakeholder's level-of-interest and level-of-influence over the organization. An organization typically engages with their stakeholders to:

- Establish which activities or services matter most to them.
- Understand their risk appetite and risk threshold.
- Understand their willingness to pay for services.

Stakeholders can take many forms and may be internal (i.e., staff, Council) or external (i.e., the public, regulatory agencies, suppliers, neighbouring municipalities, etc.) to the organization. Historically, only service recipients who pay for City services would be considered customers; however, today customers can take many forms and should include any entity that has a legitimate interest in the service being provided. In addition to service recipients (i.e., the public), this may include:

- **Regulatory Agencies** – Stakeholders that set standards, compliance regulations or other legislation that govern service delivery.
- **Special Interest Groups** – Stakeholders that are affected by or have an interest in the City's roadway services.

3.4 Level of Service (LoS) Performance Measures

A documented suite of LoS performance measures enables a common understanding of the service delivery that the City's customers currently receive, and the associated cost of maintaining infrastructure assets to provide the service. Having these performance measures set at the appropriate levels within the City ensures alignment from the corporate vision, to asset investment decisions, and to day-to-day operational activities. When establishing LoS performance measures it is important to keep in mind the "SMART" acronym, as follows:

- **S**pecific, easily evaluated and understood.
- **M**easurable, quantifiable, and easily collectable to ensure ongoing data availability.
- **A**ttainable, so that they work to motivate as opposed to discourage.
- **R**elevant, in that they relate and align with a specific goal.
- **T**ime-Bound, measured over a specific period, which is typically annually for benchmarking.

There are two types of LoS performance measures: Community LoS and Technical LoS. Community LoS are recorded in a manner that attempts to describe the LoS in terms of what is being provided to the community (i.e., the public) and how the customer experiences the service. Community LoS are qualitative, non-technical, and are driven by the municipality's strategic AM objectives. Community LoS are not concerned with the specific operating requirements of the assets that provide the service, but rather the value they obtain from the operation of the assets. To achieve Community LoS, there needs to be line of sight between the value delivered and how that value is realized. This is the purpose of Technical LoS which attempts to describe, quantitively, how the City will provide and meet the expected Community LoS.

3.5 LoS Performance Results

Ontario O. Reg. 588 / 17 requires legislated community levels of service for core assets. Community levels of service use qualitative descriptions to describe the scope or quality of service delivered by an asset category. O. Reg. 588 / 17 also requires legislated technical levels of service for core assets. Technical levels of service use metrics to measure the scope or quality of service being delivered by an asset category. Error! Reference source not found. lists the performance measures that are included in the O. Reg 588/17 requirements for road assets. References are provided to indicate where O. Reg 588/17 requirements have been attained.

A summary of the City's current and proposed community and technical service levels for Bridges are documented in Error! Reference source not found..

Table 3-2: Community and Technical Service Levels

Level of Service	Current Performance	Current Service Level Target	Proposed Service Level Target
Average Class Pavement Condition Index (PCI) out of 100 for Vehicular Bridges.	72.5	>=60	No Change
Average Class Pavement Condition Index (PCI) out of 100 for Pedestrian Bridges.	81.0	>=60	No Change
Percentage of Vehicular Bridges with loading restrictions.	3.8%	3.8%	No Change
Description or images of the condition of bridges and how this would affect use of the bridges.	See **Figure 3-4**		No Change

Figure 3-3 shows a map that outlines the location of the City's bridges.

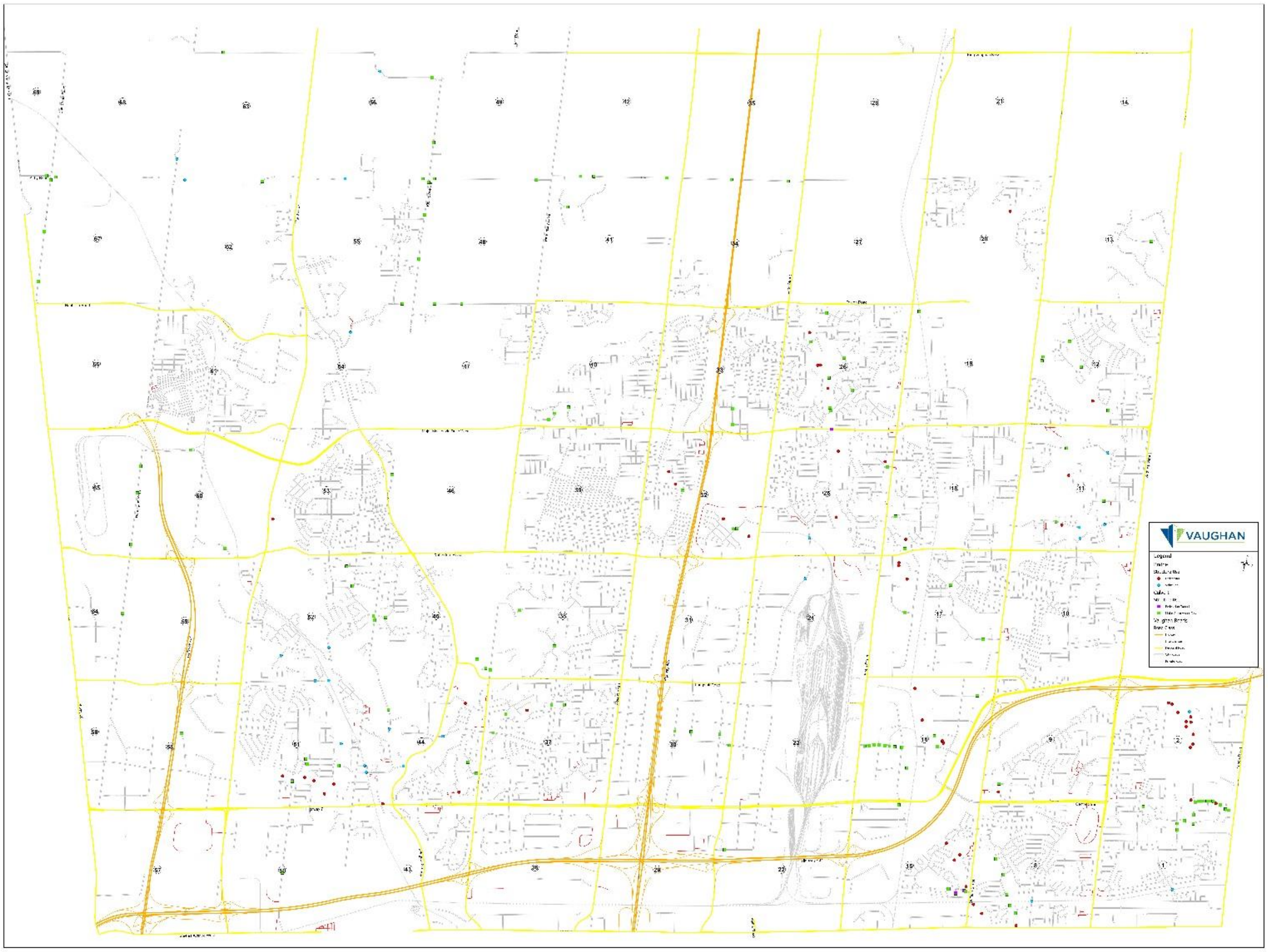


Figure 3-3: Map of Bridge Locations

Figure 3-4: Images of Bridge Inspections Compared to Asset Management Condition Rating

3.6 LoS Performance Targets

Establishing LoS targets is an important part of continual improvement and performance management. Without targets, it is difficult to ascertain whether goals are being met, or the extent of the gap if they are not. Incorporating targets into the City's LoS Framework helps to ensure that targets are reasonable, aligned with customer expectations, and evaluated on an objective basis by considering cost-benefit trade-offs.

One of the key challenges in setting targets in a municipal environment is that they can often become biased and/or politically motivated. Therefore, it is important to review LoS targets with stakeholders. An important aspect of evaluating LoS targets is determining how willing the user is to pay for the service. Regulatory requirements are an exception; however, they only provide the minimum service standard. Cost is still an important parameter to consider when assessing the merits of service improvements.

To deal with the financial realities, it is necessary to:

- Calculate how much the service costs based on current LoS.
- Determine the cost associated with varying the LoS.
- Assess the customers' willingness to pay.

4. Asset Lifecycle Strategies

Asset lifecycle management focuses on the specific activities we must undertake during all phases of the asset lifecycle. By considering entire asset lifecycles the City can ensure sound decision making that consider present and future service delivery needs.

The overarching goal of life cycle management is to maximize the long-term benefits and services that our assets deliver while minimizing the associated costs and risks in the long run. Every asset has a life cycle cost, which is the total cost of all the activities undertaken throughout its service life. The following sections describe activities across the life cycle of assets.

4.1 Lifecycle Activities

Any responsible owner of assets such as the City has a desire to preserve the condition of their existing assets for as long as possible, by maintaining or even extending their design lives through routine activities such as maintenance and active intervention. The City is continually acquiring infrastructure assets, but these assets require increased funding for operation and maintenance as they age. The City is also responsible for the replacement of deteriorated assets as long as the service is required. While individual assets may have a useful life that can be predicted in years or decades, the service that the asset provides could be for a substantially longer duration (perhaps in perpetuity). Part of the purpose of the AM planning process is to fully understand and predict the long-range financial requirements for the City's infrastructure to facilitate planning and resource management in the most cost-effective manner possible. **Figure 4-1** illustrates how costs typically accumulate over an asset's life. It is worth noting that the accumulation of the ongoing operations and maintenance, refurbishment and disposal / replacement costs is many multiples of the initial acquisition costs. A key and important take-away from **Figure 4-1** is therefore for the City to fully understand the entire life cycle costs before proceeding with asset acquisition.

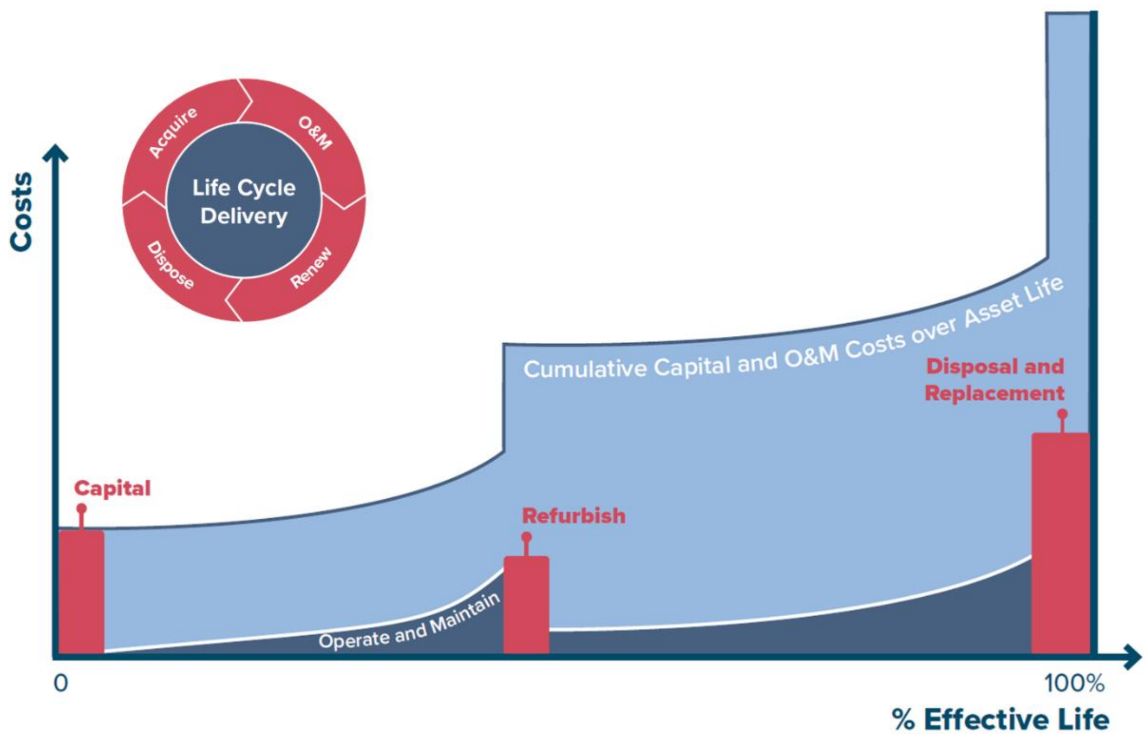
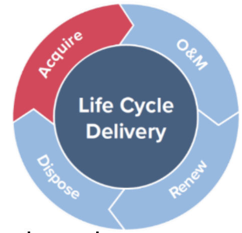


Figure 4-1: Life Cycle Cost Accumulation Over Asset Life

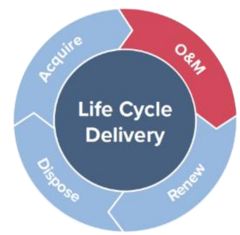
Expressed simply, full lifecycle cost of infrastructure can be accumulated under the following broad headings:

- **Asset Acquisition / Procurement / Construction**: The City has made significant investments in the design and acquisition of its municipal infrastructure assets. Added to City-purchased inventory is infrastructure that the City accepts (and takes immediate financial responsibility for) from developers as new neighborhoods are constructed. For example, as developers build new neighborhoods, the new local infrastructure (including local roads, water mains, sewer mains and storm mains) is paid for by the developer and then transferred to the City for operation, maintenance and ultimately replacement. The City's infrastructure inventory was therefore created over many decades through infrastructure paid for by the City or by developers Looking towards the future, when acquiring new assets, the City should evaluate credible alternative design solutions that consider how the asset is to be managed at each of its life cycle stages. Asset management and full life cycle considerations for the acquisition of new assets include, but are not limited to the following:

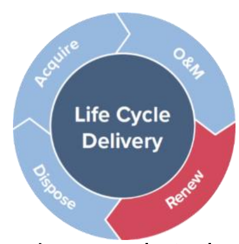


  – The asset's operability and maintainability;
  – Availability and management of spares;
  – Staff skill and availability to manage the asset;
  – The manner of the asset's eventual disposal.

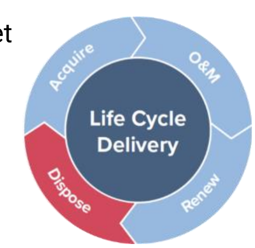
- **Asset Operations and Maintenance (O&M)**: As new infrastructure is commissioned, the City accepts the responsibility of operating and maintaining the infrastructure according to O&M standards to ensure that the infrastructure is safe and reliable. Operations staff provide the day-to-day support required to operate infrastructure. In few cases, operation costs are minor, but for most there are significant increases. For example, underground pipes require almost no operational support while a facility such as a pump station requires full-time staff to operate the facility safely and efficiently. Maintenance expenses include periodic preventive maintenance to ensure that the infrastructure can provide reliable service throughout the life of the asset and corrective maintenance that is required to repair defective assets as and when needed. Inadequate funding for O&M will have an adverse impact on the lifespan of assets. The amount of O&M resources required in any period is a function of the current inventory of infrastructure and total O&M needs required for each asset. As the inventory of infrastructure grows, total O&M requirements will also grow.



- **Renewal and Replacement:** The third portion of full life cycle costing relates to the renewal and replacement of infrastructure that has deteriorated to the point where it no longer provides the required service. Renewal cost is sometimes incurred during the life of an asset where an investment is made to improve the condition and / or functionality of the asset e.g., re-lining of a pipe or resurfacing of a road. Disposal and replacement costs are incurred at the end of an asset's life when it is disposed of and replaced by a fully new asset. Canadian municipalities, including City of Vaughan, have not traditionally factored renewal or replacement costs into future budget projections, except for assets that have a relatively short life such as computer equipment and vehicles. The main reason behind this is the fact that large portions of this infrastructure inventory can have a very long life e.g., from 75 to 100 years for underground pipes. For growing communities like the City, there has not been a historical need to forecast expenses that are not anticipated for decades. However, based on the experiences of more established Canadian cities (where vast inventories of old assets are now in dire need of renewal or replacement), it is vital that communities fully understand the looming obligations of infrastructure renewal or replacement and develop a strategy to respond in a manner that is fair and affordable.



- **Decommissioning and Disposal:** There will inevitably come a point in time when an asset must be removed from service and, depending on the type of asset, there may be significant costs associated with its decommissioning and disposal. Factors that may influence the decision to remove an asset from service include: changes to legislation that cause the asset to be in non-compliance, the inability of the asset to cope with increased service levels, technology advances that render the asset obsolete, the cost of retaining the asset is greater than the benefit gained, or the current risk associated with the asset's failure is not tolerable. Normally, major costs that may be incurred during disposal and decommissioning derive from the environmental impact of the disposal and, if required, the rehabilitation and decontamination of land. In some cases, there will be residual liabilities and risks to consider if a decision is made to partially abandon the asset as opposed to fully disposing of its components



(e.g., leaving a non-functioning pipe in the ground, or an inactive building standing). However, some cost savings may be achieved through the residual value of the asset or by exploring alternative uses for the asset. In all cases, it is important to consider disposal and decommissioning as the strategy employed has the potential to attract significant stakeholder attention. For that reason, the costs and risks associated with disposal and decommissioning should be equally considered in the City's capital investment decision-making process.

The infrastructure AMPs present the City's strategy for responding to the full lifecycle costs of all its infrastructure assets. Long-range estimates were prepared together with the AMPs, based on industry best practices to ensure the financial sustainability of the City's infrastructure assets over their full life cycle, as discussed in the next Chapters.

4.2 Acquisition / Procurement / Construction Strategies

When the City acquires new transportation core assets, they are typically transferred from developers, in a process called assumption. In some cases, the City can also purchase privately owned roads and assume control and responsibility for them. In rare cases, the City may download roads from York Region, or upload roads to the Region.

The City accepts roads from developers (and takes immediate financial responsibility for) as new neighborhoods are constructed. For example, as developers build new neighborhoods, the new local infrastructure (including roads, bridges, sewers, watermains, etc.) are paid for by the developer and then transferred to the City for operations, maintenance and eventual replacement. The City's transportation infrastructure inventory was therefore created over many decades through infrastructure paid for by the City or by developers.

For roads that are downloaded from the Region, the roads are normally in a state of good repair before the transfer. There is a development cost (DC) budgeted for the roads downloaded but the City will need to assume the life cycle costs for the downloaded roads.

A situation could also occur where the City uploads roads to the Region, and the Region takes responsibility for them. The upload and download activity are determined by transportation planning. There are criteria established between the Region and the City e.g., what type of road should be classified as a regional road or local road? As traffic patterns change, or roads are realigned, a regional road could become a local road, and vise versa. Generally, there is a candidate list for road upload and download based on discussions between the City and the Region, and DCs can be shifted based on whether a road is uploaded or downloaded.

With regards to the transportation asset assumption process, Development Engineering is involved in the subdivision plans and approving plans from developers. Inspectors from Development Engineering perform inspections to make sure transportation assets are up to standard for transportation operations. The entire road GIS database at the City was transferred from the Region, and the City will make changes when there is a technical memorandum provided by Development Engineering specifying changes.

4.3 Operations and Maintenance Strategies

The operations and maintenance requirements for bridges are either negligible in value or considered part of the asset network they are associated with. For example, snow clearing or guiderail replacement on road bridges are considered road O&M expenses. Therefore, for the purpose of this asset management report, operations and maintenance strategies specific to roads and bridges are included in the asset management plans related to them, such as roads, active transportation or stormwater.

4.4 Renewal and Replacement Strategies

Bridge treatments include minor rehabilitation, major rehabilitation, and replacement activities. The bridge treatment options include pre-emptive treatment for deck component on structure, pre-emptive treatment for substructure component on structure, pre-emptive treatment for superstructure component on structure, minor rehab treatment for deck component on structure, minor rehab treatment for substructure component on structure, minor rehab treatment for superstructure component on structure, major rehab treatment for deck component on structure, major rehab treatment for substructure component on structure, major rehab treatment for superstructure component on structure, replacement treatment for deck component on structure, replacement treatment for substructure component on structure, replacement treatment for superstructure component on structure, pre-emptive structure treatment, complete replacement structure treatment, partial replacement structure treatment, rehab structure treatment, and deck replacement structure treatment. Please refer to the Keystone bridge inspection report for more details on the OSIM renewal and replacement analysis.

4.5 Decommissioning and Disposal Activities Strategies

Asset decommissioning and disposal activities are performed to decommission and dispose of assets due to ageing or changes in performance and capacity requirements. This decision process includes the consideration of costs and benefits of rationalization using a whole life approach, the impact of asset rationalisation on other infrastructure and the processes for disposal of assets.

More specifically, the following factors need to be evaluated when considering the decommission and disposal of assets:

- Assets not required for the delivery of services, either currently, or over the longer planning period.
- Assets that have become uneconomical to maintain or operate. (e.g., roads with excessively high maintenance costs.)
- Assets that are not suitable for service delivery.
- Assets that have a negative impact on service delivery, the environment, or community. (e.g., roads which have persistent erosion problems, often located in areas of extremely erodible soils.)
- Assets that no longer support the City’s service objectives due to a change in type of service being delivered or the delivery method.
- Assets which can no longer be used for the purpose originally intended. (e.g., roads and bridges constructed for temporary access such as designated temporary roads).

Considerations for the City’s asset decommissioning and disposal activities include, but are not limited to:

- Updates to the City’s Statement of Tangible Capital Assets. Considerations related to the determination of residual value and the disposal of assets include:
    - Residual value and the useful life of an asset should be reviewed, at the very least, at each financial year-end and, if expectations differ from previous estimates, any change should be accounted for prospectively as a change in estimate.
    - Residual value or salvage value for pavement can be significant because it involves the remaining value of significant expenditures not fully consumed at the end of the analysis period. The residual value of a pavement material depends on several factors: location, volume, recycling / re-use policies, age, anticipated use the end of the design life, etc. The last preservation or rehabilitation treatment in the analysis is often used to estimate the end of life residual value.
    - The depreciation method used should reflect the pattern in which the asset's economic benefits are consumed.
    - The depreciation method should be reviewed, at the very least, annually and, if the pattern of consumption of benefits has changed, the depreciation method should be changed prospectively as a change in estimate.
- Updates to asset databases such as the GIS and CMMS.
- Environmental impact of disposal and implications for land rehabilitation, where applicable.
- Continued service delivery while a new road asset is being constructed / commissioned.
- Cost of decommissioning and disposal.

4.6 Capital Planning

Capital investment is to address community growth or changes, or to renew existing assets to maintain service levels. For the actual funding needs assessment, please refer to **Section 5**

- **Life Cycle Cost Analysis Approach**. The City’s analysis enables optimized decision making and mathematical deterioration modelling of infrastructure assets and the development of short, medium and long-term forecasts of renewal and replacement costs of a number of decision criteria and the ability to compare different intervention options to find the optimal solution in terms of timing and the intervention option chosen.

- **Forecast Periods.** The City aims to develop Short- to Medium-Term and Long-Term capital plans. Typically, short to medium-term capital plan identifies the activities required to meet current and future demand, the cost of those activities and a financing approach. It is developed or renewed every three to five years and should coincide with regulations on short to medium-term expenditure planning. A long-term plan can serve as part of Strategic Asset Management Plan, which indicates what will be spent, by service areas, over a set period of time. Long-term plans tend to focus only on costs.

  Consistent with the approach of other asset management plans, the analysis periods for funding need assessments are 20 years.

4.7 Asset Prioritization

4.7.1 Risk Assessment

Infrastructure-related risk exposure is assessed based on the combined consideration of probability and consequences of an asset failure, which is used to drive the selection and prioritization of appropriate action, based on risk tolerance thresholds and funding availability. Understanding the risk exposure for a given set of assets allows the City to identify where they are most exposed to risk, and to target their investments to most effectively reduce that exposure.

In addressing risk for infrastructure assets, the first step in the analysis is to identify assets that are most critical to the business. Critical assets are those that will potentially have the greatest impact on service delivery should they fail. It should be noted that the parameters, criteria and weighting factors area starting point, and should be reviewed and modified to reflect the priorities of the City on an ongoing basis.

The fundamental principle of consequence (or criticality) models is that they evaluate the relative importance of assets based on select criteria. The approach to risk analysis within this project utilizes a triple-bottom-line assessment approach utilizing the following four criticality indices:

- **Economic** – influence of the asset's failure on monetary resources
- **Operational** – influence of the asset's failure on operational ability
- **Social** – influence of the asset's failure on society
- **Environmental** – influence of the asset's failure on the environment

By applying specific indices, the risk assessment framework generates a risk (or priority) score for each asset. The risk score is a rating of the asset based on the detailed assessment of the likelihood and consequence of failure based on a number of key parameters. All parameters are then equated using equation [4].

$$Risk = Likelihood\ of\ Failure \times Consequence\ of\ Failure \qquad [4]$$

Based on this principal, the risk associated with a given asset's failure can be managed by limiting the likelihood of this occurring, or the impact realized, should it occur.

Consequences of Failure (CoF) reflect the relative "impact" of a given asset's failure. While traditionally these have been looked at as purely economic terms (i.e. repair cost, loss of revenue, etc.), the truth is that investment decisions are often driven by non-economic factors. Understanding both the economic and non-economic impacts associated with loss or limitation of service help in categorizing an asset's "criticality" and justifying infrastructure decisions in a consistent, defensible manner.

Risk score can be calculated for each bridge by using its Probability of Failure (PoF) and Consequence of Failure (CoF) score. For the City's bridges, PoF can be estimated using the City's four-point BCI rating system (Very Good, Good, Fair, and Poor) by assigning a score of 1 (Very Good) to 4 (Poor) for each road segment. The CoF or criticality rating considers evaluation of the relative importance of assets based on select criteria.

With a comprehensive criticality rating, the following factors could be incorporated:

- Economic: Impact of the asset's failure on monetary resources e.g., replacement cost and the economic impact on commercial areas should the asset fail.

- Operational: Impact of the asset's failure on operational ability e.g., road functional classes, AADT, underlaying water, wastewater, and stormwater systems.
- Social: Impact of the asset's failure on society e.g., residential areas and commercial areas.
- Environmental: Impact of the asset's failure on the environment e.g., environmental sensitive areas.

It is recommended that the City perform a risk assessment to prioritize resources if there are budget constraints.

4.7.2 Analytical Logic to Sequence Interventions

The asset criticality score can be used to prioritize projects within a funding constrained environment. **Figure 4-2** illustrates this logic of carrying unfunded needs to the next year in the period where they receive a higher probability of receiving funds based on their criticality score.

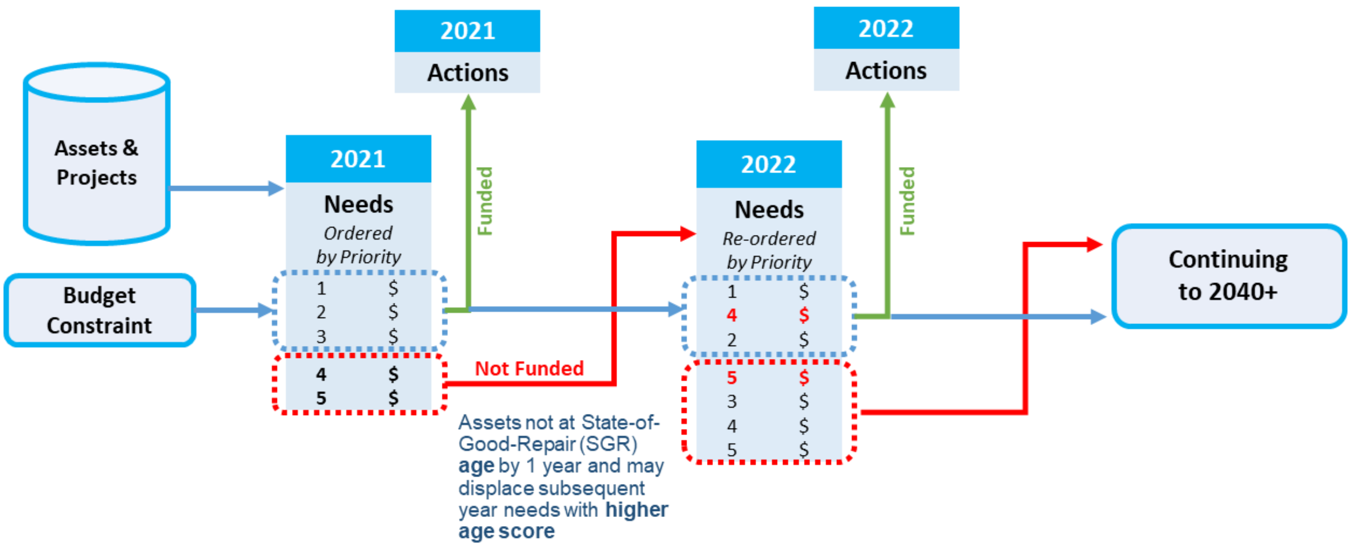


Figure 4-2: The Role of Criticality to Prioritize Projects Within A Funding Constrained Environment

4.8 Financial Planning

4.8.1 Financial Policies

The City has taken the initiative to establish financial asset management policies in 2018, which provides directions on how financial principles apply to assets to ensure that service goals are met. The policy aligns the business model of AM with the City's financial planning, financial reporting, cost management, treasury and taxation functions. The City will integrate findings from the AM Plans into its long-term financial planning and budgeting processes. Sound financial analysis will be encompassed in AM planning in order for the AM Plan to be a sought-after guide for employees in budgeting and financial planning.

4.8.2 Financial Analysis

Financial analysis activities for asset management is centered on two essential quantities: revenues and expenditures. Revenues can come from many sources. Through asset operations, the City generate its own source revenues from taxes, development charges, etc. Expenditures are all the direct and indirect costs associated with capital, operating and maintaining, and disposing of assets.

Assessing the financial implications supports in the decision-making when there are competing priorities and trade-offs between projects. Financial analysis provides a better picture of how to fund the capital plan and make critical decisions about service delivery while providing the greatest benefit for the community at the lowest cost.

4.8.3 Aligning the Financial and Non-Financial Functions of AM

ISO 55010[1] identifies the that the financial and non-financial functions of AM within organizations are generally inadequately aligned, as follows:

- **Financial Accounting Functions:** Focused on retrospective reporting of accounting / regulatory financial activities. However, there is a growing awareness in organizations of the need to focus on providing a managerial costing approach in order to support decision-making for the future.
- **Non-Financial Functions:** Have a limited understanding of financial accounting functions but are recognizing the need to improve their understanding of the financial implications of their activities.

The lack of alignment between financial and non-financial functions can be attributed to silos in an organization, including reporting structures, functional / operational business processes, and related technical data. Silos generally bring forth the necessary level of specialization. However, with a lack a communication between the silos, organizations are at risk of inefficiencies and errors in AM results, or AM failures due to a lack of alignment between AM staff and senior management. Financial and non-financial alignment needs to work both "vertically" and "horizontally", as follows:

- **Vertical Alignment:** Financial and non-financial asset-related directives by management are informed by accurate upward information flows, effectively implemented across the appropriate levels of the organization.
- **Horizontal alignment:** Financial and non-financial information that flows between departments (conducting functions such as operations, engineering, maintenance, financial accounting and management) uses the same terminology and refers to the assets identified in the same way.

Figure 4-3 presents the key elements in a framework to address the need to achieve the alignment.

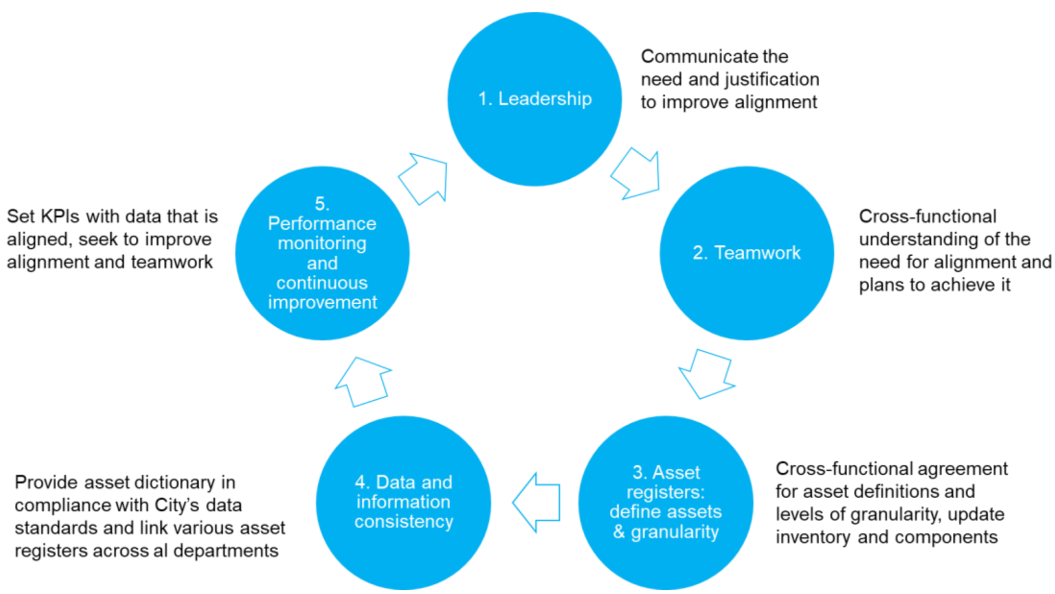


Figure 4-3: Key Elements of a Framework to Achieve Financial and Non-Financial Alignment

4.8.4 Long-Term Financial Planning

Strengthening the City's AM planning according to the recommendations in Asset Management Strategy will improve the City's long-term financial planning, by accounting for whole life cycle costs as presented in Section 4. This includes all capital, annual operation and maintenance, and disposal costs over the planning timeframe, thereby aligning financial requirements with long-term level of service objectives.

The challenge is often one of agreeing on a timeframe for such planning, recognizing that the AM perspective is ideally focused on the asset life cycle, versus the political / election cycle that could be as short as a three to four-

[1] International Organization for Standardization (2019): ISO 55010 - Asset management — Guidance on the alignment of financial and non-financial functions in asset management

year Council term. Accordingly, financial and non-financial staff, as well as top management and politicians, should agree on a long enough timeframe to provide useful forward planning information that aligns the financial and non-financial perspectives, as presented in **Figure 4-4**.

Figure 4-4: AM Planning Alignment Across the Organization

The City should have an appropriate long-term financial planning process that achieves the following:

- Stimulates long-term strategic thinking and perspective for stakeholders and decision-makers.
- Can be used as a tool to prevent or predict future financial shocks and demonstrate financial sustainability.
- Demonstrates to internal and external stakeholders that the organization has a financial strategy in place to meet their demands, now and in the future.

The long-term financial planning process needs to involve financial and non-financial staff working together to combine the important elements of strategy development, asset management planning and financial forecasting (**Figure 4-3** and **Figure 4-4**).

5. Funding Need Analysis

5.1 Bridges 20-Year Funding Need Analysis

Reinvestment needs analysis for bridges was based on the City's 2022 OSIM inspection capital recommendations from the Keystone Bridge Inspection Report. The report recommended capital works from 2025 to 2032, and City Asset Management staff applied a flat rate based on those first 8 years to the period of 2033 to 2044 to achieve a 20-year reinvestment analysis.

The average annual reinvestment rate for the City's bridges is approximately $0.9M over the next 20 years in 2024 dollars. This is equivalent to a total of approximately $17.5M over the next 20-year period, as presented in **Figure 5-1**.

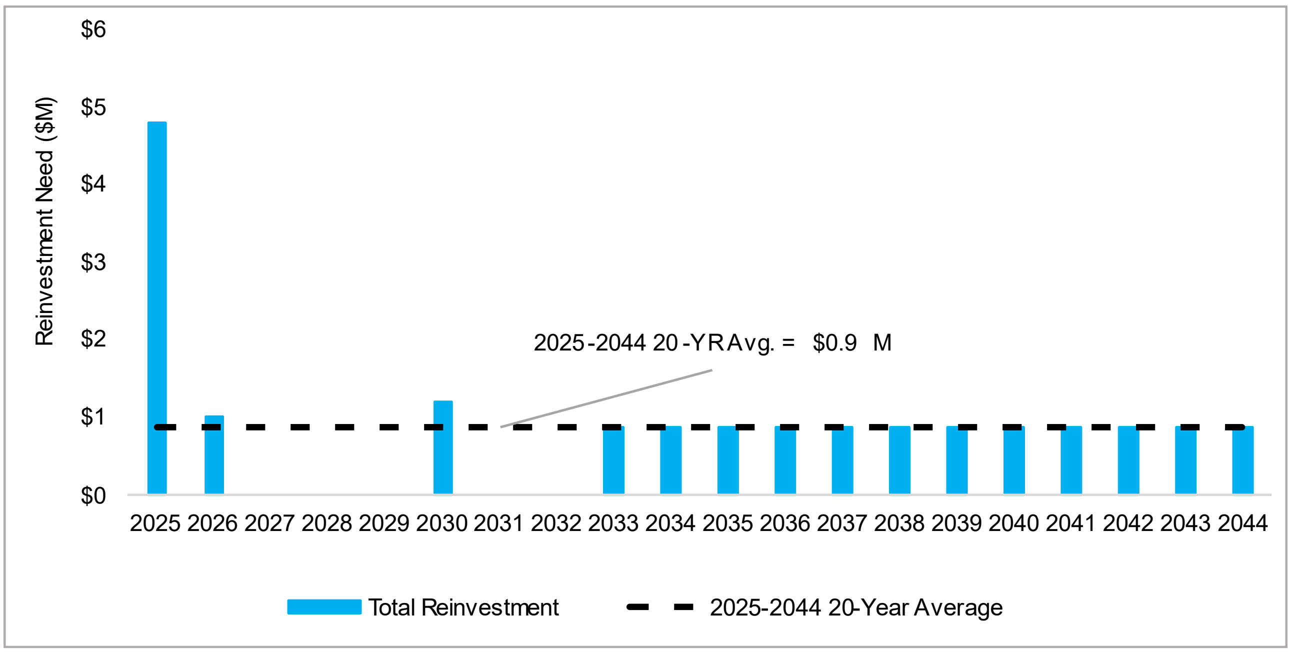


Figure 5-1: Bridges 20-Year Reinvestment Need

5.2 Infrastructure Reserves Funding Forecast

Reserve funds are important tools in the planning and management of the City's financial resources and provide a strong indicator of the City's overall financial health and are fundamental to the City's long-term financial sustainability. The City is committed to maintaining healthy reserve fund balances which are collected through various means (i.e., development charges, contributions, dedications, taxation, etc.).

There are specific infrastructure reserves for the tax-supported service areas of Roads, Facilities, Parks, Fleet and Fire (funds for Bridges assets are supported from the Roads infrastructure reserve). These reserves contain funds set aside through annual contributions from taxation to help pay for the repair and replacement of infrastructure assets. Like many municipalities across Canada, Vaughan is facing increased costs associated with maintaining aging infrastructure. Corporate Asset Management Plans for both core and non-core assets suggest the City's infrastructure deficit is large and growing. The City has continued with robust strategies and plans by developing a comprehensive Long-Range Fiscal Plan and model, which was used to better inform the 2025 and future budgets by providing information about the financial requirements to sustain growth, delivery of services and the community's infrastructure needs.

Prudent financial planning requires ongoing contributions to Roads reserves to fund the repair and replacement of infrastructure. To achieve this, continued operating and infrastructure investments are critical to ensure the City's Bridges assets remain financially sustainable now and into the future. This objective is supported by continuing to build service area infrastructure reserves. The 2024 reserve contribution for Roads reserves totalled $2.0M with the City being committed to ensuring the financial sustainability of its Bridges assets.

The City's Asset Management Plans assess average reinvestment requirements over the next 20 years for the City's assets, including Bridges infrastructure. Annual reserve contributions should generally be in line with the asset reinvestment requirement to ensure sufficient funds are set aside for asset rehabilitation and replacement needs.

For the Roads service area, the forecasted 20-year average funding need is $23.1M. In comparison, the average annual funding forecasted over the next 10 years is estimated to be $8.7M representing a funding coverage of 38% as illustrated in Error! Reference source not found.. The funding sources in this forecast are limited to annual reserve contributions, capital from taxation and the Canada Community-Building Fund (CCBF is provided from the Federal Government). Other available funding sources not included are debentures and non-CCBF grants, which would mitigate any infrastructure funding gaps.

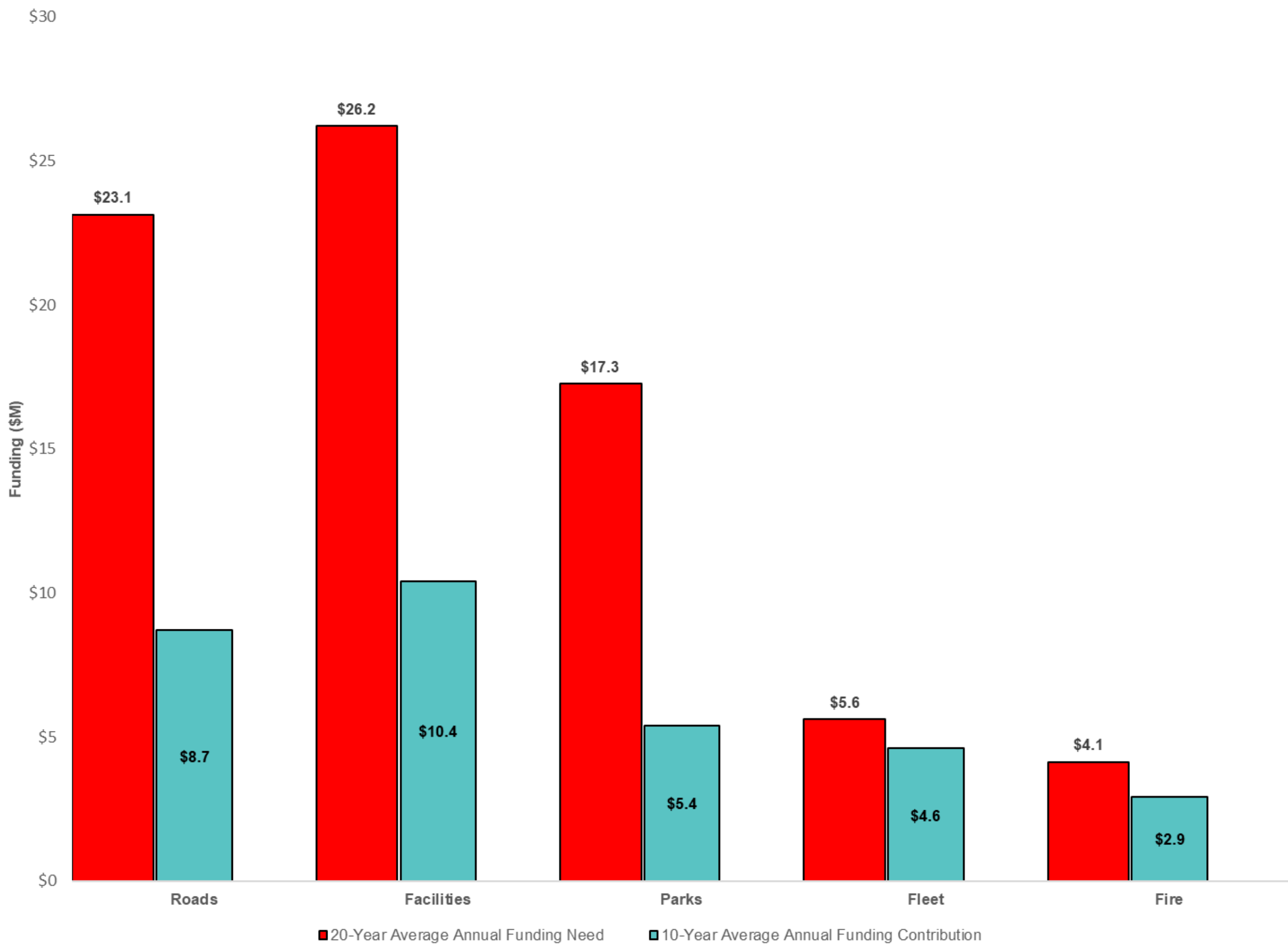


Figure 5-2: Coverage of Average Annual Funding Needs for Tax-Supported Service Areas

Revisiting the timing and scope of capital projects, optimizing the use of existing funding tools and revenue sources, such as debt and dedicated contributions to capital reserves, can help increase the City's capacity to begin to close an infrastructure funding gap.

5.3 Growth-related Assets Funding Need

The City completed a Long Range Fiscal Plan (LRFP) in 2022, which included a model to support planning to meet Bridges infrastructure needs as the City's communities continue to grow. This model analyzed the city-wide infrastructure needs to identify the required infrastructure that will meet future servicing demands. The model assessed the existing and future servicing needs and provides servicing recommendations to meet the City's growth plans. Based on the model, the forecasted funding need estimates for the construction of new Bridges assets out to 2031 is illustrated in Error! Reference source not found. with a primary funding source for these needs being Development Charges.

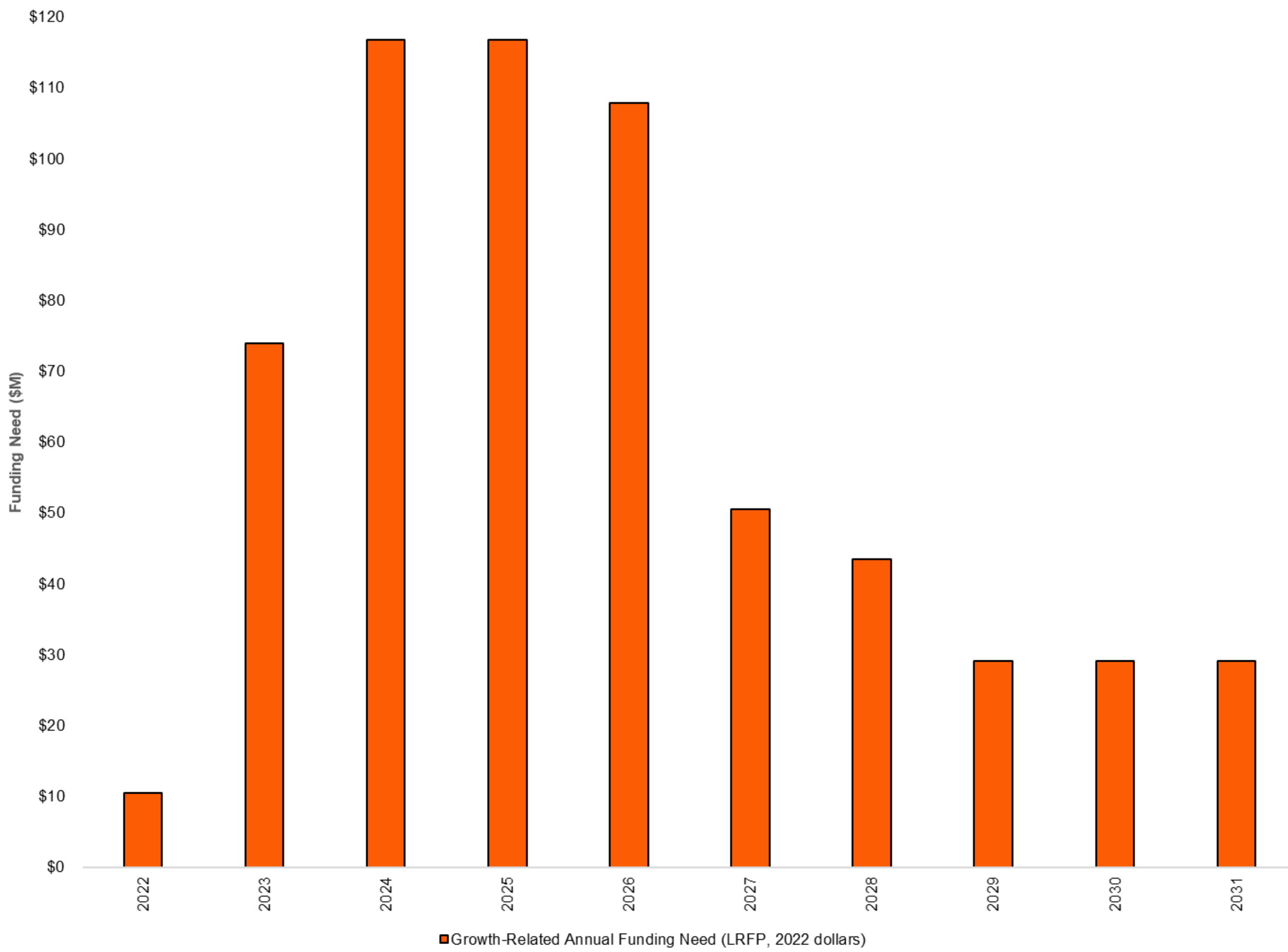


Figure 5-3: Forecasted Funding Needs for Construction of New Bridges Assets

One of the next steps in the further development of the LRFP is to apply added detail to the forecasted funding need estimates. This will provide a more refined forecast, which will serve to provide additional guidance for Asset Management planning in the future at the City of Vaughan.

Asset Management Plan

Non-Core Assets
Facilities

City of Vaughan
March 2025

Table of Contents

Figures

Tables

1. Introduction

The City of Vaughan (The City) has conducted a renewal of the City's Asset Management (AM) Plans for all its infrastructure assets, including Facilities assets.

1.1 Background

The City is one of nine area municipalities located within the Regional Municipality of York. As a lower tier municipality, the City is responsible for providing services such as buildings, fire protection, public works, water distribution, wastewater collection, and parks and recreation.

The next 25 years will see the City transition from a growing suburban municipality to a fully urban space. This type of transition will require long-term thinking about how best to accommodate and make the most of new opportunities. Planning for the future through strategic planning will position the City to deal with the many pressing issues impacting the organization such as community safety, access to health facilities, environment, traffic congestion and issues related to growth and the quality of municipal services.

The City is one of Canada's fastest growing cities, with a population of over 320,000 according to the latest census from Statistics Canada. It is projected that the number of residents will increase to 415,000 by 2031. In addition to its rapidly growing population, the City is home to a well-diversified and expanding employment sector with over 7,800 businesses and 231,000 employees. The City has the largest supply of new employment lands in the Greater Toronto Area (GTA), and it is projected that the number of employees will increase to 271,000 by 2031.

1.2 Objectives

In 2018, by City Council approval, the Corporate Asset Management (AM) Policy for the City came into effect; and, in 2013, the City's first Corporate AM Strategy was published. As identified in the Corporate AM Strategy, the City's first set of AM Plans (AMPs) were developed in 2014.

In early 2021, the City updated its AM Strategy and core infrastructure AMPs, as per Ontario Regulation (O. Reg) 588/17. The purpose of this series of AMPs is to now update the infrastructure assets so as to provide the City with a comprehensive updated AM Plan.

The objective of this AMP is to deliver a financial and technical roadmap for the management of the City's Facilities assets, and to provide the means for the City to maximize value from its assets, at the lowest overall expense while, at the same time, providing enhanced service levels for its residents and promoting green initiatives.

Organizations that implement good AM practices will benefit from improved business and financial performance, effective investment decisions, and better risk management. Stakeholders can expect lower total asset life cycle costs, higher asset performance, and confidence in sustained future performance.

1.3 AM Provincial Requirements

The Ontario Regulation 588/17 (O. Reg. 588/17) came into effect in 2018 and stipulates specific AM requirements to be in place within Ontario municipalities by certain key dates (**Table 1-1**). The development of this AMP is one of the steps to guide the City towards meeting the July 1st, 2025 deadline.

Table 1-1: O. Reg. 588/17: AM Planning for Municipal Infrastructure

Description: A regulation made under the Infrastructure for Jobs and Prosperity Act, 2015, stating that every municipality shall prepare and update a Strategic AM Policy, and that every municipality shall prepare an AM Plan for its core infrastructure assets by July 1, 2022, and an AM Plan for all other infrastructure assets by July 1, 2024. The regulation

outlines several requirements that each AM Plan must follow, such as including current and proposed level of service. Core municipal infrastructure assets include water, wastewater, stormwater, road, and bridge assets.	
Deadline Date	Regulatory Requirement
July 1st, 2019	All municipalities are required to prepare their first Strategic AM Policy.
July 1st, 2022	All municipalities are required to have an AM Plan for its entire core municipal infrastructure (i.e., water, sanitary, stormwater, and transportation).
July 1st, 2024	All municipalities are required to have an AM Plan for infrastructure assets not included under their core assets.
July 1st, 2025	All AM Plans must include information about the levels of service that the municipality proposes to provide, the activities required to meet those level of service, and a strategy to fund activities.

1.4 Scope

This AMP has been developed for the Facilities assets, which are owned and maintained by the City, as shown in **Table 1-2**.

Table 1-2: In-Scope Facilities Assets

Asset Category	Asset Types
Buildings	Administration Buildings, Community Centers, Fire Stations, Heritage Buildings, Ministry of Natural Resources and Forestry Buildings (MNRs), Libraries, Senior Clubs, Sport Buildings, Yards, Parks Facilities, and Other Buildings (Fire Tower, Outdoor Pool, and Pumping Stations).
Tanks	Above ground Tanks, and Underground Tanks.
Generators	Generators for Administration Buildings, and Fire Stations.

The following elements are included within the scope of this AMP:

- A summary of the asset inventory, including the replacement cost of the assets, the average age of the assets, the condition of the assets, and the City's approach to assessing the condition of the assets.
- Current levels of service (LoS) based on performance measures.
- Asset lifecycle management strategies to maintain identified current LoS, minimize associated asset risks, and to optimize costs over the whole lifecycle of the asset.

1.5 Approach for Asset Management Plan

The approach used in the renewal of this AM Plan is presented in **Figure 1-1**, and has been selected to ensure that the City can have the confidence to make fact-based and defensible business decisions from reliable and robust information.

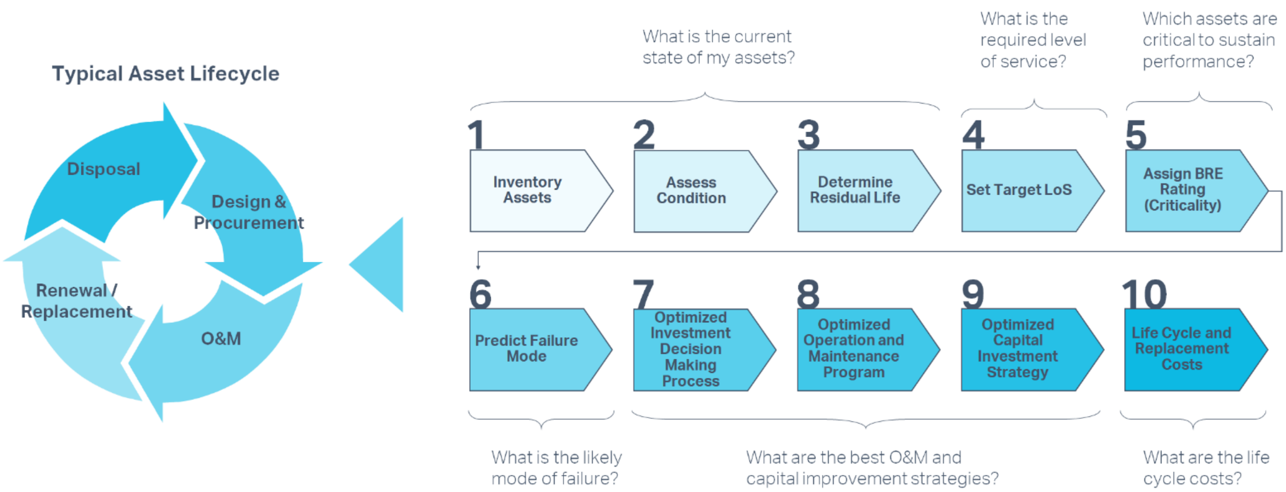


Figure 1-1: AM Plan Approach

2. State of Infrastructure

The City operates over 90 properties, facilities, and buildings. These assets are used to provide the wide range of services offered by Vaughan. The Facility Management department focuses on the efficient and effective delivery of property management services for the City allowing them to meet the City's functional requirements, and building and safety codes, while operating in a safe and efficient manner. The department plans, organizes, operates, and evaluates building systems and operation of all the City's facilities.

2.1 Asset Inventory and Hierarchy

Table 2-1 presents the City's Facilities inventory and asset hierarchy. The facilities inventory is divided into buildings, tanks, and generators.

The City is operating 112 buildings with a total square footage of 2,093,000. The building facilities are further sub-divided into administration buildings, community centers, fire stations, heritage buildings, libraries, senior clubs, sport buildings, yards, parks facilities, and other buildings.

There are 11 generators, and 15 tanks serving as backup power and fuel. Standby generators are located at critical buildings including the City Hall – Vaughan Civic Center, the Joint Operations Center (JOC), and the fire building facilities to ensure continuous operations during power outage events. The tanks stored with natural gas, diesel and unleaded fuel sit close to the generators.

Table 2-1: Facilities Asset Inventory and Hierarchy

Asset Category	Asset Type	Count	Quantity	Unit of Measure
Buildings	Administration Buildings	2	414,478	sq ft
	Community Centers	13	999,102	sq ft
	Fire Stations	11	100,576	sq ft
	Heritage Buildings	19	59,177	sq ft
	Libraries	10	174,440	sq ft
	MNRs	3	19,502	sq ft
	Parks Facilities	21	28,903	sq ft
	Pump Stations	14	9,111	sq ft
	Senior Clubs	7	23,893	sq ft
	Sport Buildings	6	212,801	sq ft
	Yards	3	44,000	sq ft
	Others	3	6,775	sq ft
	Buildings Total	**112**	**2,093,000**	sq ft
Tanks	Aboveground Tanks	12	65,000	Liters
	Underground Tanks	3	57,000	Liters
Generators	Generators	11	1,973	kW

2.2 Current Asset Replacement Value

The estimated replacement value is the cost of replacing an existing asset in 2024-dollars. These costs are collected from the City's GIS record. Where applicable, a CPI-based inflation rate was used to estimate the 2024 values.

The City owned facility asset class is valued at approximately $703M, as represented in **Table 2-2**. The estimated total replacement value for the eleven Community Centers is over $335M which accounts for the largest share of the total replacement value among the building types. The second highest value building type is the administration buildings valued at approximately $141 Million.

Table 2-2: Facilities Current Replacement Costs

Asset Category	Asset Type	Unit Cost ($ / Unit)	Total Replacement Value
Buildings	Administration Buildings	$341 /sq ft	$141,358,000
	Community Centers	$335 /sq ft	$335,181,000
	Fire Stations	$426 /sq ft	$42,826,000
	Heritage Buildings	$497 /sq ft	$29,412,000
	Libraries	$369 /sq ft	$64,290,000
	MNRs	-	$-
	Parks Facilities	$511 /sq ft	$14,772,000
	Pump Stations	$925 /sq ft	$8,432,000
	Senior Clubs	$182 /sq ft	$4,340,000
	Sport Buildings	$228 /sq ft	$48,513,000
	Yards	$195 /sq ft	$8,560,000
	Others	$446 /sq ft	$3,022,000
	Buildings Subtotal		**$700,706,000**
Tanks	Aboveground Tanks	$2,000 - $15,000 / Ea.	$65,000
	Underground Tanks	$84,000 - $30,000 / Ea.	$57,000
Generators	Generators	$75,000 - $ 255,000 / Ea.	$1,830,000
Facilities Total			**$702,658,000**

2.3 Age and Remaining Service Life

The asset age is based on the install year of the assets and the remaining service life (RSL) is estimated by using age and expected service life (ESL) in years. The ESL for each asset is obtained from the City's inventory record.

The ESL is defined as the period over which an asset is available for use and able to provide the required LoS at an acceptable risk (i.e., without unforeseen costs of disruption for maintenance and repair). The actual service life can vary significantly from the ESL. In some instances, a variation in expected vs. actual service life is evident due to the following factors:

- **Operating conditions and demands:** Some assets are operated intermittently or even infrequently or is being operated a lower demand than its design capacity, thus the actual operating "age" of the asset is reduced.
- **Environment:** Some assets are exposed to very aggressive environmental conditions (e.g., corrosive chemicals), while other assets are in relatively benign conditions, thus the deterioration of assets is affected differently.
- **Maintenance:** Assets are maintained through replacement of components, which prolongs the service life of the asset.
- **Technological Obsolescence:** Some assets can theoretically be maintained indefinitely, although considerations such as maintenance cost, energy inefficiency and new technologies are likely to render this approach uneconomical.

Figure 2-1 shows the average asset age and RSL as a proportion of average ESL weighted by replacement value for each asset type. The administration buildings including City Hall and Joint Operations Center are approximately 30% through their ESL. Community Centers are 74% through their ESL, however; it should be noted that renovations began at Garnet A. Williams Community Center, Al Palladini Community Centre, and Maple Community Centre in the Fall 2022 to upgrade the buildings, which will extend their RSL and elevate the overall RSL for Community Centers. The average ESL does not necessarily apply to City owned heritage properties as the City is the steward for these heritage resources and will conserve these properties for current and future generations. The remaining building types are less than halfway through their ESL as well as tanks and generators are slightly past their midway ESL.

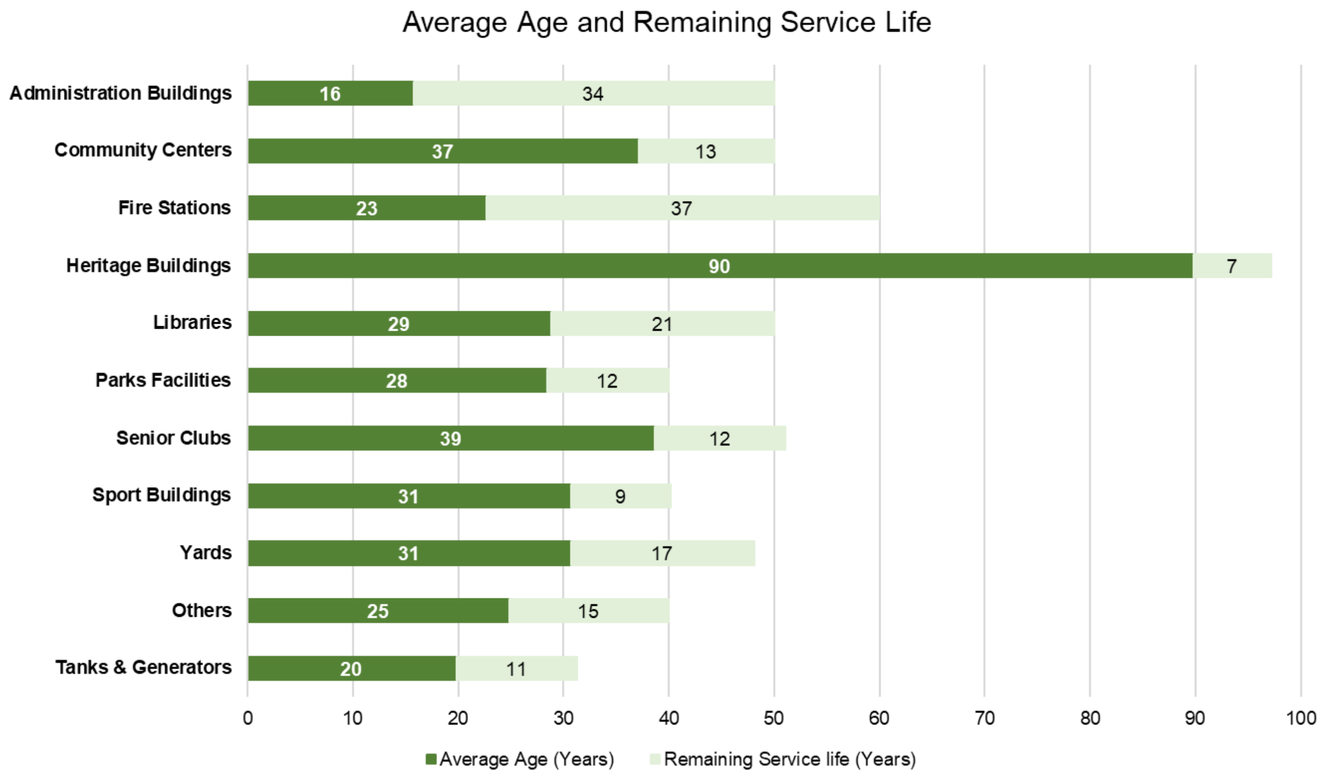


Figure 2-1: Facilities Asset Average Age and Remaining Service Life

2.4 Asset Condition

2.4.1 Facilities Condition Index

The FCI is the comparative indicator of the relative condition of assets of the facility. It is the ratio of building deficiencies costs to the current replacement value of the facility. FCI is calculated as per Equation [1].

$$\boldsymbol{FCI} = \frac{\sum \boldsymbol{Deficiencies\ Cost}\ (\boldsymbol{in\ the\ tactical\ plan\ for\ the\ next\ 3\ to\ 5\ years})(\$)}{\boldsymbol{Current\ Replacement\ Value\ of\ Facility}\ (\$)}$$

Table 23 presents the FCI ranges and the corresponding condition ratings. The condition score and rating scale are aligned with the City's overall condition rating strategy.

Table 23: FCI Condition Rating Scale

FCI Minimum	FCI Maximum	Condition Rating
0%	5%	Very Good
5%	15%	Good
15%	30%	Fair
30%	100%	Poor

2.4.2 Age-Based Condition Assessment

Two-parameter Weibull distribution function was used to assess the current condition and to project the future condition of the City's Facilities. The Weibull distribution has been used extensively in reliability studies and lifetime prediction models in industries ranging from the automotive to the oil and gas industries; it provides a suitable distribution for this type of analysis.

The Weibull probability distribution provides a left-skewed distribution that rises slowly and diminishes quickly as the population is consumed. The underlying premise of the Weibull-shaped deterioration is that while some assets fail prematurely due to severe conditions or improper installation, other assets are very long-lived and function well beyond their theoretical expected service life. In order to perform a high order network-level analysis, it was assumed that assets would fail (and require replacement) within a deterioration envelope / curve approximated by a Weibull probability distribution. The two-parameter Weibull cumulative distribution has two parameters for scale and shape, as set out in Equation [1]:

$$f(x;\alpha,\beta) = e^{-\left(\frac{x}{\beta}\right)^{\alpha}} \tag{1}$$

Where: x = Age
α = Shape parameter
β = Scale parameter (or slope)

Table 2-3 presents the condition score ranges and the corresponding range of ESL and total life consumed.

Table 2-3: Age-Based Physical Condition Scale

Condition Score (minimum)	Condition Score (maximum)	Condition Rating	Range % of ESL Consumed	Range of % Operational Life Consumed
1.0	1.5	Very Good	0% – 71%	0% – 47%
1.5	2.2	Good	72% – 84%	48% – 56%
2.2	2.8	Fair	85% – 92%	57% – 60%
2.8	5.0	Poor	93% – 100%	61% – 100%

2.4.3 Condition Summaries

Figure 2-2 provides a summary of the average weighted condition for City owned facilities. The condition of buildings is rated based on FCI and age-based condition assessment approach was conducted for Tanks and Generators.

The City's facilities are overall in very good condition with 58% of facility assets, by replacement value. Approximately 1% of assets are in poor condition; meaning that they are approaching or exceeded their ESL, indicating a need for investment in the short to medium term. The remaining 41% of assets are in good to fair condition indicating that they are meeting current needs but may require attention as they age.

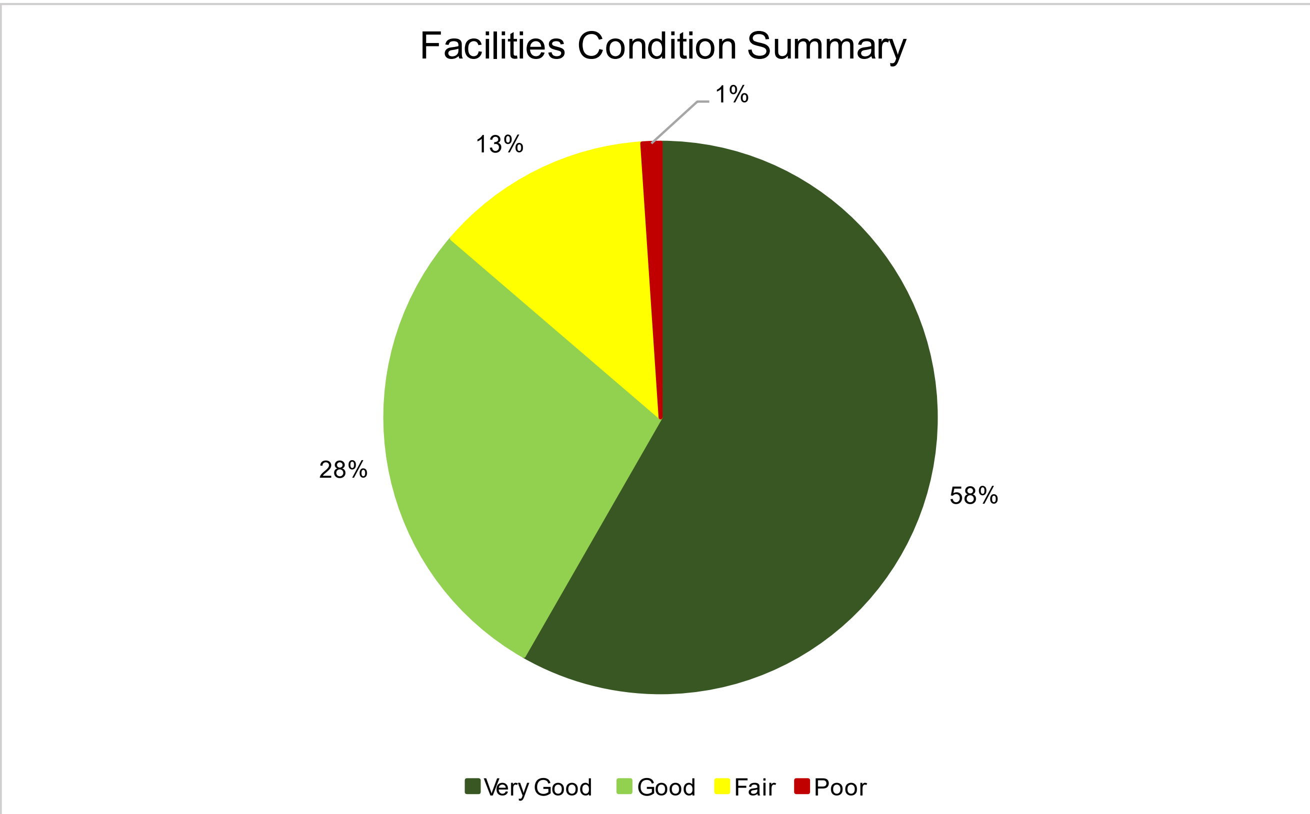


Figure 2-2: Facilities Asset Condition Summary

The City has taken efforts in addressing the deficiencies for building repairs identified by the 2022 to 2023 building condition assessment results. The City conducted a building condition assessment for eight community centres in 2022 and the rest were assessed in 2023. The condition ratings are updated in this plan accordingly. In addition, the City is currently undertaking over 60 capital projects for the renewal of various facilities which will significantly improve the facilities' condition.

Figure 2-3 presents the distribution of condition for each facility type weighted by replacement cost. **Figure 2-4** shows the details of the condition of community center buildings which account for the largest replacement value in the facility asset group. Nearly all the City's administration buildings, community centers, and fire stations are in very good to good condition. Overall, the parks, yards, and senior club facilities are in fair condition.

Figure 2-3: Distribution of Facilities Asset Condition

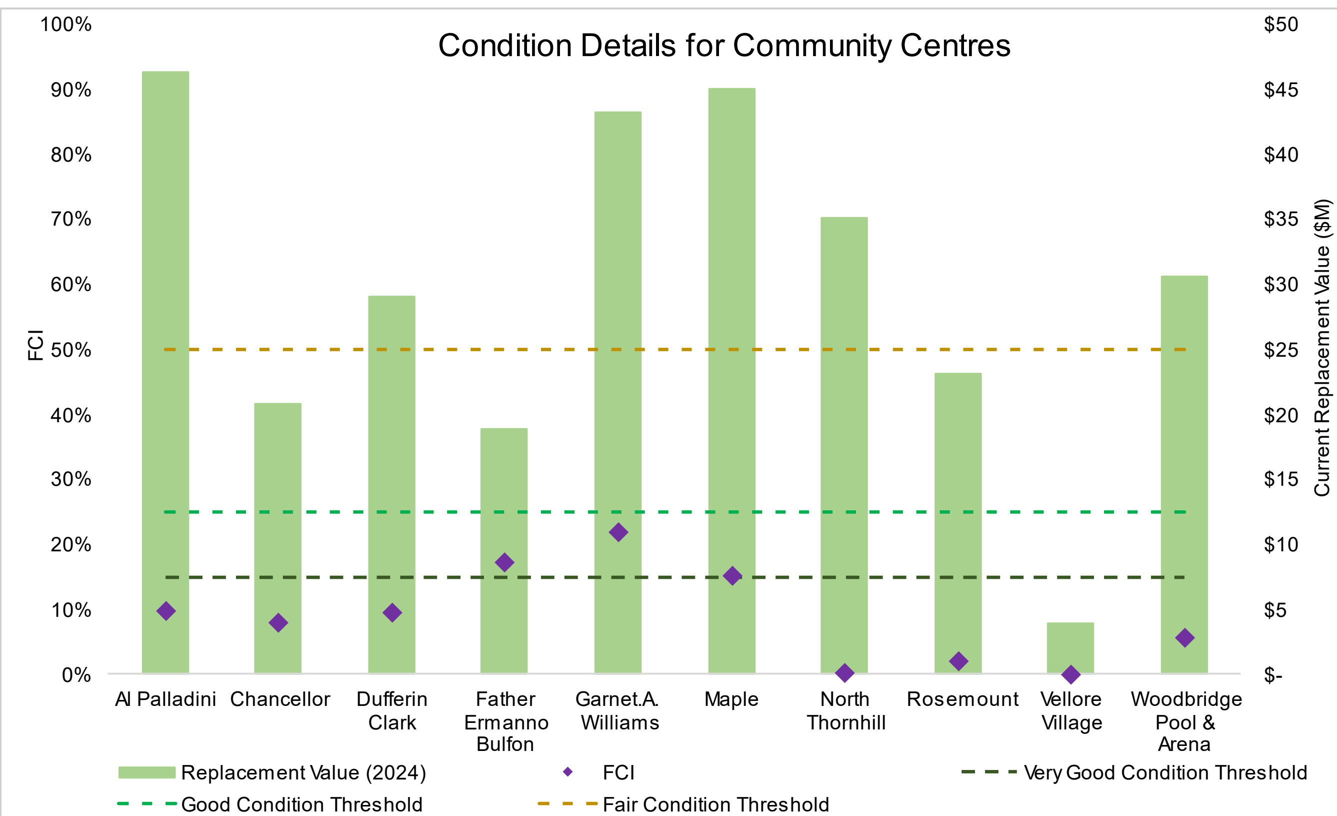


Figure 2-4: Community Centres FCI Details by Replacement Cost

3. Levels of Service

3.1 Purpose

Levels of Service (LoS) supports every aspect of the overall AM System as shown in **Figure 3-1**. The objective of establishing clearly defined service levels is to help the City meet stakeholder values, achieve its strategic goals, make informed risk-based decisions, and implement effective asset lifecycle activities.

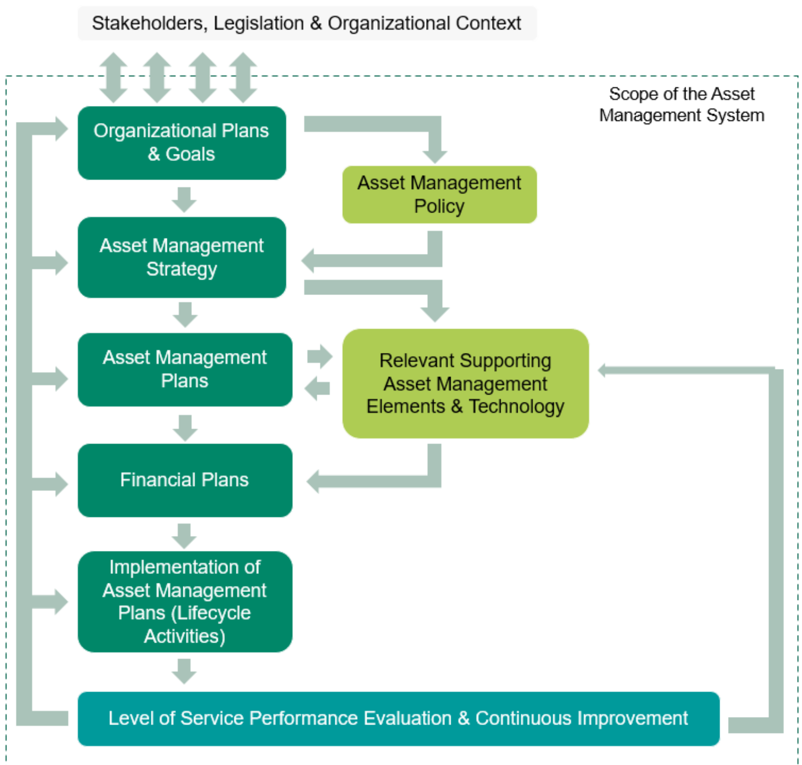


Figure 3-1: LoS within the AM System

In the City's experience, documenting LoS is a proven practice that will enable the City to:

- Link corporate strategic objectives to customer expectations and technical operations.
- Balance customer needs and expectations while evaluating the effectiveness of operations and whether the right LoS is being provided at the right cost.
- Transition from an "Asset Stewardship" approach that focuses on making decisions based on maintaining assets in an acceptable condition to a "Serviceability" approach that is geared towards making decisions based on balancing the costs, risks, and goals for the LoS being provided by the City's assets.
- Communicate the physical nature of infrastructure that the City owns and is financially responsible for while promoting the use of LoS to enable effective consultation with stakeholders regarding alternative funding options according to desired LoS outcomes.
- Make recommendations on strategies that the City can take now to minimize future renewal costs while ensuring that adequate LoS can be delivered without burdening future generations.
- Assess internal (e.g., program changes) and external (e.g., climate change) factors that have the potential to impact the City's ability to deliver services and how these factors may impact the LoS being provided.
- Implement a corporate continuous improvement program to further optimize AM across all service areas.

The O. Reg. 588/17 requires that all AMPs include information about the LoS that the City proposes to provide, the activities required to meet those service levels, and a strategy to fund those activities. The deadline for formalizing these LoS requirements is July 1, 2025 (see **Section 1.3**).

Successful AM programs aim to achieve targeted service levels through customer-based decision making. To achieve this, the City considered a customer-centric approach, where the customer is at the heart of every decision from development to implementation, consultation, and roll-out of the LoS Framework (**Figure 3-2**).

There are two types of LoS measures: Customer LoS (also called "Community" LoS) and Technical LoS. Customer LoS are recorded in a manner that attempts to describe the LoS in terms of what is actually being provided to the customer (i.e., the public) and how the customers experience the service. It is important to note that customers are not concerned with the specific operating requirements of the assets that provide the service, but rather the value they obtain from the operation of the assets. To achieve Customer LoS there needs to be line of sight between the value delivered and how that value is realized. This is the purpose of Technical LoS which attempts to describe how the City will provide and meet the expected Customer LoS.

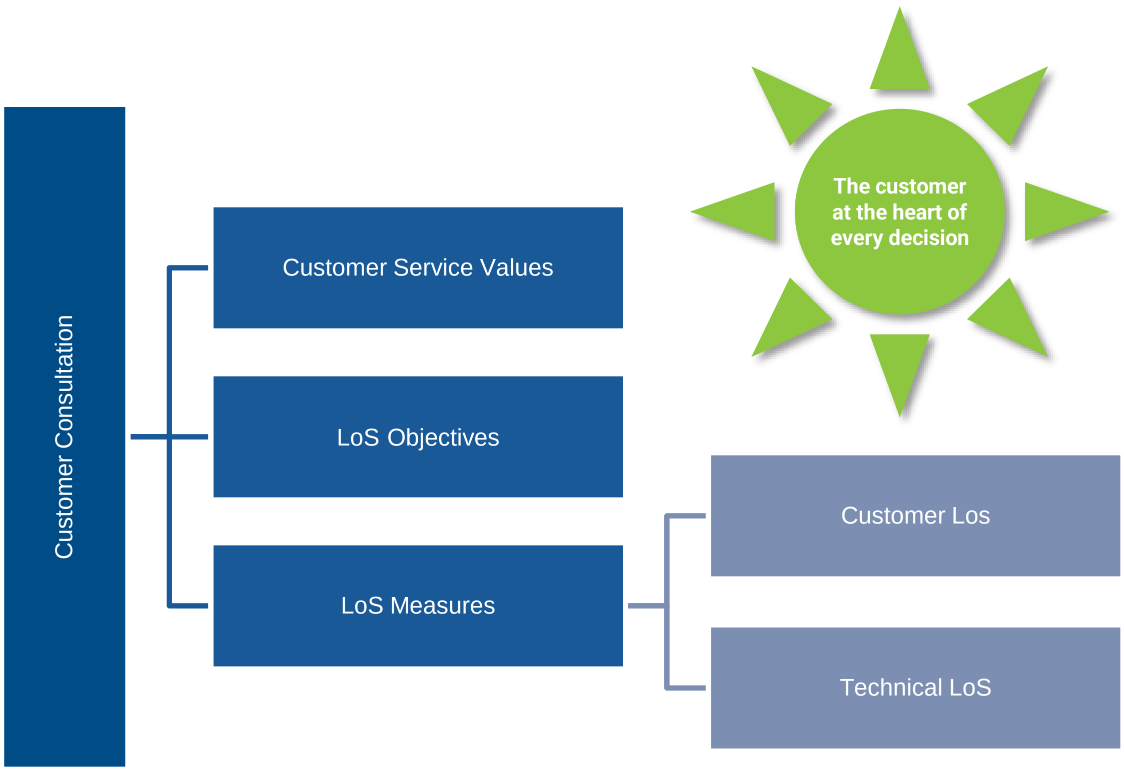


Figure 3-2: The LoS Framework Customer-Centric Approach

The LoS Framework was primarily conceived through a collaborative workshop process. In 2020, four workshops with City staff were conducted across each of the fourteen service areas.

The following outcomes were achieved during each service area workshop:

- Staff were oriented as to the purpose and importance of establishing a consistent LoS Framework;
- Stakeholders were identified, including their expectations, interests, and any regulatory requirements;
- Customer service values were established and reviewed;
- LoS objectives were established for each customer service value;
- Staff provided several performance measures that are currently being tracked as well as those that the City would like to track in the future;
- Where information was available, current performance, targets, and data sources were documented; and
- Growth and shifts in future demand were discussed across the City's service areas.

3.2 Objectives

Defining LoS objectives is important for drawing a line of sight between the City's corporate objectives and the tangible asset performance outcomes. To do so, the LoS objectives must take into consideration stakeholder

interests to develop asset performance measures that aim to meet the needs and expectations of the community. By doing this, the City will ensure that their assets are striving towards optimal performance, not only operationally, but economically, socially, and sustainably as well.

Every stakeholder has certain interests in the service being provided and in general, these interests can be categorized into six universal stakeholder values, as shown in **Table 3-1**. Each universal stakeholder value is also assigned a corporate LoS objective.

Table 3-1: The City's Values and LoS Objectives

Customer Value	LoS Objective
Quality and Reliability	The service is delivered with a high standard of excellence, and the service is available when needed.
Affordability	The cost of the service is delivered in a financially sustainable manner and does not burden customers.
Environmental Sustainability	The service is delivered in a manner that does not compromise the ability of future generations to meet their needs.
Access and Capacity	Customers can easily access the service with minimal inconvenience.
Health and Safety	The service is delivered with minimal health and safety impacts.
Responsiveness	Customer service requests are responded to efficiently and in a timely manner.

3.3 Stakeholders and Their Interests

A stakeholder is any person or organization that can affect, be affected by, or perceive themselves to be affected by a decision or an activity. Stakeholder analysis is the process of understanding stakeholder needs, expectations, and perceptions relative to the stakeholder's level-of-interest and level-of-influence over the organization. An organization typically engages with their stakeholders to:

- Establish which activities or services matter most to them.
- Understand their risk appetite and risk threshold.
- Understand their willingness to pay for services.

Stakeholders can take many forms and may be internal (i.e., staff, Council) or external (i.e., the public, regulatory agencies, suppliers, neighbouring municipalities, etc.) to the organization. Historically, only service recipients who pay for City services would be considered customers; however, today customers can take many forms and should include any entity that has a legitimate interest in the service being provided. In addition to service recipients (i.e., the public), this may include:

- **Regulatory Agencies** – Stakeholders that set standards, compliance regulations or other legislation that govern service delivery.
- **Special Interest Groups** – Stakeholders that are affected by or have an interest in the City's roadway services.

Table 3-2 identifies the key stakeholders as they pertain to the City's facility asset class. These stakeholders were documented during a collaborative workshop process with the City and is not intended to be an exhaustive list; however, the following groups provide a good starting point for future stakeholder engagement.

Table 3-2: The City's Key Facilities Stakeholders and Their Interests

Key Stakeholder Group	Description	Stakeholder Interests / Priorities	
Facility Users	This includes the general public who use the City's facilities (i.e., recreation centres, libraries, etc.) as well as internal City staff. It is important to meet LoS expectations and maintain adequate communication to keep users up to date on any facility repairs.	• Cleanliness • Good state of repair • Safety • Accessibility • Responsiveness	• Security • Function • Energy efficient • Environmental Stewardship
Regulatory Agencies	The City has integrated more than 30 mandated regulations and codes within the Facilities risk management approach which seeks to keep the City's facilities operating safely and efficiently.	• Compliance • Safety • Function	• Accessibility • Energy efficiency
Internal Departments	Facilities provide services to other City departments by providing the buildings they operate (i.e., City Hall, library, community centres, fire stations, heritage buildings, etc.)	• State of good repair • Aesthetics • Cleanliness	• Safety • Security • Responsiveness
Building Owners	Facilities leases or rents buildings to provide services to the public; although it is the City's preference to own buildings to provide services.	• State of good repair • Aesthetics	• Cleanliness • Lease payments

3.4 Level of Service (LoS) Performance Measures

A documented suite of LoS performance measures enables a common understanding of the service delivery that the City's customers currently receive, and the associated cost of maintaining infrastructure assets to provide the service. Having these performance measures set at the appropriate levels within the City ensures alignment from the corporate vision, to asset investment decisions, and to day-to-day operational activities. When establishing LoS performance measures it is important to keep in mind the "SMART" acronym, as follows:

- **S**pecific, easily evaluated and understood.
- **M**easurable, quantifiable, and easily collectable to ensure ongoing data availability.
- **A**ttainable, so that they work to motivate as opposed to discourage.
- **R**elevant, in that they relate and align with a specific goal.
- **T**ime-Bound, measured over a specific period, which is typically annually for benchmarking.

There are two types of LoS performance measures: Community LoS and Technical LoS. Community LoS are recorded in a manner that attempts to describe the LoS in terms of what is being provided to the community (i.e., the public) and how the customer experiences the service. Community LoS are qualitative, non-technical, and are driven by the municipality's strategic AM objectives. Community LoS are not concerned with the specific operating requirements of the assets that provide the service, but rather the value they obtain from the operation of the assets. To achieve Community LoS, there needs to be line of sight between the value delivered and how that value is realized. This is the purpose of Technical LoS which attempts to describe, quantitively, how the City will provide and meet the expected Community LoS.

3.5 LoS Performance Results

A summary of the City's current and proposed community and technical service levels for the Facilities assets are documented in **Table 3-3.**

Table 3-3: Community and Technical Service Levels

Asset Type	Level of Service	Current Performance	Current Service Level Target	Proposed Service Level Target
All Assets	Facility Condition Index (FCI)	16.82%	<25%	No Change
All Assets	Number of Facilities with Green Building Certification	7	7	9
All Assets	Percentage of Facilities with Accessibility Audits	100%	100%	No Change
All Assets	Repair Responsiveness	Reportable on a case-by-case basis	Completed within 5-7 days	No Change
Tanks	Percentage of Equipment Meeting the Manufacturer's Recommended Scheduled Maintenance	100%	100%	No Change
Generators	Percentage of Equipment Meeting the Manufacturer's Recommended Scheduled Maintenance	100%	100%	No Change
All Assets (Mechanical Sub-Components)	Percentage of Equipment Meeting the Manufacturer's Recommended Scheduled Maintenance	100%	100%	No Change

Measured in the most recent Citizen Satisfaction Survey conducted by Ipsos, the percentage of respondents satisfied with Recreation and Fitness Facilities was 81% and regarding Local Public Libraries, the percentage was 94%. Additionally, as illustrated in **Figure 3-3**, the percentage of properties within 3 km of a Library facility is 91%. In **Figure 3-4,** the percentage of properties within 3 km of a community centre is 80%.

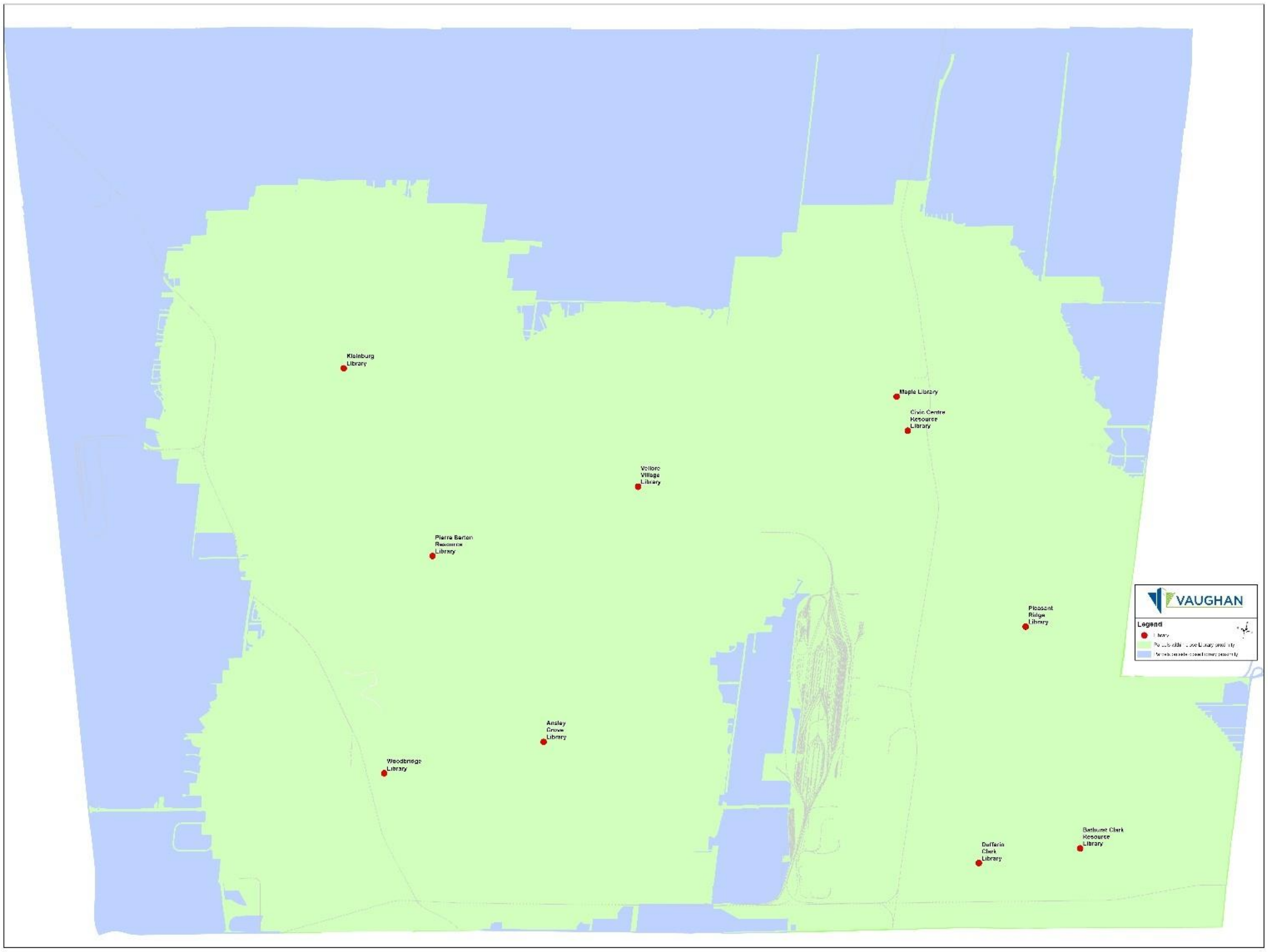


Figure 3-3: Properties within 3 Km of a Library Facility

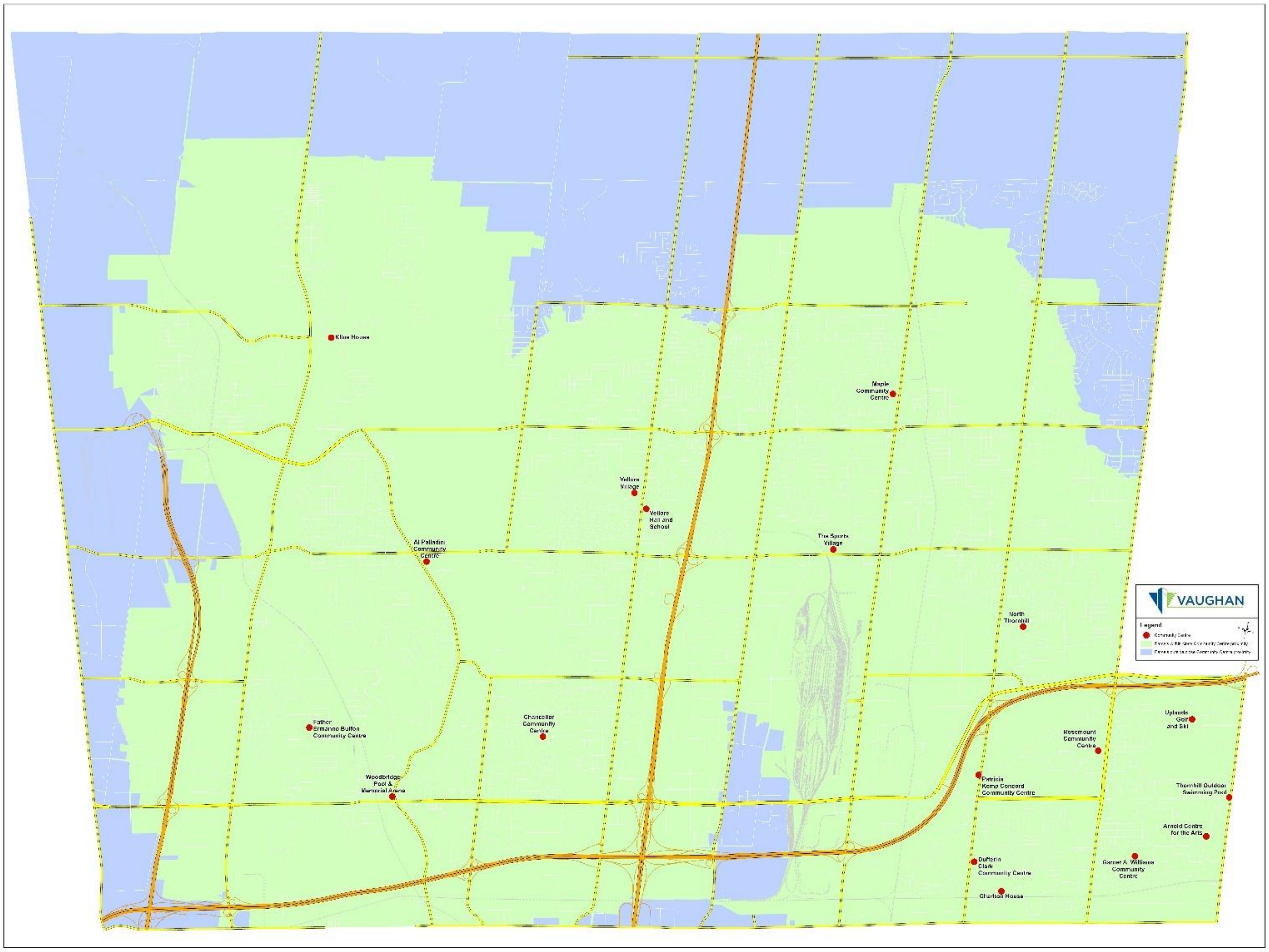


Figure 3-4: Properties with 3 km of a Community Centre

3.6 LoS Performance Targets

Establishing LoS targets is an important part of continual improvement and performance management. Without targets, it is difficult to ascertain whether goals are being met, or the extent of the gap if they are not. Incorporating targets into the City's LoS Framework helps to ensure that targets are reasonable, aligned with customer expectations, and evaluated on an objective basis by considering cost-benefit trade-offs.

One of the key challenges in setting targets in a municipal environment is that they can often become biased and/or politically motivated. Therefore, it is important to review LoS targets with stakeholders. An important aspect of evaluating LoS targets is determining how willing the user is to pay for the service. Regulatory requirements are an exception; however, they only provide the minimum service standard. Cost is still an important parameter to consider when assessing the merits of service improvements.

To deal with the financial realities, it is necessary to:

- Calculate how much the service costs based on current LoS.
- Determine the cost associated with varying the LoS.
- Assess the customers' willingness to pay.

3.7 Future Demand Drivers

Understanding internal and external factors that may impact service delivery (positively or negatively), such as staff resources, climate change, and shifts in population is a critical component for managing desired service levels in a sustainable manner. It is important to proactively develop effective, long-term strategies that are suitable for the City's unique economic, environmental, and social landscape.

In most cases, the factors presented in **Table 3-4** may result in a negative impact on the City's existing service levels, unless additional funding or resources can be allocated to meet future needs; however, in some instances, such as technological advancements and higher regulation standards, the impact on service delivery may actually improve as a result.

Table 3-4: Potential Future Demand Drivers

Anticipated Issue	Potential Impact on Service Delivery
Regulatory Changes	Regulatory requirements related to the 2050 Net Zero Policy are expected to impact many building components such as the HVAC systems.
Aging Infrastructure / Deferred Maintenance	The City uses the FCI to inform the capital plan for addressing aging or deteriorated facility infrastructure. The City's current threshold is 25% to keep the building well maintained. If the FCI is more than 25%, the cost of operations will be higher, at which point the City will consider decommission or retiring the building. The City envisions this threshold to be 15% in the future to meet the LoS targets. Deferred maintenance is one of the most significant challenges that the City is currently facing.
Climate Change	The City has a goal to meet the 2050 Net Zero Policy, which requires increased costs to reach this objective, such as purchasing more indoor air filters. Furthermore, the City is tracking the carbon generation of new building construction in order to meet the City's carbon reduction target in 2030.
Staff Availability	The City is currently outsourcing certain services which is more expensive over the long-term compared to an in-house sourced approach.
Financial Funding	The City's facilities are funded for now, but in three to five years, there will be new budget requirements for the replacement of facility assets. Technological obsolescence is expected to contribute to an increase in funding needs as newer, and more expensive, technology replaces older ones. Facility assets are primarily replaced using the capital budget; however, a small number of assets can be replaced using the O&M budget.

By considering potential drivers, as well as any issues that may pose a threat to meeting future demand, the City has the advantage to proactively plan and prepare mitigation strategies.

Approaches for the City to consider include:

- Asset-based solutions (e.g., upgrading existing assets, providing new assets, etc.).
- Non-asset-based solutions (e.g., restricting usage, changing habits through education, providing service alternatives, etc.).

A hybrid solution often works well since every municipality has its own challenges and there is not a "one solution fits all" approach. It is important that the City remains aware of its internal and external situational context and modifies its approach and mitigation strategies in a consistent, periodic, and well documented manner.

4. Asset Lifecycle Strategies

Asset lifecycle management focuses on the specific activities we must undertake during all phases of the asset lifecycle. By considering entire asset lifecycles the City can ensure sound decision making that consider present and future service delivery needs.

The overarching goal of life cycle management is to maximize the long-term benefits and services that our assets deliver while minimizing the associated costs and risks in the long run. Every asset has a life cycle cost, which is the total cost of all the activities undertaken throughout its service life. The following sections describe activities across the life cycle of assets.

4.1 Lifecycle Activities

Any responsible owner of assets such as the City has a desire to preserve the condition of their existing assets for as long as possible, by maintaining or even extending their design lives through routine activities such as maintenance and active intervention. The City is continually acquiring infrastructure assets, but these assets require increased funding for operation and maintenance as they age. The City is also responsible for the replacement of deteriorated assets as long as the service is required. While individual assets may have a useful life that can be predicted in years or decades, the service that the asset provides could be for a substantially longer duration (perhaps in perpetuity). Part of the purpose of the AM planning process is to fully understand and predict the long-range financial requirements for the City's infrastructure to facilitate planning and resource management in the most cost-effective manner possible. **Figure 4-1** illustrates how costs typically accumulate over an asset's life. It is worth noting that the accumulation of the ongoing operations and maintenance, refurbishment and disposal / replacement costs is many multiples of the initial acquisition costs. A key and important take-away from **Figure 4-1** is therefore for the City to fully understand the entire life cycle costs before proceeding with asset acquisition.

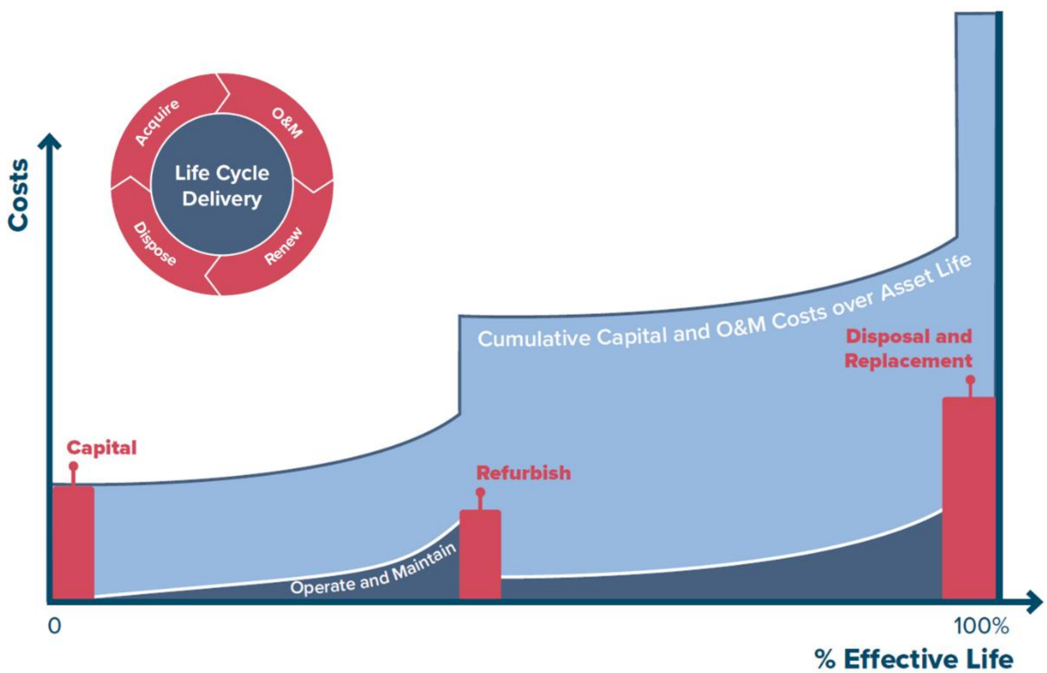


Figure 4-1: Life Cycle Cost Accumulation Over Asset Life

4.2 Asset Acquisition Strategies

The City has made significant investments in the design and acquisition of its municipal infrastructure assets. In the earlier days, the City leased many facilities, however, for the ease of managing, the City anticipates owning the majority of its facilities in the future. The acquisition of new facility assets is derived by planning, growth, and the real estate market. The City undertakes long-range planning studies to identify current needs and future facility provision strategies, which also include meeting the broader objectives around carbon neutrality.

The City's Active Together Master Plan[1] guides and defines priorities for the provision of facilities, and library services. Facilities also get acquired through high-density developments, such as the upcoming Green Park and the Vellore Village Skate Park due to the construction of high-rises in the vicinity. For achieving carbon neutrality, the City has planned two new carbon net zero facilities, which include a community centre and a fire hall.

Looking towards the future, when acquiring new assets, the City should evaluate credible alternative design solutions that consider how the asset is to be managed at each of its life cycle stages.

Asset management and full life cycle considerations for the acquisition of new assets include, but are not limited to, the following:

- The asset's operability and maintainability.
- Availability and management of spares.
- Staff skill and availability to manage the asset.
- The manner of the asset's eventual disposal.

4.3 Operations and Maintenance Strategies

As new infrastructure is commissioned, the City accepts the responsibility of operating and maintaining the infrastructure according to operation and maintenance (O&M) standards to ensure that the infrastructure is safe and reliable. Operations staff provide the day-to-day support required to operate infrastructure. In few cases, operation costs are minor, but for most there are significant increases.

Maintenance expenses include periodic preventive maintenance to ensure that the infrastructure can provide reliable service throughout the life of the asset and corrective maintenance that is required to repair defective assets as and when needed. Inadequate funding for O&M will have an adverse impact on the lifespan of assets. The O&M resources required in any period is a function of the current inventory of infrastructure and total O&M needs required for each asset. As the inventory of infrastructure grows, total O&M requirements will also grow.

Facility asset O&M cost consists of two major components: general and preventive maintenance. **Table 4-1** provides an overall five-year average O&M actual of $23,408,291. **Table 4-2** presents the estimated five-year average unit O&M cost per building type.

Table 4-1: Historic Facilities O&M Expenditures

Year	Total O&M Actuals
2024	$27,269,000
2023	$25,592,000
2022	$23,227,000
2021	$20,742,000
2020	$16,160,000
5-Yr. Average	**$23,408,291**

Table 4-2: Unit O&M Cost of Building Types

Building Type	5-year Average Unit O&M Cost ($/Sq.ft.)
Administration Building	$ 7.58
Community Centers	$ 6.41
Fire Stations	$ 4.95

[1] Active Together Master Plan 2018 Update (vaughan.ca).

Heritage Buildings	$ 7.69
Libraries	$ 11.61
MNRs	$ 20.97
Parks Washrooms	$ 12.16
Senior Clubs	$ 14.49
Sport Buildings	$ 15.97
Yards	$ 16.28
Other buildings	$ 8.82

The City undertakes scheduled preventive maintenance which includes weekly tasks related to each of the categories: plumbing, HVAC, fire protection, electrical, janitorial, foundation, basement construction, superstructure, exterior enclosure, roofing, interior construction, site civil/mechanical utilities, site electrical utilities and sport fields. These inspections then feed into the City's Facility Maintenance Services Monthly Building Inspection Report.

Table 4-3 presents the five-year average annual general maintenance and cleaning service costs related to preventive maintenance. In particular, the City has the following comprehensive scheduled maintenance plans for its generators:

- Four quarterly inspections for Civic Center and Joint Operations Center.
- Ten semi-annual inspections including fuel/oil sampling.
- Ten annual inspections including oil/filter replacement.
- Ten annual of 100% load testing using auxiliary load banks; each testing is for two hours.
- Annual fuel polishing at all sites for diesel fuel sites.
- Semi-annual fuel conditioning at all diesel fuel sites.

Table 4-3: Facilities O&M Activities and Five-Year Average Costs

O&M Activities	Five-Year Average Cost
General maintenance	$ 2,459,507
Preventative maintenance (Cleaning services only)	$ 899,178

4.4 Renewal and Replacement Strategies

The third portion or phase of full life cycle costing relates to the renewal and replacement of infrastructure that has deteriorated to the point where it no longer provides the required service. Renewal cost is sometimes incurred during the life of an asset where an investment is made to improve the condition and / or functionality of the asset. Disposal and replacement costs are incurred at the end of an asset's life when it is disposed of and replaced by a fully new asset. It is vital that communities fully understand the looming obligations of infrastructure renewal or replacement and develop a strategy to respond in a manner that is fair and affordable. For this analysis, the Facilities assets renewal need is based on age and ESLs.

For growing communities like the City, there has not been a historical need to forecast expenses that are not anticipated for decades. However, based on the experiences of more established Canadian cities (where vast inventories of old assets are now in dire need of renewal or replacement), it is vital that communities fully understand the looming obligations of infrastructure renewal or replacement and develop a strategy to respond in a manner that is fair and affordable.

For the facilities, the City identifies the heritage buildings as a priority for renewal activities as they are politicly sensitive and have approved capital budgets in-place. The City undertakes assessments, repair, and upgrades of the facilities to ensure they are maintained for public use and to make them energy efficient, such as the recent repairs to its recreational facilities. The recent assessments of the Maple Community Centre also provided recommendations to improve the space functionality, energy utilization and upgrades to ensure sustainability and accessibility enhancements. The similar steps for feasibility study will take place for Al Palladini Community

Centre. The City then developed a renovation plan for the community centre based on public feedback and industry best practices.

Currently, the City undertakes various retrofit and renovation projects to meet its carbon net zero target, examples of these projects include LED retrofit program within facilities and the ongoing fire hall renovation project. For this, the City has an Energy Retrofit Fund where $300,000 are allocated annually. The City also embarks on various feasibility studies, such as net zero ice rinks and rooftop solar projects to understand the impact on carbon reduction and to achieve specific performance standards.

The City is currently facing challenges around resourcing, especially for project management as the same staff is responsible for both facility operations and other management related work. Thus, the City envisions to move to a more centralized approach for project management in the near future.

4.5 Disposal and Decommissioning Strategies

There will inevitably come a point in time when an asset must be removed from service and, depending on the type of asset, there may be significant costs associated with its decommissioning and disposal. Factors that may influence the decision to remove an asset from service, include changes to legislation that cause the asset to be in non-compliance, the inability of the asset to cope with increased service levels, technology advances that render the asset obsolete, the cost of retaining the asset is greater than the benefit gained, or the current risk associated with the asset's failure is not tolerable. The current practices at the City look at disposal of Facilities at the end of their useful life.

Normally, major costs that may be incurred during disposal and decommissioning derive from the environmental impact of the disposal and, if required, the rehabilitation and decontamination of land. In some cases, there will be residual liabilities and risks to consider if a decision is made to partially abandon the asset as opposed to fully disposing of its components (e.g., leaving a non-functioning pipe in the ground, or an inactive building standing). For now, there is no formalized procedures in place at the City to track any environmental costs associated with Facilities disposal activities.

4.6 Capital Planning

Capital investment is to address community growth or changes, or to renew existing assets to maintain service levels. For the actual funding needs analysis, please refer to **Section 5**.

- **Life Cycle Cost Analysis Approach**. The City's analysis enables optimized decision making and mathematical deterioration modelling of infrastructure assets and the development of short, medium and long-term forecasts of renewal and replacement costs of a number of decision criteria and the ability to compare different intervention options to find the optimal solution in terms of timing and the intervention option chosen.
- **Forecast Periods.** The City aims to develop Short- to Medium-Term and Long-Term capital plans. Typically, short to medium-term capital plan identifies the activities required to meet current and future demand, the cost of those activities and a financing approach. It is developed or renewed every three to five years and should coincide with regulations on short to medium-term expenditure planning. A long-term plan can serve as part of Strategic Asset Management Plan, which indicates what will be spent, by service areas, over a set period of time. Long-term plans tend to focus only on costs.
  Consistent with the approach of other asset management plans, the analysis periods for funding need assessments are 20 years.

4.7 Asset Prioritization

4.7.1 Risk Assessment

Infrastructure-related risk exposure is assessed based on the combined consideration of probability and consequences of an asset failure, which is used to drive the selection and prioritization of appropriate action, based on risk tolerance thresholds and funding availability. Understanding the risk exposure for a given set of assets allows the City to identify where they are most exposed to risk, and to target their investments to most effectively reduce that exposure.

In addressing risk for infrastructure assets, the first step in the analysis is to identify assets that are most critical to the business. Critical assets are those that will potentially have the greatest impact on service delivery should they fail. It should be noted that the parameters, criteria and weighting factors area starting point, and should be reviewed and modified to reflect the priorities of the City on an ongoing basis.

The fundamental principle of consequence (or criticality) models is that they evaluate the relative importance of assets based on select criteria. The approach to risk analysis within this project utilizes a triple-bottom-line assessment approach utilizing the following four criticality indices:

- **Economic** – influence of the asset's failure on monetary resources
- **Operational** – influence of the asset's failure on operational ability
- **Social** – influence of the asset's failure on society
- **Environmental** – influence of the asset's failure on the environment

By applying specific indices, the risk assessment framework generates a risk (or priority) score for each asset. The risk score is a rating of the asset based on the detailed assessment of the likelihood and consequence of failure based on a number of key parameters. All parameters are then equated using equation [4].

$$Risk = Likelihood\ of\ Failure \times Consequence\ of\ Failure \qquad [4]$$

Based on this principal, the risk associated with a given asset's failure can be managed by limiting the likelihood of this occurring, or the impact realized, should it occur.

Consequences of Failure (CoF) reflect the relative "impact" of a given asset's failure. While traditionally these have been looked at as purely economic terms (i.e. repair cost, loss of revenue, etc.), the truth is that investment decisions are often driven by non-economic factors. Understanding both the economic and non-economic

impacts associated with loss or limitation of service help in categorizing an asset's "criticality" and justifying infrastructure decisions in a consistent, defensible manner.

4.7.2 Analytical Logic to Sequence Interventions

The asset criticality score can be used to prioritize projects within a funding constrained environment. **Figure 4-2** illustrates this logic of carrying unfunded needs to the next year in the period where they receive a higher probability of receiving funds based on their criticality score.

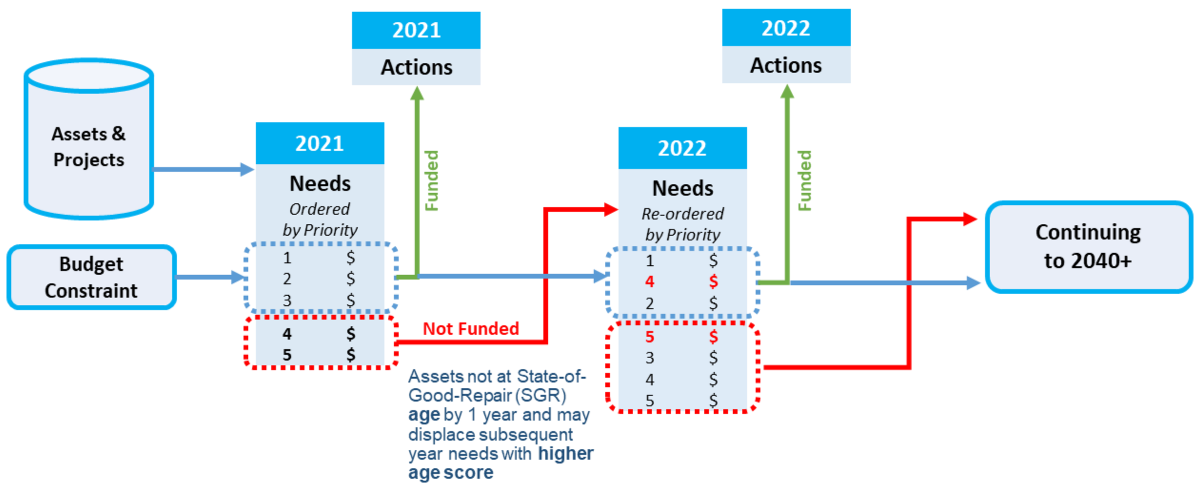


Figure 4-2: The Role of Criticality to Prioritize Projects Within A Funding Constrained Environment

4.8 Financial Planning

4.8.1 Financial Policies

The City has taken the initiative to establish financial asset management policies in 2018, which provides directions on how financial principles apply to assets to ensure that service goals are met. The policy aligns the business model of AM with the City's financial planning, financial reporting, cost management, treasury and taxation functions. The City will integrate findings from the AM Plans into its long-term financial planning and budgeting processes. Sound financial analysis will be encompassed in AM planning in order for the AM Plan to be a sought-after guide for employees in budgeting and financial planning.

4.8.2 Financial Analysis

Financial analysis activities for asset management is centered on two essential quantities: revenues and expenditures. Revenues can come from many sources. Through asset operations, the City generate its own source revenues from taxes, development charges, etc. Expenditures are all the direct and indirect costs associated with capital, operating and maintaining, and disposing of assets.

Assessing the financial implications supports in the decision-making when there are competing priorities and trade-offs between projects. Financial analysis provides a better picture of how to fund the capital plan and make critical decisions about service delivery while providing the greatest benefit for the community at the lowest cost.

4.8.3 Aligning the Financial and Non-Financial Functions of AM

ISO 55010[2] identifies the that the financial and non-financial functions of AM within organizations are generally inadequately aligned, as follows:

- **Financial Accounting Functions:** Focused on retrospective reporting of accounting / regulatory financial activities. However, there is a growing awareness in organizations of the need to focus on providing a managerial costing approach in order to support decision-making for the future.
- **Non-Financial Functions:** Have a limited understanding of financial accounting functions but are recognizing the need to improve their understanding of the financial implications of their activities.

The lack of alignment between financial and non-financial functions can be attributed to silos in an organization, including reporting structures, functional / operational business processes, and related technical data. Silos generally bring forth the necessary level of specialization. However, with a lack a communication between the silos, organizations are at risk of inefficiencies and errors in AM results, or AM failures due to a lack of alignment between AM staff and senior management. Financial and non-financial alignment needs to work both “vertically” and “horizontally”, as follows:

- **Vertical Alignment:** Financial and non-financial asset-related directives by management are informed by accurate upward information flows, effectively implemented across the appropriate levels of the organization.
- **Horizontal alignment:** Financial and non-financial information that flows between departments (conducting functions such as operations, engineering, maintenance, financial accounting and management) uses the same terminology and refers to the assets identified in the same way.

Figure 4-3 presents the key elements in a framework to address the need to achieve the alignment.

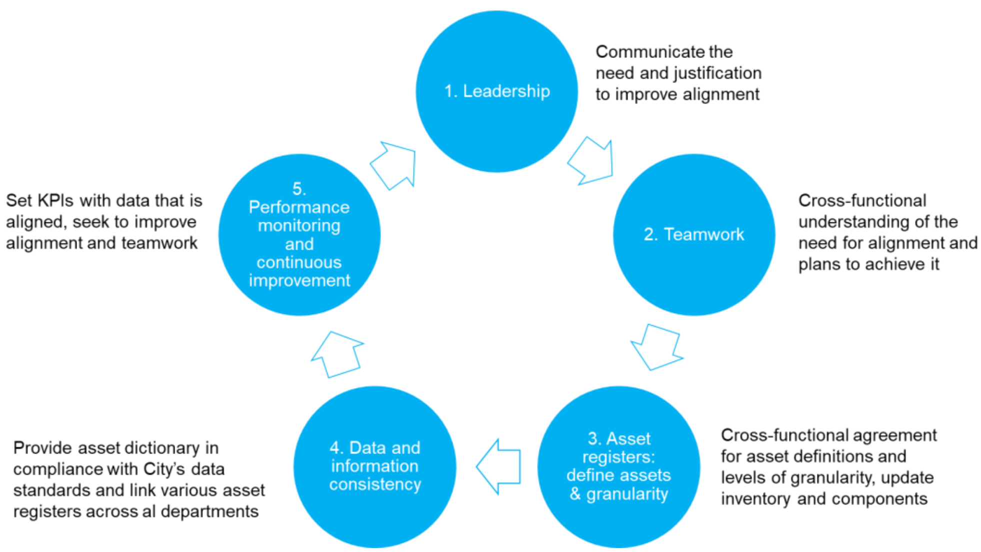


Figure 4-3: Key Elements of a Framework to Achieve Financial and Non-Financial Alignment

4.8.4 Long-Term Financial Planning

Strengthening the City’s Asset Management planning according to the recommendations in Asset Management Strategy will improve the City’s long-term financial planning, by accounting for whole life cycle costs as presented in **Section 4.1**. This includes all capital, annual operation and maintenance, and disposal costs over the planning timeframe, thereby aligning financial requirements with long-term level of service objectives.

The challenge is often one of agreeing on a timeframe for such planning, recognizing that the AM perspective is ideally focused on the asset life cycle, versus the political / election cycle that could be as short as a three to four-year Council term. Accordingly, financial and non-financial staff, as well as top management and politicians,

[2] International Organization for Standardization (2019): ISO 55010 - Asset management — Guidance on the alignment of financial and non-financial functions in asset management

should agree on a long enough timeframe to provide useful forward planning information that aligns the financial and non-financial perspectives, as presented in **Figure 4-4**.

Figure 4-4: AM Planning Alignment Across the Organization

The City should have an appropriate long-term financial planning process that achieves the following:

- Stimulates long-term strategic thinking and perspective for stakeholders and decision-makers.
- Can be used as a tool to prevent or predict future financial shocks and demonstrate financial sustainability.
- Demonstrates to internal and external stakeholders that the organization has a financial strategy in place to meet their demands, now and in the future.

The long-term financial planning process needs to involve financial and non-financial staff working together to combine the important elements of strategy development, asset management planning and financial forecasting (**Figure 4-3** and **Figure 4-4**).

5. Funding Need Analysis

The lifecycle analysis was implemented in an MS Excel Asset Lifecycle Model, which integrated asset inventory, age, ESL, replacement values, and condition to create a theoretical asset replacement cycle for each Facilities asset. The asset reinvestment forecasts prepared for this assessment are estimates of what it will cost over the next 20 and 60 years to sustain the City's each Facilities assets.

The annual renewal needs for buildings were based on Class D estimates provided by the most recent building condition assessment reports in 2024 dollars, while the annual reinvestment need for tanks and generators were based on age and ESL (i.e., replacing assets that have exceeded their ESL) in 2024 dollars. It should be noted that the nature of this type of analysis is based on a wide range of data inputs, currently available information, and a number of assumptions, and is therefore at best a high-level estimate of future funding needs.

5.1 20-Year Reinvestment Funding Need

The average annual reinvestment rate for the City's facilities assets is $26M over the next 20 years in 2024 dollars. This is equivalent to a total of approximately $523M over the next 20-year period, as presented in **Figure 5-1**.

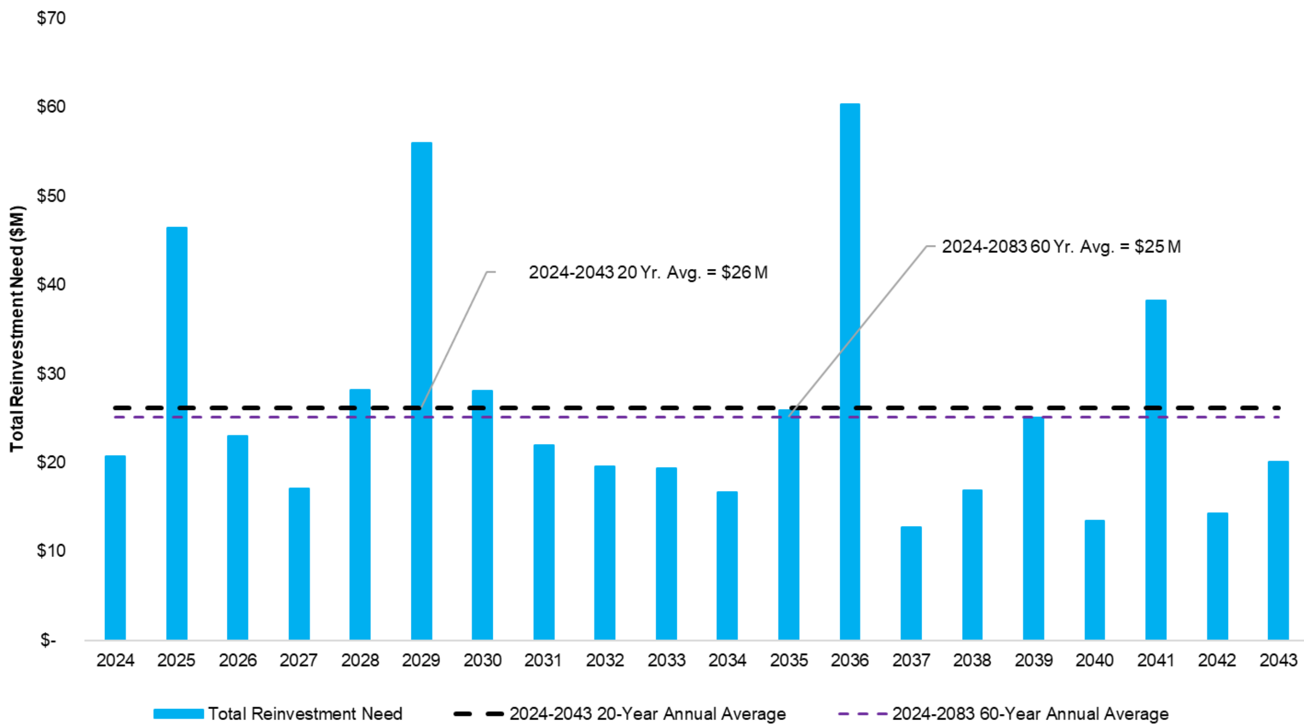


Figure 5-1: Facilities 20-Year Reinvestment Need

The detailed reinvestment needs in 2024 dollars for each building type are presented in **Figure 5-2** and **Table 5-1** The administration buildings and community centers are the top two building categories that require significant reinvestment funding.

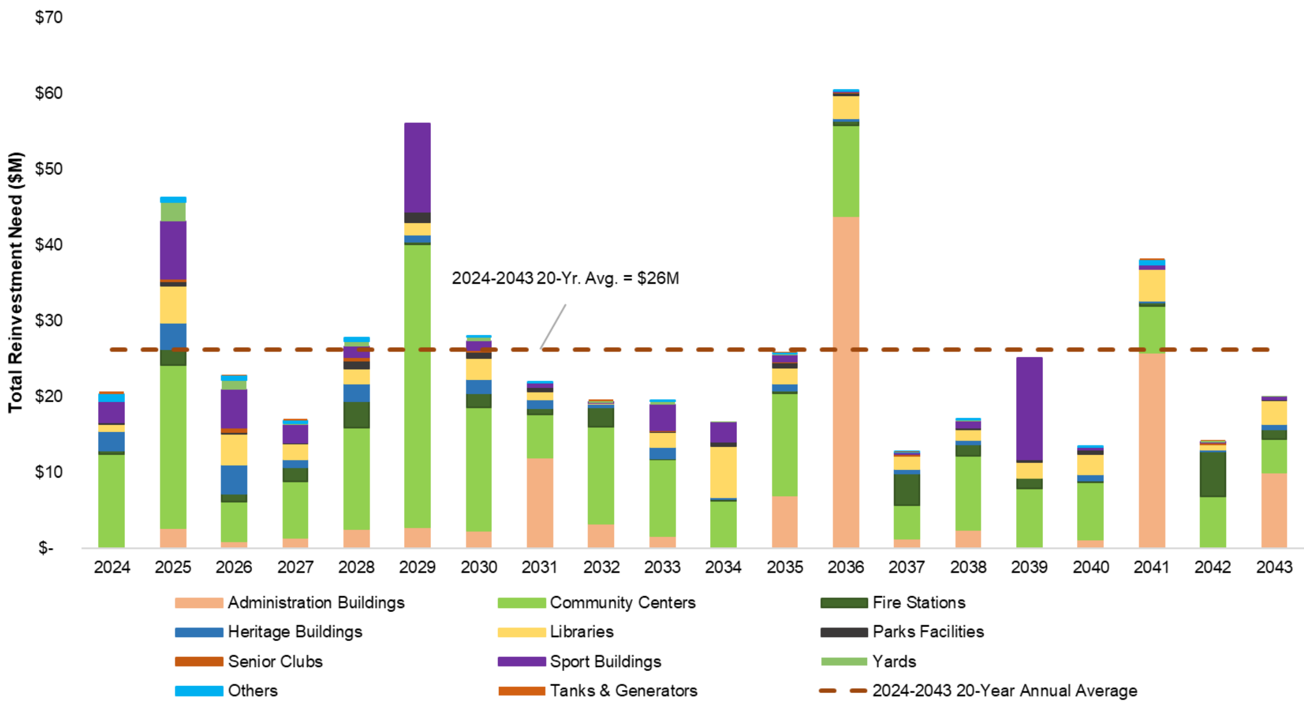


Figure 5-2: Facilities 20-Year Reinvestment Need Details

Table 5-1: Facilities 20-Year Total and Annual Average Reinvestment Need

Asset Type	Annual Average Need	20-Year Total
Administration Buildings	$6,040,400	$120,807,000
Community Centers	$11,034,700	$220,693,000
Fire Stations	$1,540,700	$30,815,000
Heritage Buildings	$1,189,600	$23,792,000
Libraries	$2,473,200	$49,464,000
Parks Facilities	$388,600	$7,772,000
Senior Clubs	$142,200	$2,845,000
Sport Buildings	$2,727,200	$54,544,000
Yards	$367,600	$7,351,000
Other building facilities	$190,700	$3,815,000
Tanks & Generators	$76,500	$1,530,000
Total	$26,171,400	$523,427,000

5.2 Full Funding Need Profile

Figure 5-3 shows a full picture of the City's Facilities funding need forecast over the next 20 years, which provides the City the full funding requirements to perform effective financial planning activities. The total annual reinvestment rate from **Figure 5-1** was overlaid with the City's Facilities O&M cost, in 2024 dollars.

Facilities assets requires approximately $23.4M annually over the next 20 years for O&M, equivalent to a total of $472M in 2024 dollars. As such, with the addition of O&M, the total average annual funding need for the City's facilities assets increases to approximately $50.4M annually, for a total of $1.01B over the next 20-year period.

It is important to note that the City is taking responsibilities of new buildings which indicates additional funding need for O&M cost and the reinvestment need. The annual O&M and reinvestment need for Carrville Library (expected to be in service in 2024) was estimated and added on top of the City's O&M and reinvestment funding need starting from 2025.

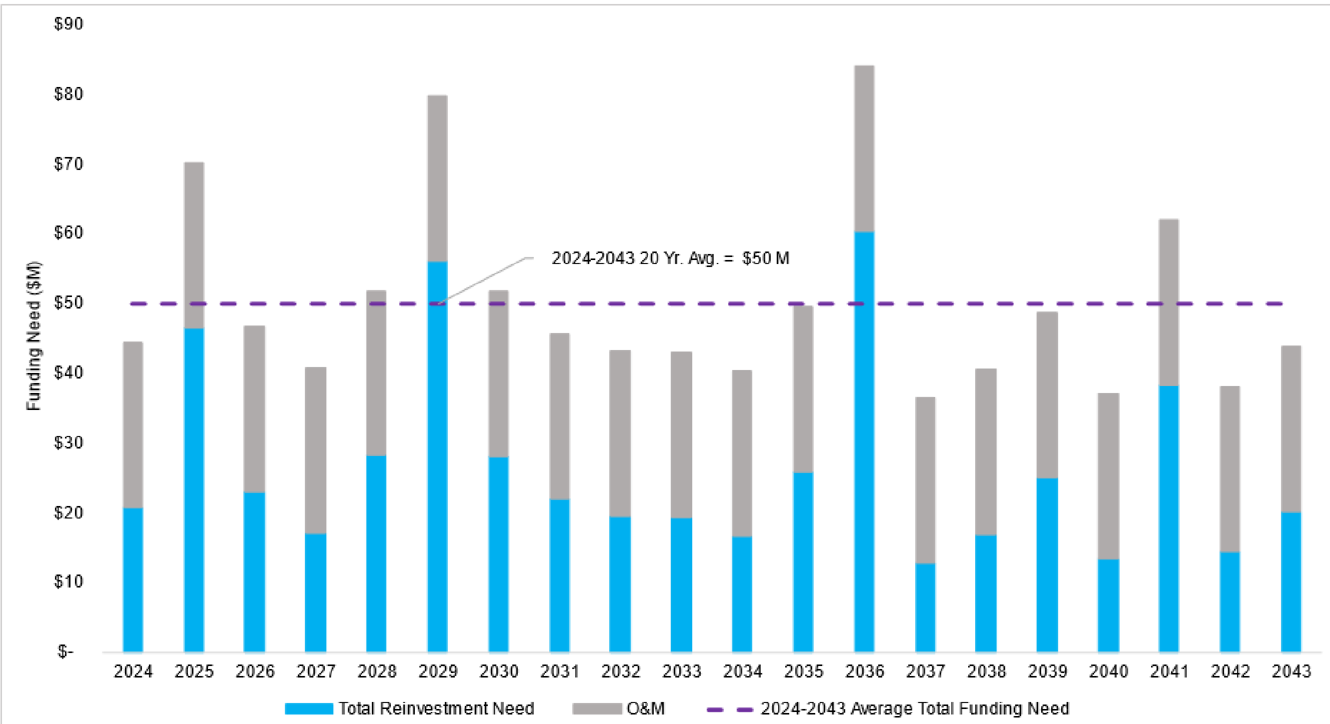


Figure 5-3: Facilities 20-Year Capital Investment and O&M Cost Forecast

5.3 Infrastructure Reserves Funding Forecast

Reserve funds are important tools in the planning and management of the City's financial resources and provide a strong indicator of the City's overall financial health and are fundamental to the City's long-term financial sustainability. The City is committed to maintaining healthy reserve fund balances which are collected through various means (i.e., development charges, contributions, dedications, taxation, etc.).

There are specific infrastructure reserves for the tax-supported service areas of Roads, Facilities, Parks, Fleet and Fire. These reserves contain funds set aside through annual contributions from taxation to help pay for the repair and replacement of infrastructure assets. Like many municipalities across Canada, Vaughan is facing increased costs associated with maintaining aging infrastructure. Corporate Asset Management Plans for both core and non-core assets suggest the City's infrastructure deficit is large and growing. The City has continued with robust strategies and plans by developing a comprehensive Long-Range Fiscal Plan and model, which was used to better inform the 2025 and future budgets by providing information about the financial requirements to sustain growth, delivery of services and the community's infrastructure needs.

Prudent financial planning requires ongoing contributions to Facilities reserves to fund the repair and replacement of infrastructure. To achieve this, continued operating and infrastructure investments are critical to ensure the City's Facilities assets remain financially sustainable now and into the future. This objective is supported by continuing to build service area infrastructure reserves. The 2024 reserve contribution for Facilities reserves totalled $11.1M with the City being committed to ensuring the financial sustainability of its Facilities assets.

The City's Asset Management Plans assess average reinvestment requirements over the next 20 years for the City's assets, including Facilities infrastructure. Annual reserve contributions should generally be in line with the asset reinvestment requirement to ensure sufficient funds are set aside for asset rehabilitation and replacement needs.

For the Facilities service area, the forecasted 20-year average funding need is $26.2M. In comparison, the average annual funding forecasted over the next 10 years is estimated to be $10.4M representing a funding coverage of 40% as illustrated in Error! Reference source not found.. The funding sources in this forecast are limited to annual reserve contributions, capital from taxation and the Canada Community-Building Fund (CCBF is provided from the Federal Government). Other available funding sources not included are debentures and non-CCBF grants, which would mitigate any infrastructure funding gaps.

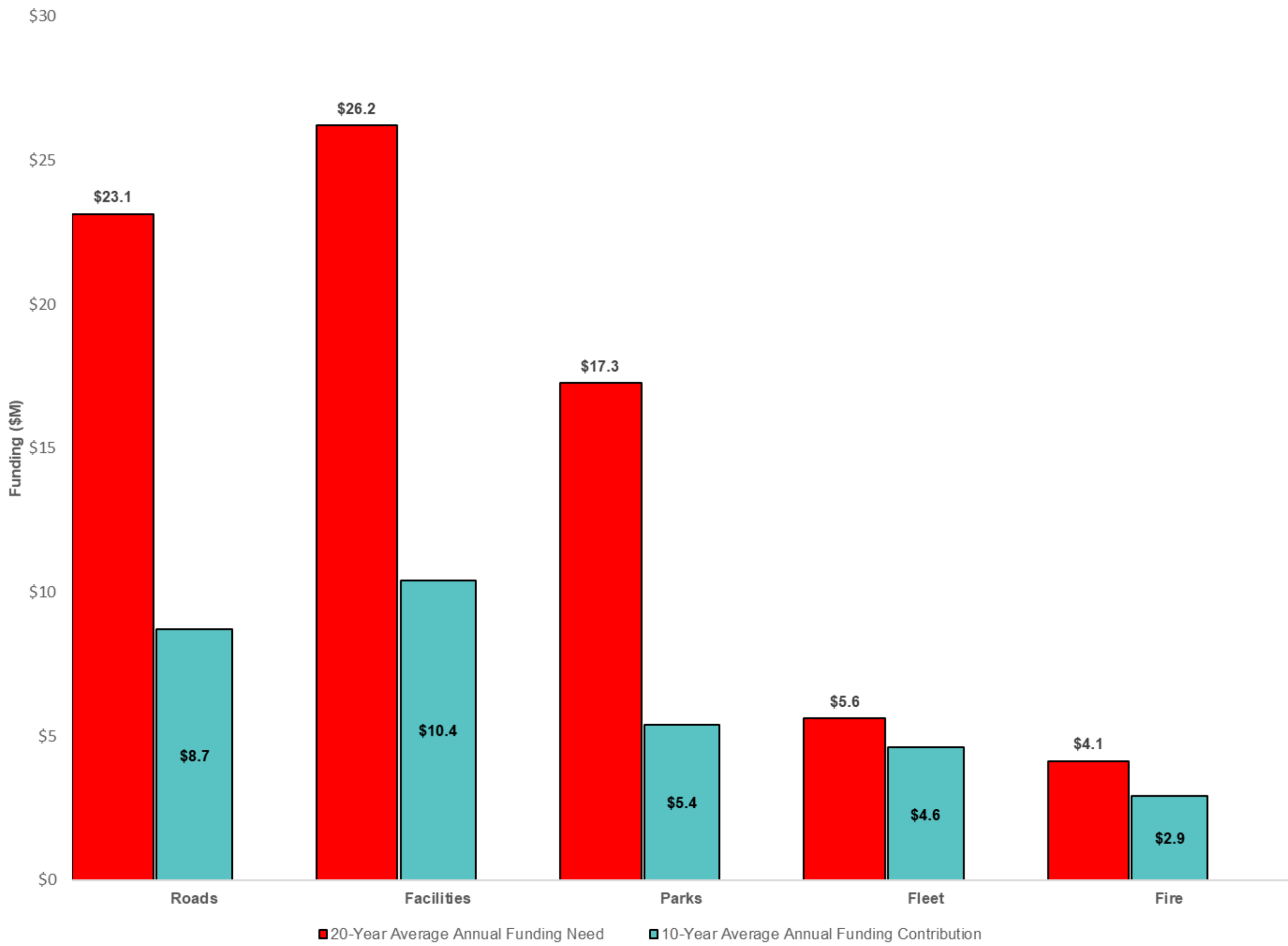


Figure 5-4: Coverage of Average Annual Funding Needs for Tax-Supported Service Areas

Revisiting the timing and scope of capital projects, optimizing the use of existing funding tools and revenue sources, such as debt and dedicated contributions to capital reserves, can help increase the City's capacity to begin to close an infrastructure funding gap.

5.4 Growth-related Assets Funding Need

The City completed a Long Range Fiscal Plan (LRFP) in 2022, which included a model to support planning to meet Facilities infrastructure needs as the City's communities continue to grow. This model analyzed the city-wide infrastructure needs to identify the required infrastructure that will meet future servicing demands. The model assessed the existing and future servicing needs and provides servicing recommendations to meet the City's growth plans. Based on the model, the forecasted funding need estimates for the construction of new Facilities assets out to 2031 is illustrated in Error! Reference source not found. with a primary funding source for these needs being Development Charges.

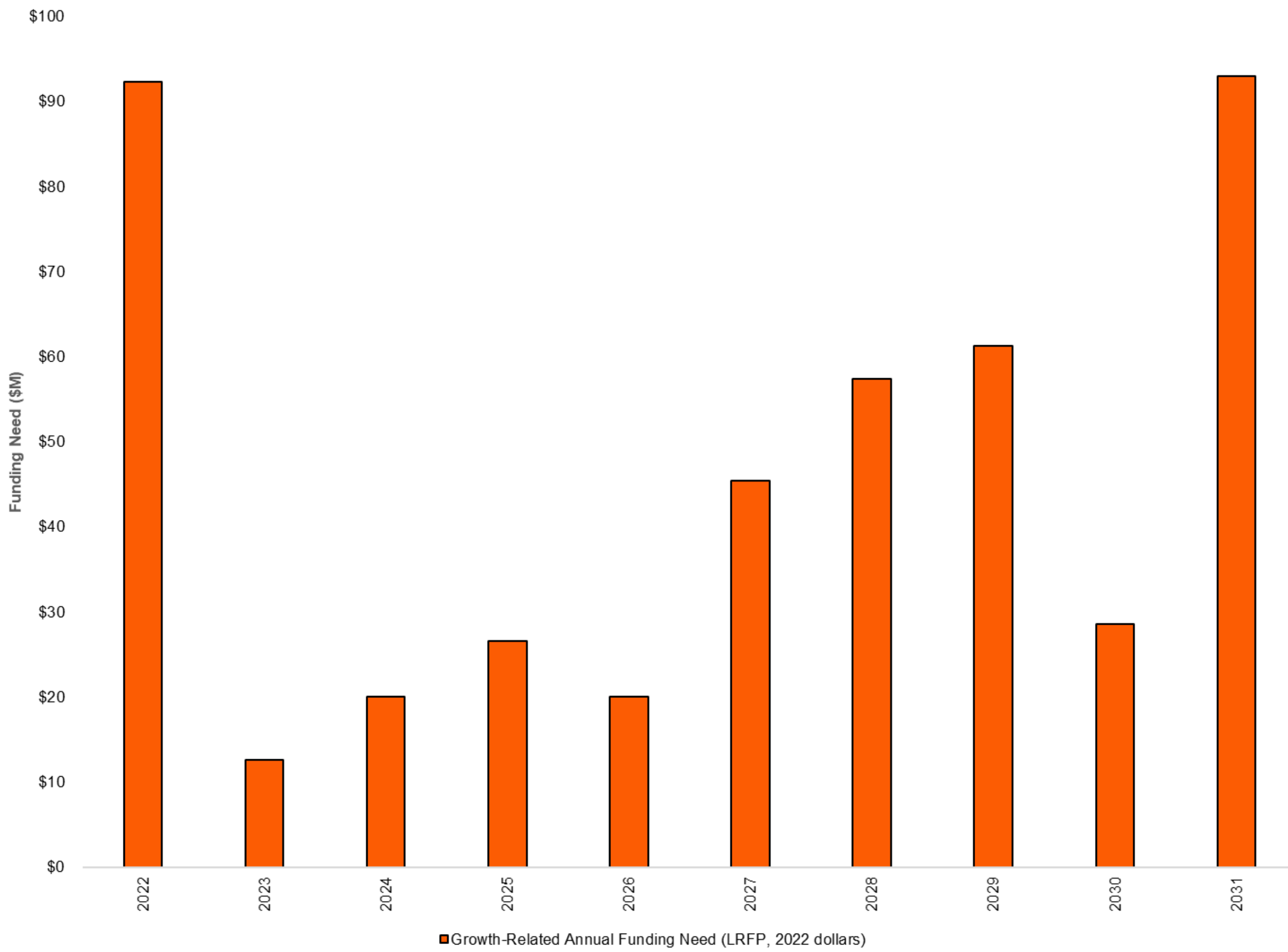


Figure 5-5: Forecasted Funding Needs for Construction of New Facilities Assets

One of the next steps in the further development of the LRFP is to apply added detail to the forecasted funding need estimates. This will provide a more refined forecast, which will serve to provide additional guidance for Asset Management planning in the future at the City of Vaughan.

Asset Management Plan

Non-Core Assets
Parks

City of Vaughan
March 2025

Table of Contents

Figures

Tables

1. Introduction

The City of Vaughan (The City) has conducted a renewal of the City's Asset Management (AM) Plans for all its infrastructure assets, including park assets.

1.1 Background

The City is one of nine area municipalities located within the Regional Municipality of York. As a lower tier municipality, the City is responsible for providing services such as buildings, fire protection, public works, water distribution, wastewater collection, and parks and recreation.

The next 25 years will see the City transition from a growing suburban municipality to a fully urban space. This type of transition will require long-term thinking about how best to accommodate and make the most of new opportunities. Planning for the future through strategic planning will position the City to deal with the many pressing issues impacting the organization such as community safety, access to health facilities, environment, traffic congestion and issues related to growth and the quality of municipal services.

The City is one of Canada's fastest growing cities, with a population of over 320,000 according to the latest census from Statistics Canada. It is projected that the number of residents will increase to 415,000 by 2031. In addition to its rapidly growing population, the City is home to a well-diversified and expanding employment sector with over 7,800 businesses and 231,000 employees. The City has the largest supply of new employment lands in the Greater Toronto Area (GTA), and it is projected that the number of employees will increase to 271,000 by 2031.

1.2 Objectives

In 2018, by City Council approval, the Corporate Asset Management (AM) Policy for the City came into effect; and, in 2013, the City's first Corporate AM Strategy was published. As identified in the Corporate AM Strategy, the City's first set of AM Plans (AMPs) were developed in 2014.

In early 2021, the City updated its AM Strategy and core infrastructure AMPs, as per Ontario Regulation (O. Reg) 588/17. The purpose of this series of AMPs is to now update the infrastructure assets so as to provide the City with a comprehensive updated AM Plan.

The objective of this AMP is to deliver a financial and technical roadmap for the management of the City's roadway appurtenance assets, and to provide the means for the City to maximize value from its assets, at the lowest overall expense while, at the same time, providing enhanced service levels for its residents and promoting green initiatives.

Organizations that implement good AM practices will benefit from improved business and financial performance, effective investment decisions, and better risk management. Stakeholders can expect lower total asset life cycle costs, higher asset performance, and confidence in sustained future performance.

1.3 AM Provincial Requirements

The Ontario Regulation 588/17 (O. Reg. 588/17) came into effect in 2018 and stipulates specific AM requirements to be in place within Ontario municipalities by certain key dates (**Table 1-1**). The development of this AMP is one of the steps to guide the City towards meeting the July 1st, 2025 deadline.

Table 1-1: O. Reg. 588/17: AM Planning for Municipal Infrastructure

Description: A regulation made under the Infrastructure for Jobs and Prosperity Act, 2015, stating that every municipality shall prepare and update a Strategic AM Policy, and that every municipality shall prepare an AM Plan for its core infrastructure assets by July 1, 2022, and an AM Plan for all other infrastructure assets by July 1, 2024. The regulation outlines several requirements that each AM Plan must follow, such as including current and proposed level of service. Core municipal infrastructure assets include water, wastewater, stormwater, road, and bridge assets.	
Deadline Date	Regulatory Requirement
July 1st, 2019	All municipalities are required to prepare their first Strategic AM Policy.
July 1st, 2022	All municipalities are required to have an AM Plan for its entire core municipal infrastructure (i.e., water, sanitary, stormwater, and transportation).
July 1st, 2024	All municipalities are required to have an AM Plan for infrastructure assets not included under their core assets.
July 1st, 2025	All AM Plans must include information about the levels of service that the municipality proposes to provide, the activities required to meet those level of service, and a strategy to fund activities.

1.4 Scope

This AMP has been developed for the Parks assets, which are owned and maintained by the City, as shown in **Table 1-2**.

Table 1-2: In-Scope Parks Assets

Asset Category	Asset Types
Sports Fields	Baseball Diamonds, Basketball Courts, Bocce Courts, Soccer Fields, and Tennis Courts.
Park Amenities	Benches, Fitness Equipment, Field Benches, Field Bleachers, Ice Rinks, Picnic Tables, Playgrounds, Skate Parks, Spray Pads, and Trash Cans.
Parks Transportation Infrastructure	Park Pathways, Park Parking Lots, and Park Signs.
Parks Electrical	Parking Lot Lights, Pathway Lighting, Pathway Light Underground Cables
Parks Structures	Shade and Shelters
Cemetery Amenities	Benches, Bollards, Entry Gates, Fences, Flag Poles, Flower and Plantings, and Trash Cans
Cemetery Buildings	Buildings/Storages, Monuments
Cemetery Transportation Infrastructure	Pathways, Roads, Signs, Stairs

The following elements are included within the scope of this AMP:

- A summary of the asset inventory, including the replacement cost of the assets, the average age of the assets, the condition of the assets, and the City's approach to assessing the condition of the assets.
- Current levels of service (LoS) based on performance measures.
- Asset lifecycle management strategies to maintain identified current LoS, minimize associated asset risks, and to optimize costs over the whole lifecycle of the asset.

1.5 Approach for Asset Management Plan

The approach used in the renewal of this AM Plan is presented in **Figure 1-1**, and has been selected to ensure that the City can have the confidence to make fact-based and defensible business decisions from reliable and robust information.

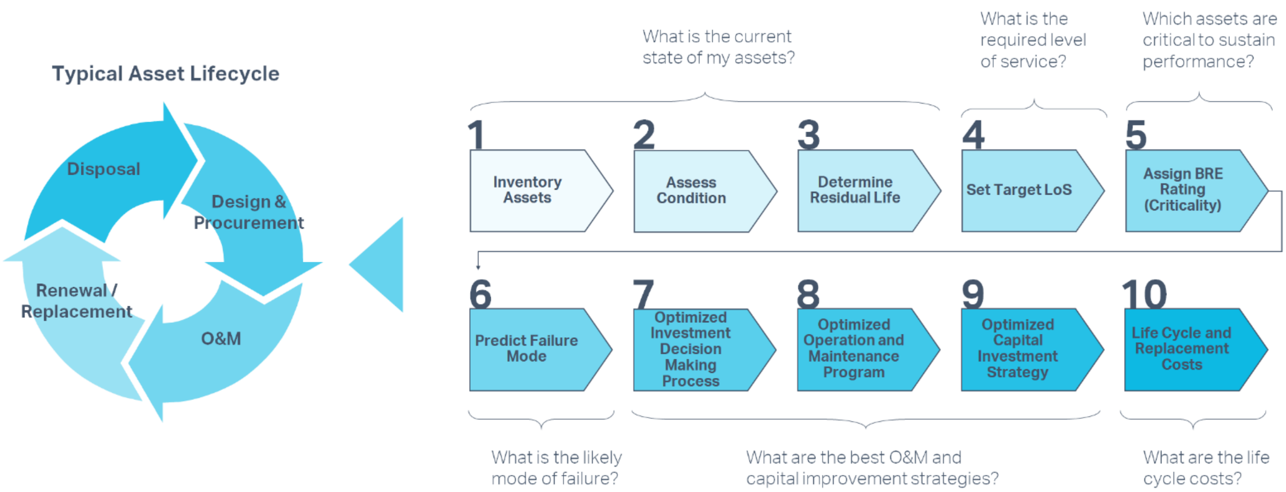


Figure 1-1: AM Plan Approach

2. State of Infrastructure

The City's network of parks includes over 230 sites distributed across the City accounting for approximately 640 hectares of park areas within the City's municipal boundaries. The Parks Operations maintains and operates parks assets that contribute to the quality of life and liveability of the City to meet the current and future needs of the community in a sustainable manner.

Table 2-1 present the inventory of Parks according to the City's parkland classification system outlined in the 2018 Vaughan Parks Redevelopment Strategy[1].

Table 2-1: City of Vaughan Parks Inventory and Classification

Park Type	Count	Hectares (ha)
Neighbourhood	199	386
Public Square	7	1
District	15	112
Regional	4	133
Greenway	8	4
Total	**233**	**636**

[1] City of Vaughan. 2018. Vaughan Parks Redevelopment Strategy

2.1 Asset Inventory and Hierarchy

Table 2-2 presents the City's Parks assets inventory and hierarchy. Parks assets are categorized into four categories: Sports Fields, Park Amenities, Transportation Infrastructure and Structures.

The City's sport fields include a total of 385 fields of baseball diamonds, basketball courts, bocce courts, soccer fields, and tennis courts. Park amenities include 1,624 assets such as playgrounds, picnic tables, etc. Transportation Infrastructure include 100 km park pathways, 22 park parking lots, and 986 park signs. There are a total of 167 shade and shelters.

Table 2-2: Parks Inventory and Hierarchy

Asset Category	Asset Type	Quantity	Unit of Measure
Sports Fields	Baseball Diamonds	61	Ea.
	Basketball Courts	75	Ea.
	Bocce Courts	23	Ea.
	Ice Rinks	8	Ea.
	Skate Parks	10	Ea.
	Soccer Fields	148	Ea.
	Tennis Courts	60	Ea.
Park Amenities	Benches	955	Ea.
	Fitness Equipment	23	Ea.
	Picnic Tables	168	Ea.
	Playgrounds	296	Ea.
	Soccer Benches	101	Ea.
	Soccer Bleachers	58	Ea.
	Spray Pads	23	Ea.
Transportation Infrastructure	Pathways	105	km
	Park Parking Lots	22	Ea.
	Park Signs	986	Ea.
Electrical	Parking Lot Lights	195	Ea.
	Pathway Lighting	2,112	Ea.
	Pathway Light Underground Cables	53	km
Structures	Shade and Shelter	167	Ea.
Park Buildings	Storage Bunkers	4	Ea.

2.2 Current Asset Replacement Value

The estimated replacement value is the cost of replacing an existing asset in 2024 dollars. These costs are collected from the City's GIS record. Where applicable, a CPI-based inflation rate was used to estimate the 2024 values.

Table 2-3 shows that the City owned parks assets are valued at approximately $296M, with sports fields and parks amenities comprising approximately 33% and 40% of the total replacement value, respectively. Note that the real-estate value of parklands is not included in this AMP. Furthermore, park related washrooms, storage bunkers, and club buildings are under the Facility AMP. In addition, bridges and trees are captured under the Transportation AMP, and Urban Forestry AMP, respectively.

Table 2-3: Park Assets Current Replacement Costs

Asset Category	Asset Type	Unit Cost ($ / Unit)	Total Replacement Value
Sports Fields	Baseball Diamonds	$61,000 - $597,000	$23,236,000
	Basketball Courts	$54,000 - $113,000	$7,661,000
	Bocce Courts	$96,000 - $603,000	$7,003,000
	Ice Rinks	$1,270,000	$12,191,000
	Skate Parks	$225,000 - $1,110,000	$3,075,000
	Soccer Fields	$17,000 - $2,211,000	$37,395,000
	Tennis Courts	$81,400 - $383,000	$10,725,000
Park Amenities	Benches	$2,260	$2,256,000
	Fitness Equipment	$33,800	$886,000
	Picnic Tables	$2,600	$457,000
	Playgrounds	$56,400 - $508,000	$105,423,000
	Soccer Benches	$3,100	$329,000
	Soccer Bleachers	$6,000	$559,000
	Spray Pads	$233,000 - $326,000	$7,536,000
Transportation Infrastructure	Pathways	$150 / m	$15,698,000
	Park Parking Lots	$115 / m2	$12,767,000
	Park Signs	$415 - $5,500	$1,805,000
Electrical	Parking Lot Lights	$8,000	$1,636,000
	Pathway Lighting	$8,000	$17,719,000
	Pathway Light Underground Cables	$75 / m	$4,147,000
Structures	Shade and Shelter	$45,100 - $226,000	$22,991,000
Park Buildings	Storage Bunkers	$118,250	$981,000
Total			**$296,476,000**

2.3 Age and Remaining Service Life

The asset age is based on the install year of the assets and the remaining service life (RSL) is estimated by using age and expected service life (ESL) in years. The ESL for each asset is obtained from the City's inventory record.

The ESL is defined as the period over which an asset is available for use and able to provide the required LoS at an acceptable risk (i.e., without unforeseen costs of disruption for maintenance and repair). The actual service life can vary significantly from the ESL. In some instances, a variation in expected vs. actual service life is evident due to the following factors:

- **Operating conditions and demands:** Some assets are operated intermittently or even infrequently or is being operated a lower demand than its design capacity, thus the actual operating "age" of the asset is reduced.
- **Environment:** Some assets are exposed to very aggressive environmental conditions (e.g., corrosive chemicals), while other assets are in relatively benign conditions, thus the deterioration of assets is affected differently.
- **Maintenance:** Assets are maintained through replacement of components, which prolongs the service life of the asset.
- **Technological Obsolescence:** Some assets can theoretically be maintained indefinitely, although considerations such as maintenance cost, energy inefficiency and new technologies are likely to render this approach uneconomical.

Figure 2-1 shows the average asset age and RSL as a proportion of average ESL weighted by replacement value for each asset type.

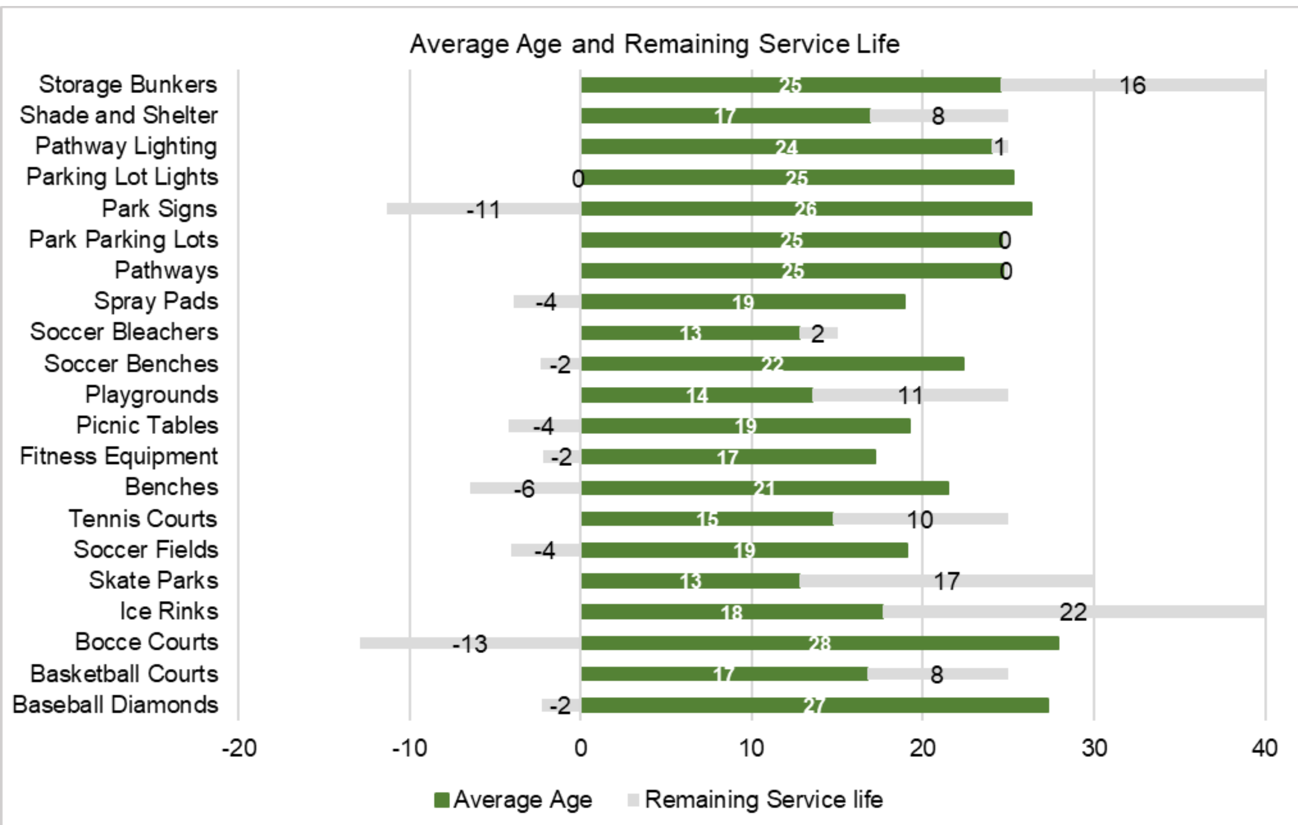


Figure 2-1: Parks Asset Average Age and Remaining Service Life

2.4 Asset Condition

2.4.1 Age-Based Condition Assessment

Two-parameter Weibull distribution function was used to assess the current condition and to project the future condition of the City's parks assets. The Weibull distribution has been used extensively in reliability studies and lifetime prediction models in industries ranging from the automotive to the oil and gas industries; it provides a suitable distribution for this type of analysis.

The Weibull probability distribution provides a left-skewed distribution that rises slowly and diminishes quickly as the population is consumed. The underlying premise of the Weibull-shaped deterioration is that while some assets fail prematurely due to severe conditions or improper installation, other assets are very long-lived and function well beyond their theoretical expected service life. In order to perform a high order network-level analysis, it was assumed that assets would fail (and require replacement) within a deterioration envelope / curve approximated by a Weibull probability distribution. The two-parameter Weibull cumulative distribution has two parameters for scale and shape, as set out in Equation [1]:

$$f(x;\alpha,\beta) = e^{-\left(\frac{x}{\beta}\right)^{\alpha}} \qquad [1]$$

Where: x = Age
α = Shape parameter
β = Scale parameter (or slope)

Table 2-4 presents the condition score ranges and the corresponding range of ESL and total life consumed.

Table 2-4: Age-Based Physical Condition Scale

Condition Score (minimum)	Condition Score (maximum)	Condition Rating	Range % of ESL Consumed	Range of % Operational Life Consumed
1.0	1.5	Very Good	0% – 71%	0% – 47%
1.5	2.2	Good	72% – 84%	48% – 56%
2.2	2.8	Fair	85% – 92%	57% – 60%
2.8	5.0	Poor	93% – 100%	61% – 100%

2.4.2 Condition Summaries

Figure 2-2 provides a summary of the condition weighted by replacement value for Parks assets. It shows that almost 73% of the assets are in Very Good to Good condition. However, 24% of the Parks assets are in Poor condition indicating that they have reached or exceeded their ESL and require renewal or replacement, most likely, in the short-term. The remaining 3% of assets are in Fair condition, based on Replacement Value, indicating that they are meeting current needs but may require attention as they age. Note that trash cans and underground pathway lighting cables have not undergone a condition assessment, thus, they are not represented in Figure 2-2. In addition, it is noteworthy that the condition rating percentages in the Parks Redevelopment Strategy (2018) differ from this plan, as the former is based on a count-based approach, whereas the latter is based on a Replacement Value approach.

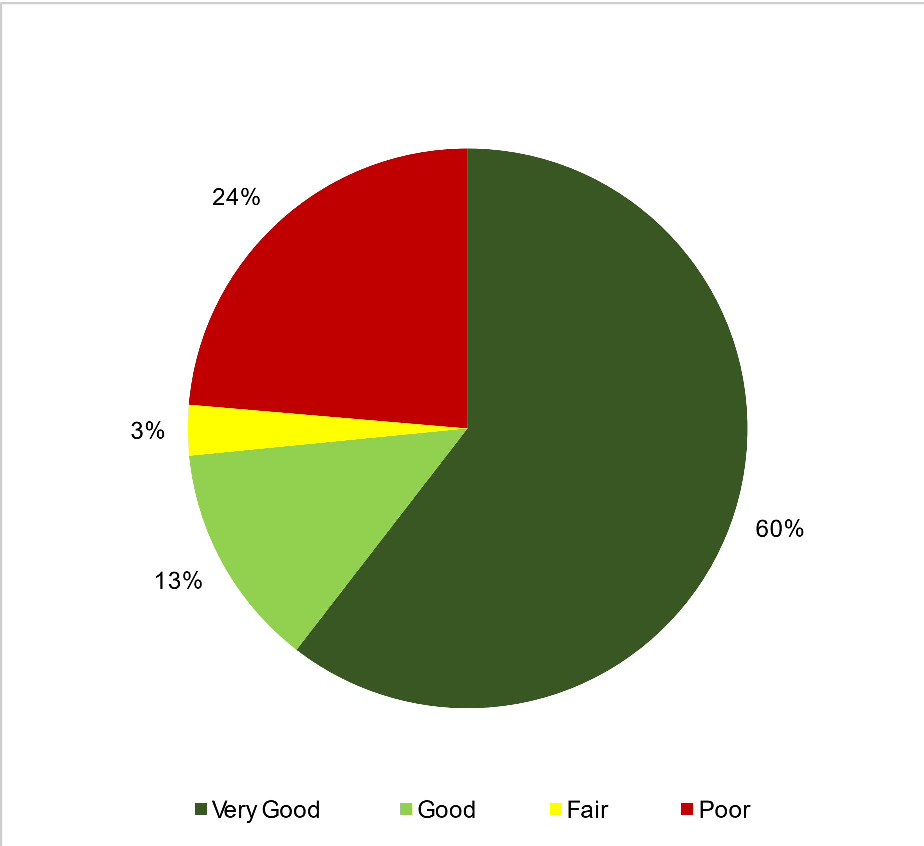


Figure 2-2: Parks Asset Condition Summary

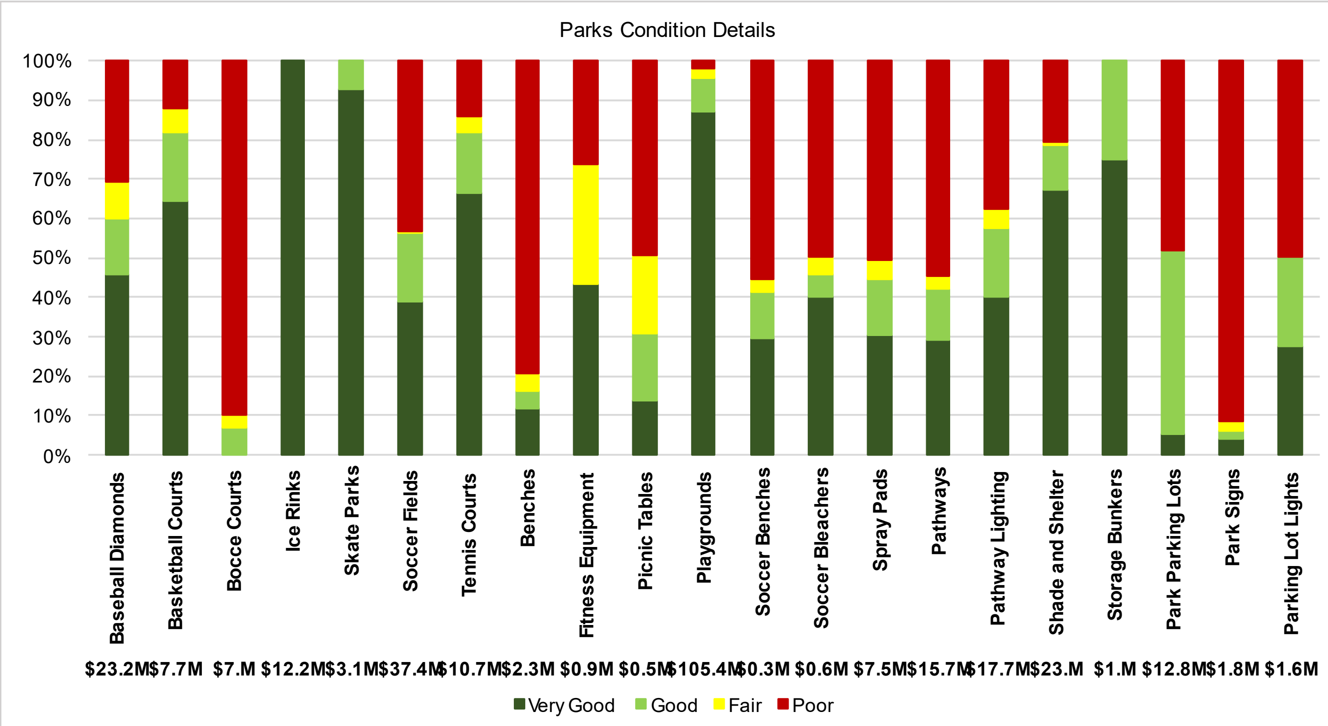


Figure 2-3 presents the distribution of condition for parks asset types weighted by replacement value. The total replacement cost for each asset type is also presented in the horizontal axis. The City has approximately 96% of playgrounds (the highest replacement value among parks assets) in Very Good to Good condition. Overall, ice rinks and skate parks are in Very Good to Good condition. As per the same graph, Bocce courts have over 90% in Poor condition.

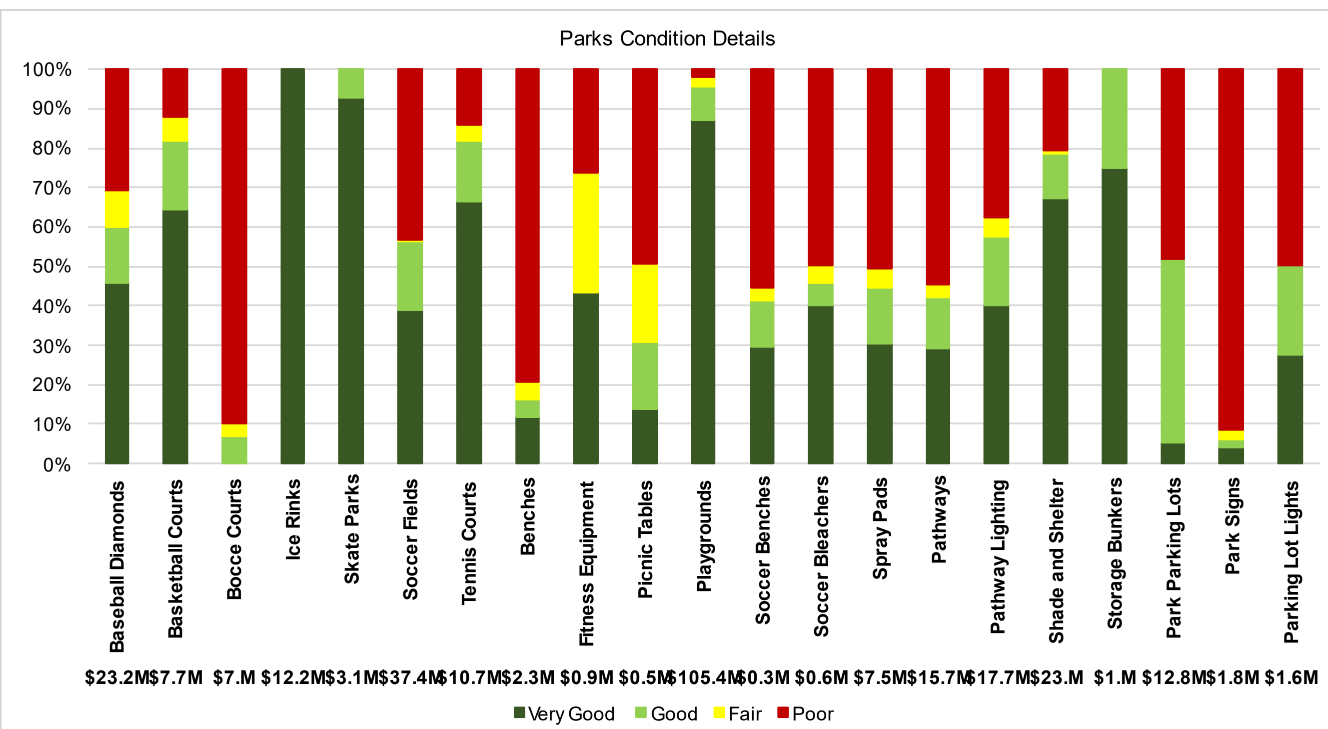


Figure 2-3: Distribution of Parks Asset Condition

3. Levels of Service

3.1 Purpose

Levels of Service (LoS) supports every aspect of the overall AM System as shown in **Figure 3-1**. The objective of establishing clearly defined service levels is to help the City meet stakeholder values, achieve its strategic goals, make informed risk-based decisions, and implement effective asset lifecycle activities.

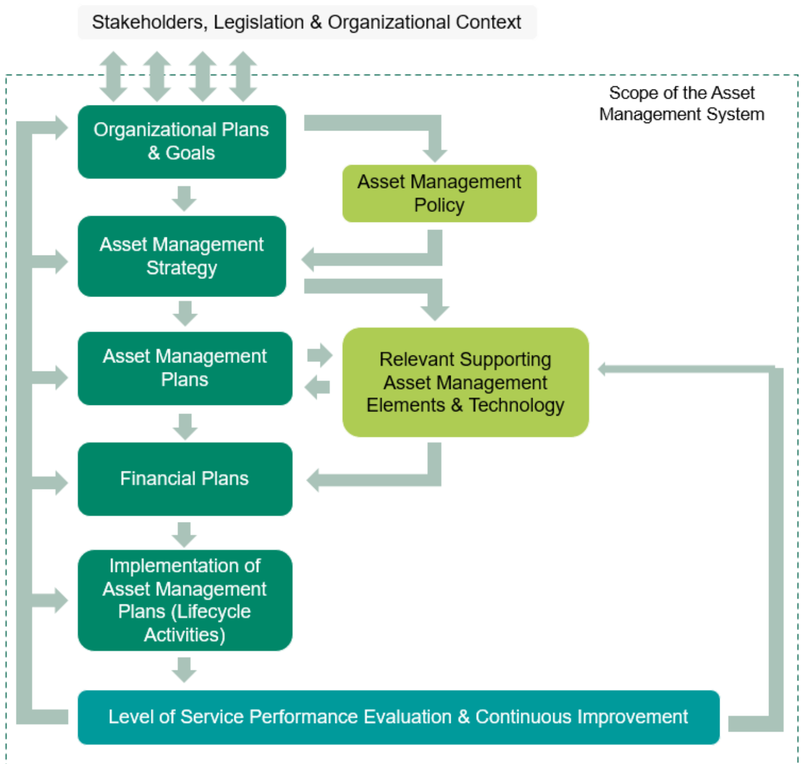


Figure 3-1: LoS within the AM System

In the City's experience, documenting LoS is a proven practice that will enable the City to:

- Link corporate strategic objectives to customer expectations and technical operations.
- Balance customer needs and expectations while evaluating the effectiveness of operations and whether the right LoS is being provided at the right cost.
- Transition from an "Asset Stewardship" approach that focuses on making decisions based on maintaining assets in an acceptable condition to a "Serviceability" approach that is geared towards making decisions based on balancing the costs, risks, and goals for the LoS being provided by the City's assets.
- Communicate the physical nature of infrastructure that the City owns and is financially responsible for while promoting the use of LoS to enable effective consultation with stakeholders regarding alternative funding options according to desired LoS outcomes.
- Make recommendations on strategies that the City can take now to minimize future renewal costs while ensuring that adequate LoS can be delivered without burdening future generations.
- Assess internal (e.g., program changes) and external (e.g., climate change) factors that have the potential to impact the City's ability to deliver services and how these factors may impact the LoS being provided.
- Implement a corporate continuous improvement program to further optimize AM across all service areas.

The O. Reg. 588/17 requires that all AMPs include information about the LoS that the City proposes to provide, the activities required to meet those service levels, and a strategy to fund those activities. The deadline for formalizing these LoS requirements is July 1, 2025 (see **Section 1.3**).

Successful AM programs aim to achieve targeted service levels through customer-based decision making. To achieve this, the City considered a customer-centric approach, where the customer is at the heart of every decision from development to implementation, consultation, and roll-out of the LoS Framework (**Figure 3-2**).

There are two types of LoS measures: Customer LoS (also called "Community" LoS) and Technical LoS. Customer LoS are recorded in a manner that attempts to describe the LoS in terms of what is actually being provided to the customer (i.e., the public) and how the customers experience the service. It is important to note that customers are not concerned with the specific operating requirements of the assets that provide the service, but rather the value they obtain from the operation of the assets. To achieve Customer LoS there needs to be line of sight between the value delivered and how that value is realized. This is the purpose of Technical LoS which attempts to describe how the City will provide and meet the expected Customer LoS.

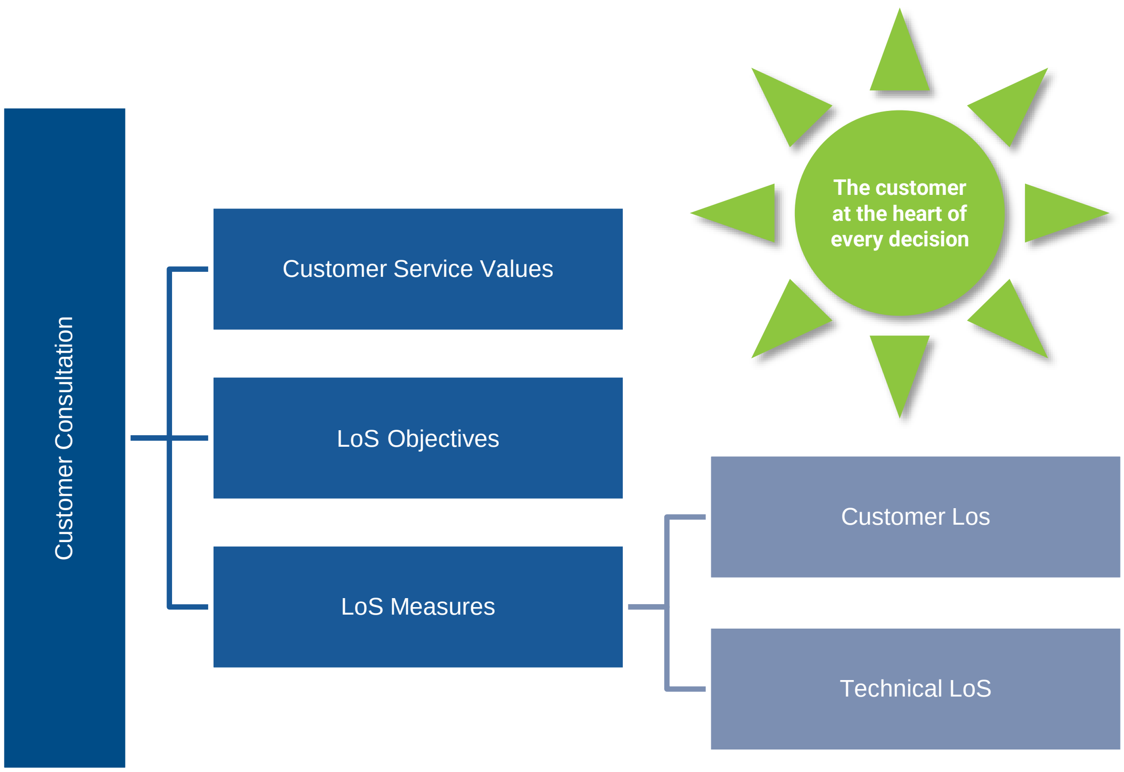


Figure 3-2: The LoS Framework Customer-Centric Approach

The LoS Framework was primarily conceived through a collaborative workshop process. In 2020, four workshops with City staff were conducted across each of the fourteen service areas.

The following outcomes were achieved during each service area workshop:

- Staff were oriented as to the purpose and importance of establishing a consistent LoS Framework;
- Stakeholders were identified, including their expectations, interests, and any regulatory requirements;
- Customer service values were established and reviewed;
- LoS objectives were established for each customer service value;
- Staff provided several performance measures that are currently being tracked as well as those that the City would like to track in the future;
- Where information was available, current performance, targets, and data sources were documented; and
- Growth and shifts in future demand were discussed across the City's service areas.

3.2 Objectives

Defining LoS objectives is important for drawing a line of sight between the City's corporate objectives and the tangible asset performance outcomes. To do so, the LoS objectives must take into consideration stakeholder interests to develop asset performance measures that aim to meet the needs and expectations of the community. By doing this, the City will ensure that their assets are striving towards optimal performance, not only operationally, but economically, socially, and sustainably as well.

Every stakeholder has certain interests in the service being provided and in general, these interests can be categorized into six universal stakeholder values, as shown in **Table 3-1**. Each universal stakeholder value is also assigned a corporate LoS objective.

Table 3-1: The City's Values and LoS Objectives

Customer Value	LoS Objective
Quality and Reliability	The service is delivered with a high standard of excellence, and the service is available when needed.
Affordability	The cost of the service is delivered in a financially sustainable manner and does not burden customers.
Environmental Sustainability	The service is delivered in a manner that does not compromise the ability of future generations to meet their needs.
Access and Capacity	Customers can easily access the service with minimal inconvenience.
Health and Safety	The service is delivered with minimal health and safety impacts.
Responsiveness	Customer service requests are responded to efficiently and in a timely manner.

3.3 Stakeholders and Their Interests

A stakeholder is any person or organization that can affect, be affected by, or perceive themselves to be affected by a decision or an activity. Stakeholder analysis is the process of understanding stakeholder needs, expectations, and perceptions relative to the stakeholder's level-of-interest and level-of-influence over the organization. An organization typically engages with their stakeholders to:

- Establish which activities or services matter most to them.
- Understand their risk appetite and risk threshold.
- Understand their willingness to pay for services.

Stakeholders can take many forms and may be internal (i.e., staff, Council) or external (i.e., the public, regulatory agencies, suppliers, neighbouring municipalities, etc.) to the organization. Historically, only service recipients who pay for City services would be considered customers; however, today customers can take many forms and should include any entity that has a legitimate interest in the service being provided. In addition to service recipients (i.e., the public), this may include:

- **Regulatory Agencies** – Stakeholders that set standards, compliance regulations or other legislation that govern service delivery.
- **Special Interest Groups** – Stakeholders that are affected by or have an interest in the City's roadway services.

Table 3-2 identifies the key stakeholders as they pertain to the City's Parks. These stakeholders were documented during a collaborative workshop process with the City and is not intended to be an exhaustive list; however, the following groups provide a good starting point for future stakeholder engagement.

Table 3-2: The City's Parks Stakeholders and Their Interests

Key Stakeholder Group	Description	Stakeholder Interests / Priorities	
Regulatory Agencies	This stakeholder group includes the Ministry of Environment and the Toronto and Region Conservation Authority (TRCA) which owns parkland. As such, a service level agreement (SLA) exists between the TRCA and the City to ensure parks are maintained to an agreed upon standard.	• Cleanliness • Aesthetics • Good state of repair	• Safety • Accessibility • Environmental
Park Users	This includes the general public who use the City's parks. It is important to meet LoS expectations to keep users safe and satisfied with the City's park amenities.	• Cleanliness • Aesthetics • Good state of repair • Safety	• Accessibility • Responsiveness • Environmental
Local User Groups	This stakeholder group may include local community gardeners and volunteers associated with the Adopt-a-Park Program. Local user groups also include recreational sports teams. A sports field SLA exists between the City and this stakeholder group.	• Cleanliness • Aesthetics • Good state of repair • Safety	• Accessibility • Responsiveness • Environmental
Service Providers	The City conducts the majority of park maintenance inhouse, including snow clearing. The City outsources its park irrigation contractors which belong to this stakeholder group.	• Good state of repair • Safety	
School Board	A joint use SLA exists between the School Board and the City exists.	• Good state of repair • Cleanliness	• Safety • Security
Internal Departments	This stakeholder group includes City departments such as facilities maintenance, roads operations, permitting, recreation and environmental sustainability.	• Good state of repair • Cleanliness • Safety	• Security • Environmental

3.4 Level of Service (LoS) Performance Measures

A documented suite of LoS performance measures enables a common understanding of the service delivery that the City's customers currently receive, and the associated cost of maintaining infrastructure assets to provide the service. Having these performance measures set at the appropriate levels within the City ensures alignment from the corporate vision, to asset investment decisions, and to day-to-day operational activities. When establishing LoS performance measures it is important to keep in mind the "SMART" acronym, as follows:

- **S**pecific, easily evaluated and understood.
- **M**easurable, quantifiable, and easily collectable to ensure ongoing data availability.
- **A**ttainable, so that they work to motivate as opposed to discourage.
- **R**elevant, in that they relate and align with a specific goal.
- **T**ime-Bound, measured over a specific period, which is typically annually for benchmarking.

There are two types of LoS performance measures: Community LoS and Technical LoS. Community LoS are recorded in a manner that attempts to describe the LoS in terms of what is being provided to the community (i.e., the public) and how the customer experiences the service. Community LoS are qualitative, non-technical, and are driven by the municipality's strategic AM objectives. Community LoS are not concerned with the specific operating requirements of the assets that provide the service, but rather the value they obtain from the operation of the assets. To achieve Community LoS, there needs to be line of sight between the value delivered and how that value is realized. This is the purpose of Technical LoS which attempts to describe, quantitively, how the City will provide and meet the expected Community LoS.

3.5 LoS Performance Results

A summary of the City's current and proposed community and technical service levels for the Parks assets are documented in **Table 3-3.**

Table 3-3: Community and Technical Service Levels

Level of Service	Current Performance	Current Service Level Target	Proposed Service Level Target
Hectares of Maintained Parkland/1000 Population	1.86	2.00	No Change
Percentage of Residential Properties within 500m walking distance of Park	88.6%	100%	No Change
Playground Redevelopments per Year, including Accessibility Upgrades	5	5	No Change
Park Grass Cuts	14 day cutting cycle	14 day cutting cycle	No Change

Measured in the most recent Citizen Satisfaction Survey conducted by Ipsos, the percentage of respondents satisfied with Maintenance of Parks and Greenspace was 80%. Additionally, as illustrated in **Figure 3-3**, are the established parks within the City.

Figure 3-3: Established Parks within the City

3.6 LoS Performance Targets

Establishing LoS targets is an important part of continual improvement and performance management. Without targets, it is difficult to ascertain whether goals are being met, or the extent of the gap if they are not. Incorporating targets into the City's LoS Framework helps to ensure that targets are reasonable, aligned with customer expectations, and evaluated on an objective basis by considering cost-benefit trade-offs.

One of the key challenges in setting targets in a municipal environment is that they can often become biased and/or politically motivated. Therefore, it is important to review LoS targets with stakeholders. An important aspect of evaluating LoS targets is determining how willing the user is to pay for the service. Regulatory requirements are an exception; however, they only provide the minimum service standard. Cost is still an important parameter to consider when assessing the merits of service improvements.

To deal with the financial realities, it is necessary to:

- Calculate how much the service costs based on current LoS.
- Determine the cost associated with varying the LoS.
- Assess the customers' willingness to pay.

3.7 Future Demand Drivers

Understanding internal and external factors that may impact service delivery (positively or negatively), such as staff resources, climate change, and shifts in population is a critical component for managing desired service levels in a sustainable manner. It is important to proactively develop effective, long-term strategies that are suitable for the City's unique economic, environmental, and social landscape.

In most cases, the factors presented in **Table 3-4** may result in a negative impact on the City's existing service levels, unless additional funding or resources can be allocated to meet future needs; however, in some instances, such as technological advancements and higher regulation standards, the impact on service delivery may actually improve as a result.

Table 3-4: Potential Future Demand Drivers

Anticipated Issue	Potential Impact on Service Delivery
Population Growth & Development	• The pace of development is increasing and is contributing to a greater demand for new parks spaces and park improvements. • Densification is continuing across the City as there is a shift from low-rise to high-rise development. • Developers will often pay cash in lieu (CIL) rather than convey parkland within areas of intensification. • There is an interest by developers to build private parks exclusive to strata owners only.
Climate Change	• Change in climatic temperature is leading to changes in seasonal temperatures and more extreme weather. This may lead to damaged trees due to extreme weather (i.e., thunderstorms), invasive species, pests and/or diseases. • Programs that used to take place outside in the winter have not been able to take place due to warmer temperatures (i.e., outdoor skating, etc.). • The window for planting trees and vegetation is being impacted by climate change.
Demographics and Shifting Behaviours	• The City is noticing an increased need for off-leash dog areas. • There seems to be low or declining interest in the City's bocce courts, but an increase in pickleball courts as well as emerging sports across the City by park users.
Staff Availability	• The City is finding it harder to hire full-time permanent staff for Parks, although it is not hard to find short-term/temporary staff. • There seems to be a declining interest from millennials to fulfill permanent full-time roles at the City.
Financial Funding	• Parks competes with other departments for funding from the City's tax base. Parks will need to find creative ways to save money. This is a challenge because the use of parks and sport facilities has been increasing but funding has remained the same. • It is challenging for Park to find sufficient resources to keep up with the increasing development and population growth across the City. Changes to legislation, such as Bill 23 in 2022, will lead to increased pressures in securing future parks as well as maintaining consistent provision levels and the ability to fund new parks through Development Charge Reserves within new growth areas.

By considering potential drivers, as well as any issues that may pose a threat to meeting future demand, the City has the advantage to proactively plan and prepare mitigation strategies.

Approaches for the City to consider include:

- Asset-based solutions (e.g., upgrading existing assets, providing new assets, etc.).
- Non-asset-based solutions (e.g., restricting usage, changing habits through education, providing service alternatives, etc.).

A hybrid solution often works well since every municipality has its own challenges and there is not a "one solution fits all" approach. It is important that the City remains aware of its internal and external situational context and modifies its approach and mitigation strategies in a consistent, periodic, and well documented manner.

4. Asset Lifecycle Strategies

Asset lifecycle management focuses on the specific activities we must undertake during all phases of the asset lifecycle. By considering entire asset lifecycles the City can ensure sound decision making that consider present and future service delivery needs.

The overarching goal of life cycle management is to maximize the long-term benefits and services that our assets deliver while minimizing the associated costs and risks in the long run. Every asset has a life cycle cost, which is the total cost of all the activities undertaken throughout its service life. The following sections describe activities across the life cycle of assets.

4.1 Lifecycle Activities

Any responsible owner of assets such as the City has a desire to preserve the condition of their existing assets for as long as possible, by maintaining or even extending their design lives through routine activities such as maintenance and active intervention. The City is continually acquiring infrastructure assets, but these assets require increased funding for operation and maintenance as they age. The City is also responsible for the replacement of deteriorated assets as long as the service is required. While individual assets may have a useful life that can be predicted in years or decades, the service that the asset provides could be for a substantially longer duration (perhaps in perpetuity). Part of the purpose of the AM planning process is to fully understand and predict the long-range financial requirements for the City's infrastructure to facilitate planning and resource management in the most cost-effective manner possible. **Figure 4-1** illustrates how costs typically accumulate over an asset's life. It is worth noting that the accumulation of the ongoing operations and maintenance, refurbishment and disposal / replacement costs is many multiples of the initial acquisition costs. A key and important take-away from **Figure 4-1** is therefore for the City to fully understand the entire life cycle costs before proceeding with asset acquisition.

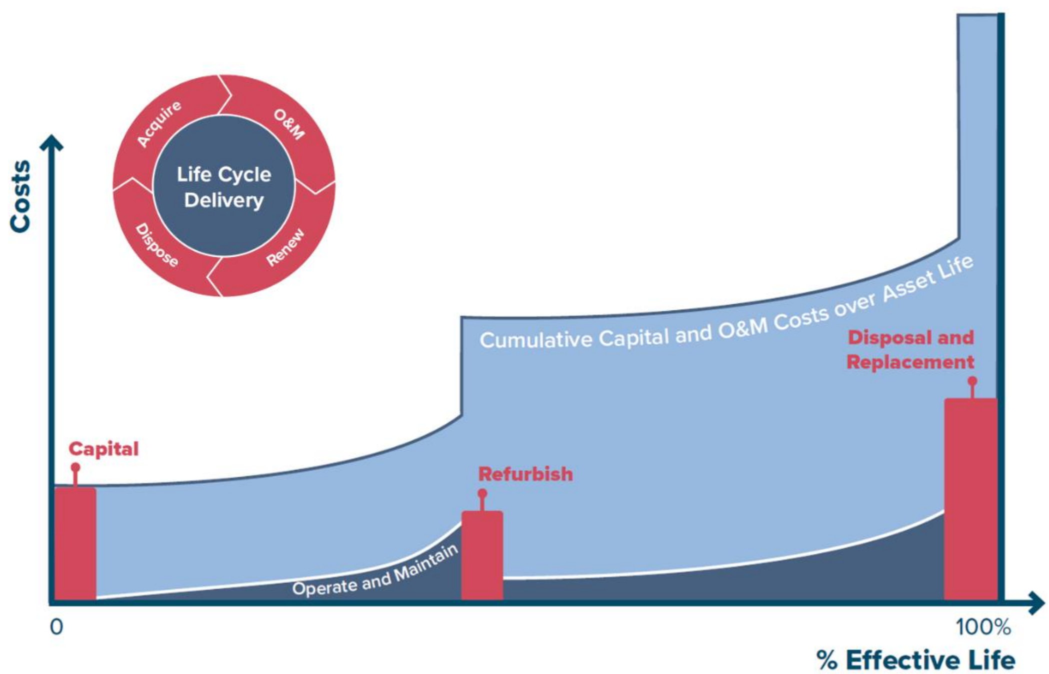


Figure 4-1: Life Cycle Cost Accumulation Over Asset Life

4.2 Asset Acquisition Strategies

The City has made significant investments in the design and acquisition of its municipal infrastructure assets. The parks assets are acquired through capital projects. The City has two systems in place for the purposes of parks development, namely, classical approach and developer-build avenues, for the latter they get reimbursed based on development charges and approved budget for the specific parks.

For the City developed parks, the procurement process looks at the design of playgrounds, asphalt pathways, and other sub-divisional requirements. Budgets are determined based on levels of service and provisions standards guided by the in-effect Active Together Master Plan and Development Charges Background Studies. It covers the business-as-usual budgeting process, design, construction, and development over the three-year period and public outreach as a crucial component for finalizing park designs. The City envisions to move towards the developer-build approach for all of its future projects.

Looking towards the future, when acquiring new assets, the City should evaluate credible alternative design solutions that consider how the asset is to be managed at each of its life cycle stages.

Asset management and full life cycle considerations for the acquisition of new assets include, but are not limited to, the following:

- The asset's operability and maintainability.
- Availability and management of spares.
- Staff skill and availability to manage the asset.
- The manner of the asset's eventual disposal.

4.3 Operations and Maintenance Strategies

As new infrastructure is commissioned, the City accepts the responsibility of operating and maintaining the infrastructure according to operation and maintenance (O&M) standards to ensure that the infrastructure is safe and reliable. Operations staff provide the day-to-day support required to operate infrastructure. In few cases, operation costs are minor, but for most there are significant increases.

Maintenance expenses include periodic preventive maintenance to ensure that the infrastructure can provide reliable service throughout the life of the asset and corrective maintenance that is required to repair defective assets as and when needed. Inadequate funding for O&M will have an adverse impact on the lifespan of assets. The O&M resources required in any period is a function of the current inventory of infrastructure and total O&M needs required for each asset. As the inventory of infrastructure grows, total O&M requirements will also grow. **Table 4-1** provides a breakdown of City's parks related O&M costs and an overall five-year average expenditure of approximately $8.5M.

Table 4-1: Parks O&M Activities and Five-year Average Costs

O&M Activities	Description	Five-Year Average Cost
Pure O&M activities	Parks cultural practices, sports field irrigation, baseball diamond maintenance, playground inspection and maintenance, sign installation and maintenance, vandalism repairs, graffiti removal, off-leash dog park and shrub bed maintenance, maintenance of soccer, baseball and synthetic fields, sidewalk snow removal, hard surface walkway repairs, fence repairs, park furniture repair, sale of plots, debris pickup, tennis courts and ice rinks related activities, trails maintenance and cemeteries general maintenance.	$6,339,000
Overhead	All overhead costs (e.g., assistant supervision, admin costs, staff training, yard operations, equipment/ vehicle maintenance, services-in-kind)	$2,165,000
Total		**$8,504,000**

Currently, the O&M activities carried out by the City's Parks Operations are tax-based and a few activities, such as the grass cutting are outsourced. The City also experiences increased pressure on its existing parks assets due to the spike in public usage for social gatherings, events, etc. during the pandemic. This has led to shortage and hence reallocation of the staff to meet the desired service levels. For some of the parks assets, such as the sports fields, the City has sharing agreements with school boards, where recreation is identified as a revenue source.

4.4 Renewal and Replacement Strategies

The third portion or phase of full life cycle costing relates to the renewal and replacement of infrastructure that has deteriorated to the point where it no longer provides the required service. Renewal cost is sometimes incurred during the life of an asset where an investment is made to improve the condition and / or functionality of the asset. Disposal and replacement costs are incurred at the end of an asset's life when it is disposed of and replaced by a fully new asset. It is vital that communities fully understand the looming obligations of infrastructure renewal or replacement and develop a strategy to respond in a manner that is fair and affordable.

The City's renewal and replacement activities are driven by the growth and development plans to provide services to unserved areas and expand services to meet growth demands. The replacement activities are also based on state of good repair, where parks are regularly inspected for comprehensive condition assessments as part of the Park Redevelopment Strategy (PRS) at neighbourhood and community level. The PRS is a companion to City's Active Together Master Plan and guides the renewal and redevelopment of municipal parks over a 10-year period

(2019-2028), with due considerations to the community specific needs and targeted improvements[2]. Currently, the reconstruction programs for the tennis courts and playgrounds are underway.

4.5 Disposal and Decommissioning Strategies

There will inevitably come a point in time when an asset must be removed from service and, depending on the type of asset, there may be significant costs associated with its decommissioning and disposal. Factors that may influence the decision to remove an asset from service include changes to legislation that cause the asset to be in non-compliance, the inability of the asset to cope with increased service levels, technology advances that render the asset obsolete, the cost of retaining the asset is greater than the benefit gained, or the current risk associated with the asset's failure is not tolerable. Normally, major costs that may be incurred during disposal and decommissioning derive from the environmental impact of the disposal and, if required, the rehabilitation and decontamination of land. In some cases, there will be residual liabilities and risks to consider if a decision is made to partially abandon the asset as opposed to fully disposing of its components (e.g., leaving a non-functioning pipe in the ground, or an inactive building standing). However, some cost savings may be achieved through the residual value of the asset or by exploring alternative uses for the asset. In all cases, it is important to consider disposal and decommissioning as the strategy employed has the potential to attract significant stakeholder attention. For that reason, the costs and risks associated with disposal and decommissioning should be equally considered in the City's capital investment decision-making process.

The current City practices include salvaging and re-purposing of some of its parks assets, such as the sports and soccer fields. The synthetic components are disposed-of whereas others such as rubber crumble is recycled.

[2] City of Vaughan. 2018. Vaughan Parks Redevelopment Study.

4.6 Capital Planning

Capital investment is to address community growth or changes, or to renew existing assets to maintain service levels. For the actual funding needs analysis, please refer to **Section 5**.

- **Life Cycle Cost Analysis Approach**. The City's analysis enables optimized decision making and mathematical deterioration modelling of infrastructure assets and the development of short, medium and long-term forecasts of renewal and replacement costs of a number of decision criteria and the ability to compare different intervention options to find the optimal solution in terms of timing and the intervention option chosen.

- **Forecast Periods.** The City aims to develop Short- to Medium-Term and Long-Term capital plans. Typically, short to medium-term capital plan identifies the activities required to meet current and future demand, the cost of those activities and a financing approach. It is developed or renewed every three to five years and should coincide with regulations on short to medium-term expenditure planning. A long-term plan can serve as part of Strategic Asset Management Plan, which indicates what will be spent, by service areas, over a set period of time. Long-term plans tend to focus only on costs.

  Consistent with the approach of other asset management plans, the analysis periods for funding need assessments are 20 years.

4.7 Asset Prioritization

4.7.1 Risk Assessment

Infrastructure-related risk exposure is assessed based on the combined consideration of probability and consequences of an asset failure, which is used to drive the selection and prioritization of appropriate action, based on risk tolerance thresholds and funding availability. Understanding the risk exposure for a given set of assets allows the City to identify where they are most exposed to risk, and to target their investments to most effectively reduce that exposure.

In addressing risk for infrastructure assets, the first step in the analysis is to identify assets that are most critical to the business. Critical assets are those that will potentially have the greatest impact on service delivery should they fail. It should be noted that the parameters, criteria and weighting factors area starting point, and should be reviewed and modified to reflect the priorities of the City on an ongoing basis.

The fundamental principle of consequence (or criticality) models is that they evaluate the relative importance of assets based on select criteria. The approach to risk analysis within this project utilizes a triple-bottom-line assessment approach utilizing the following four criticality indices:

- **Economic** – influence of the asset's failure on monetary resources
- **Operational** – influence of the asset's failure on operational ability
- **Social** – influence of the asset's failure on society
- **Environmental** – influence of the asset's failure on the environment

By applying specific indices, the risk assessment framework generates a risk (or priority) score for each asset. The risk score is a rating of the asset based on the detailed assessment of the likelihood and consequence of failure based on a number of key parameters. All parameters are then equated using equation [4].

$$\textit{Risk} = \textit{Likelihood of Failure} \times \textit{Consequence of Failure} \qquad [4]$$

Based on this principal, the risk associated with a given asset's failure can be managed by limiting the likelihood of this occurring, or the impact realized, should it occur.

Consequences of Failure (CoF) reflect the relative "impact" of a given asset's failure. While traditionally these have been looked at as purely economic terms (i.e. repair cost, loss of revenue, etc.), the truth is that investment decisions are often driven by non-economic factors. Understanding both the economic and non-economic impacts associated with loss or limitation of service help in categorizing an asset's "criticality" and justifying infrastructure decisions in a consistent, defensible manner.

4.7.2 Analytical Logic to Sequence Interventions

The asset criticality score can be used to prioritize projects within a funding constrained environment. **Figure 4-2** illustrates this logic of carrying unfunded needs to the next year in the period where they receive a higher probability of receiving funds based on their criticality score.

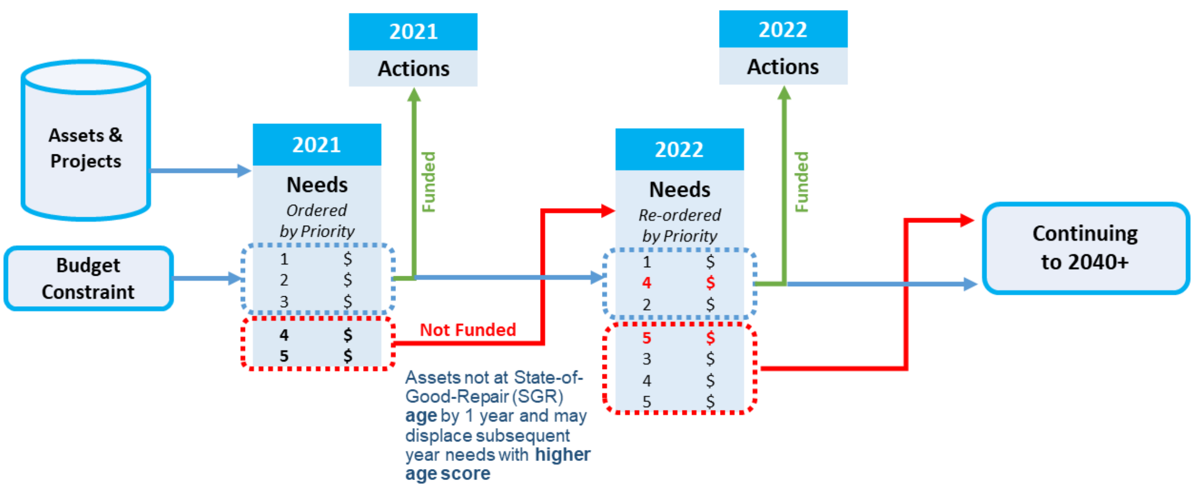


Figure 4-2: The Role of Criticality to Prioritize Projects Within A Funding Constrained Environment

4.8 Financial Planning

4.8.1 Financial Policies

The City has taken the initiative to establish financial asset management policies in 2018, which provides directions on how financial principles apply to assets to ensure that service goals are met. The policy aligns the business model of AM with the City's financial planning, financial reporting, cost management, treasury and taxation functions. The City will integrate findings from the AM Plans into its long-term financial planning and budgeting processes. Sound financial analysis will be encompassed in AM planning in order for the AM Plan to be a sought-after guide for employees in budgeting and financial planning.

4.8.2 Financial Analysis

Financial analysis activities for asset management is centered on two essential quantities: revenues and expenditures. Revenues can come from many sources. Through asset operations, the City generate its own source revenues from taxes, development charges, etc. Expenditures are all the direct and indirect costs associated with capital, operating and maintaining, and disposing of assets.

Assessing the financial implications supports in the decision-making when there are competing priorities and trade-offs between projects. Financial analysis provides a better picture of how to fund the capital plan and make critical decisions about service delivery while providing the greatest benefit for the community at the lowest cost.

4.8.3 Aligning the Financial and Non-Financial Functions of AM

ISO 55010[3] identifies the that the financial and non-financial functions of AM within organizations are generally inadequately aligned, as follows:

- **Financial Accounting Functions:** Focused on retrospective reporting of accounting / regulatory financial activities. However, there is a growing awareness in organizations of the need to focus on providing a managerial costing approach in order to support decision-making for the future.
- **Non-Financial Functions:** Have a limited understanding of financial accounting functions but are recognizing the need to improve their understanding of the financial implications of their activities.

The lack of alignment between financial and non-financial functions can be attributed to silos in an organization, including reporting structures, functional / operational business processes, and related technical data. Silos generally bring forth the necessary level of specialization. However, with a lack a communication between the silos, organizations are at risk of inefficiencies and errors in AM results, or AM failures due to a lack of alignment between AM staff and senior management. Financial and non-financial alignment needs to work both “vertically” and “horizontally”, as follows:

- **Vertical Alignment:** Financial and non-financial asset-related directives by management are informed by accurate upward information flows, effectively implemented across the appropriate levels of the organization.
- **Horizontal alignment:** Financial and non-financial information that flows between departments (conducting functions such as operations, engineering, maintenance, financial accounting and management) uses the same terminology and refers to the assets identified in the same way.

[3] International Organization for Standardization (2019): ISO 55010 - Asset management — Guidance on the alignment of financial and non-financial functions in asset management

Figure 4-3 presents the key elements in a framework to address the need to achieve the alignment.

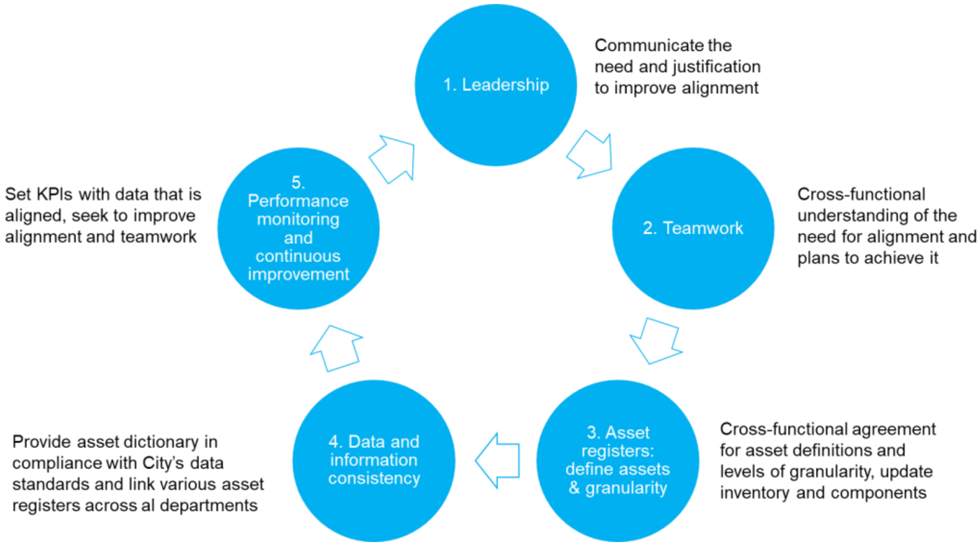


Figure 4-3: Key Elements of a Framework to Achieve Financial and Non-Financial Alignment

4.8.4 Long-Term Financial Planning

Strengthening the City's Asset Management planning according to the recommendations in Asset Management Strategy will improve the City's long-term financial planning, by accounting for whole life cycle costs as presented in **Section 4.1**. This includes all capital, annual operation and maintenance, and disposal costs over the planning timeframe, thereby aligning financial requirements with long-term level of service objectives.

The challenge is often one of agreeing on a timeframe for such planning, recognizing that the AM perspective is ideally focused on the asset life cycle, versus the political / election cycle that could be as short as a three to four-year Council term. Accordingly, financial and non-financial staff, as well as top management and politicians, should agree on a long enough timeframe to provide useful forward planning information that aligns the financial and non-financial perspectives, as presented in **Figure 4-4**.

Figure 4-4: AM Planning Alignment Across the Organization

The City should have an appropriate long-term financial planning process that achieves the following:

- Stimulates long-term strategic thinking and perspective for stakeholders and decision-makers.
- Can be used as a tool to prevent or predict future financial shocks and demonstrate financial sustainability.
- Demonstrates to internal and external stakeholders that the organization has a financial strategy in place to meet their demands, now and in the future.

The long-term financial planning process needs to involve financial and non-financial staff working together to combine the important elements of strategy development, asset management planning and financial forecasting (**Figure 4-3** and **Figure 4-4**).

5. Funding Need Analysis

The lifecycle analysis was implemented in an MS Excel Asset Lifecycle Model, which integrated asset inventory, age, ESL, replacement values, and condition to create a theoretical asset replacement cycle for each Parks asset. The asset reinvestment forecasts prepared for this assessment are estimates of what it will cost over the next 20 and 50 years to sustain the City's Parks assets.

The annual reinvestment needs for the Parks assets were based on age and ESL (i.e., replacing assets that have exceeded their ESL) in 2024 dollars. Where the installation date data is not available, an annual change-out rate is applied to estimate the asset replacement need.

It should be noted that the nature of this type of analysis is based on a wide range of data inputs, currently available information, and a number of assumptions, and is therefore at best a high-level estimate of future funding needs.

5.1 20-Year Reinvestment Funding Need

The average annual reinvestment rate for the City's parks assets is $14.3M over the next 20 years in 2024 dollars. This is equivalent to a total of approximately $286M over the next 20-year period, as presented in **Figure 5-1**.

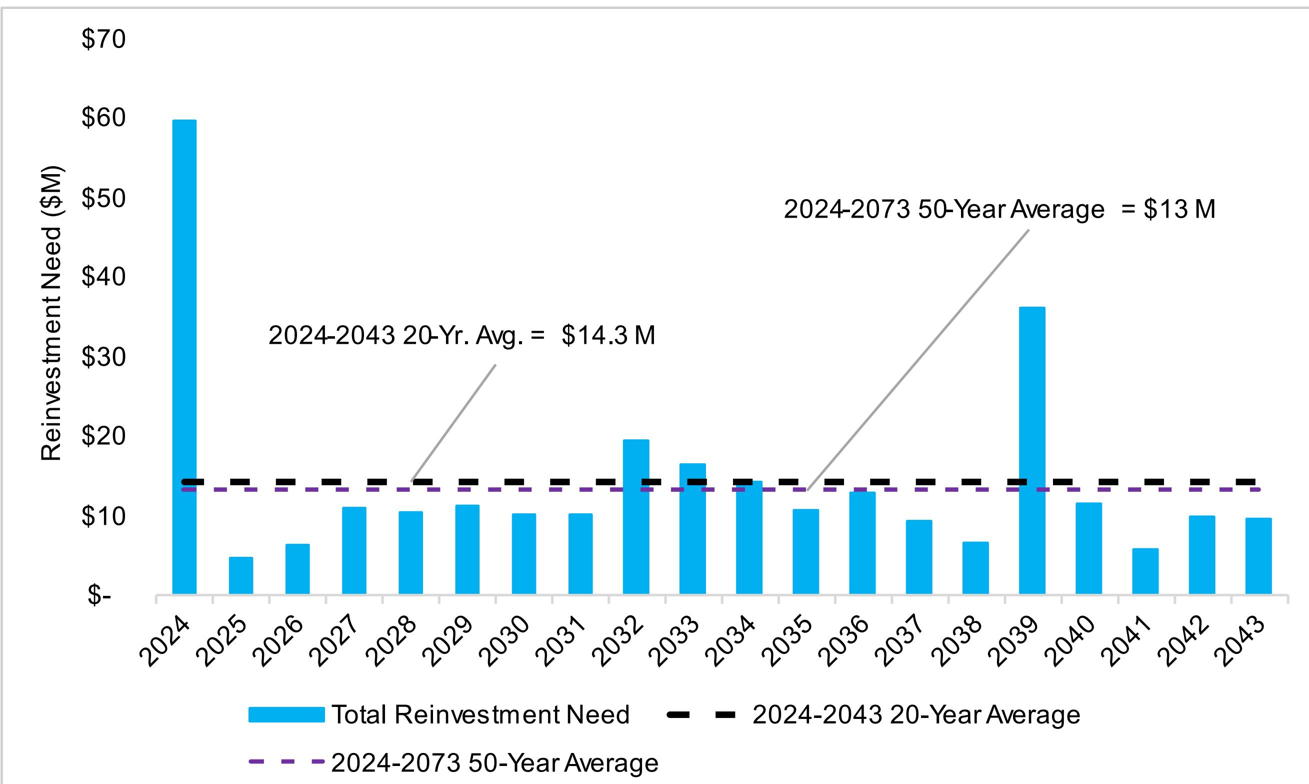


Figure 5-1: Parks 20-Year Reinvestment Need

As shown in **Figure 5-2**, in 2024, the reinvestment needs are primarily from the aged sports fields followed by transportation infrastructure. The rise is logical for that year, given that the majority of assets are in good condition.

Looking ahead to the period starting 2039, the City should prepare for the increased reinvestment need as the assets continue to age and approach and exceed their respective ESLs.

The detailed reinvestment needs for sports fields, park amenities, transportation infrastructure, structures, and cemeteries are presented in **Table 5-1** in 2024 dollars.

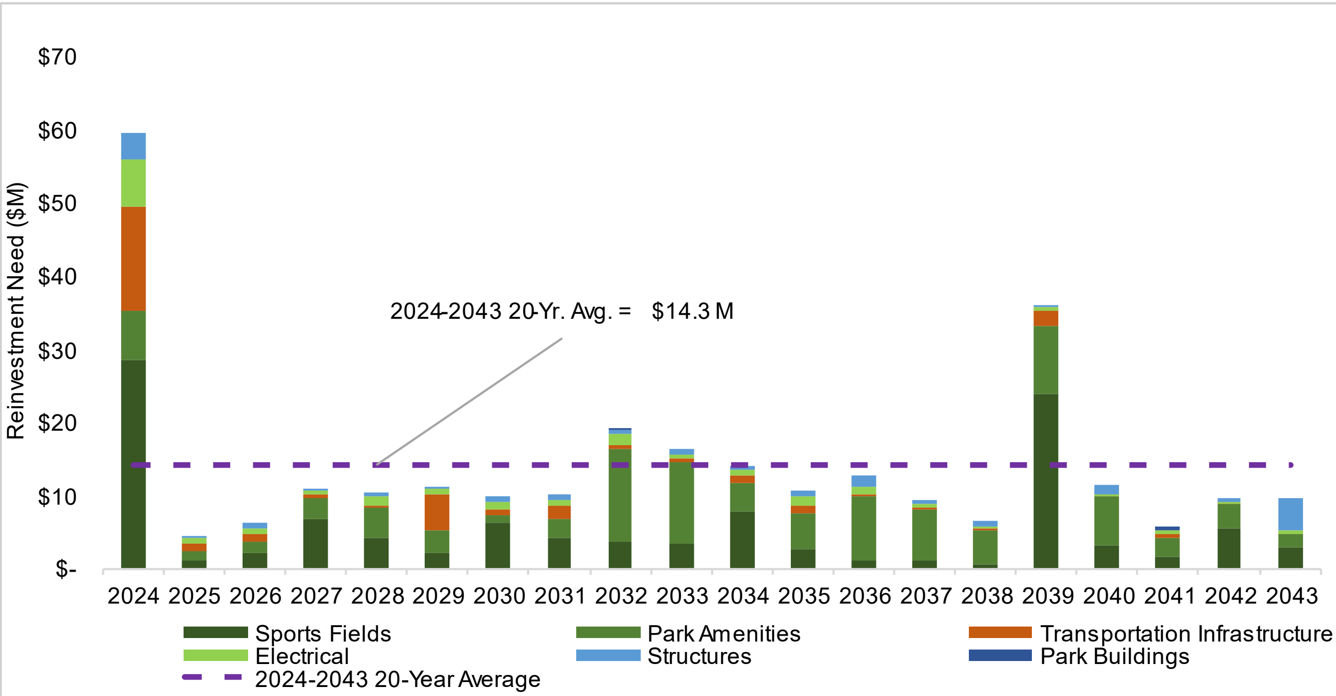


Figure 5-2: Parks 20-Year Reinvestment Need Details

Table 5-1: Parks 20-Year Total and Annual Average Reinvestment Need

	Sports Fields	Park Amenities	Transportation Infrastructure	Electrical	Structures	Park Buildings	Total
Annual Average Need	$5,625,000	$5,021,000	$1,555,000	$1,047,000	$966,000	$37,000	$14,300,000
20-Year Total	$112,500,000	$100,420,000	$31,100,000	$20,940,000	$19,320,000	$740,000	$286,000,000

5.2 Full Funding Need Profile

Figure 5-3 shows a full picture of the City's Parks funding need forecast over the next 20 years, which provides the City the full funding requirements to perform effective financial planning activities. The total annual reinvestment rate from **Figure 5-1** was overlaid with the City's parks O&M cost, in 2024 dollars.

Parks assets require approximately $8.5M annually over the next 20 years for O&M, equivalent approximately to a total of $170M in 2024 dollars. As such, with the addition of O&M, the total average annual funding need for the City's parks assets increases to approximately $22.8M annually, for a total of $455.1M over the next 20-year period.

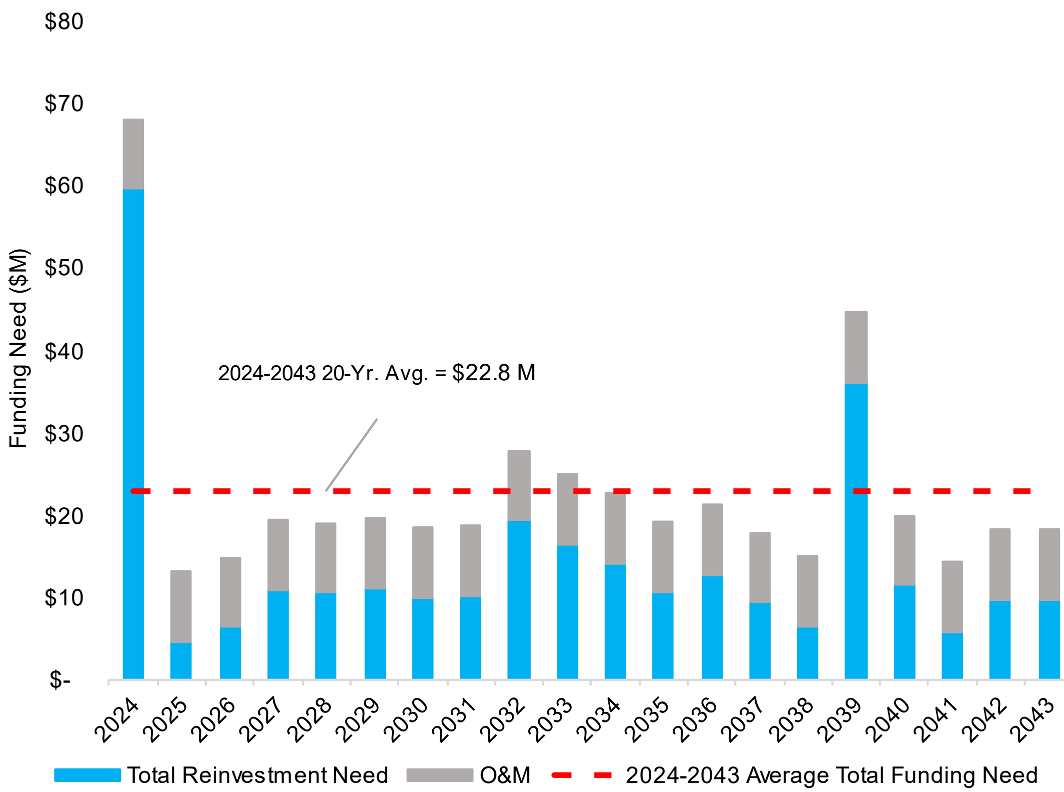


Figure 5-3: Parks 20-Year Capital Investment and O&M Cost Forecast

5.3 Infrastructure Reserves Funding Forecast

Reserve funds are important tools in the planning and management of the City's financial resources and provide a strong indicator of the City's overall financial health and are fundamental to the City's long-term financial sustainability. The City is committed to maintaining healthy reserve fund balances which are collected through various means (i.e., development charges, contributions, dedications, taxation, etc.).

There are specific infrastructure reserves for the tax-supported service areas of Roads, Facilities, Parks, Fleet and Fire. These reserves contain funds set aside through annual contributions from taxation to help pay for the repair and replacement of infrastructure assets. Like many municipalities across Canada, Vaughan is facing increased costs associated with maintaining aging infrastructure. Corporate Asset Management Plans for both core and non-core assets suggest the City's infrastructure deficit is large and growing. The City has continued with robust strategies and plans by developing a comprehensive Long-Range Fiscal Plan and model, which was used to better inform the 2025 and future budgets by providing information about the financial requirements to sustain growth, delivery of services and the community's infrastructure needs.

Prudent financial planning requires ongoing contributions to Parks reserves to fund the repair and replacement of infrastructure. To achieve this, continued operating and infrastructure investments are critical to ensure the City's Parks assets remain financially sustainable now and into the future. This objective is supported by continuing to build service area infrastructure reserves. The 2024 reserve contribution for Parks reserves totalled $1.7M with the City being committed to ensuring the financial sustainability of its Parks assets.

The City's Asset Management Plans assess average reinvestment requirements over the next 20 years for the City's assets, including Parks infrastructure. Annual reserve contributions should generally be in line with the asset reinvestment requirement to ensure sufficient funds are set aside for asset rehabilitation and replacement needs.

For the Parks service area, the forecasted 20-year average funding need is $17.3M. In comparison, the average annual funding forecasted over the next 10 years is estimated to be $5.4M representing a funding coverage of 31% as illustrated in Error! Reference source not found.. The funding sources in this forecast are limited to annual reserve contributions, capital from taxation and the Canada Community-Building Fund (CCBF is provided from the Federal Government). Other available funding sources not included are debentures and non-CCBF grants, which would mitigate any infrastructure funding gaps.

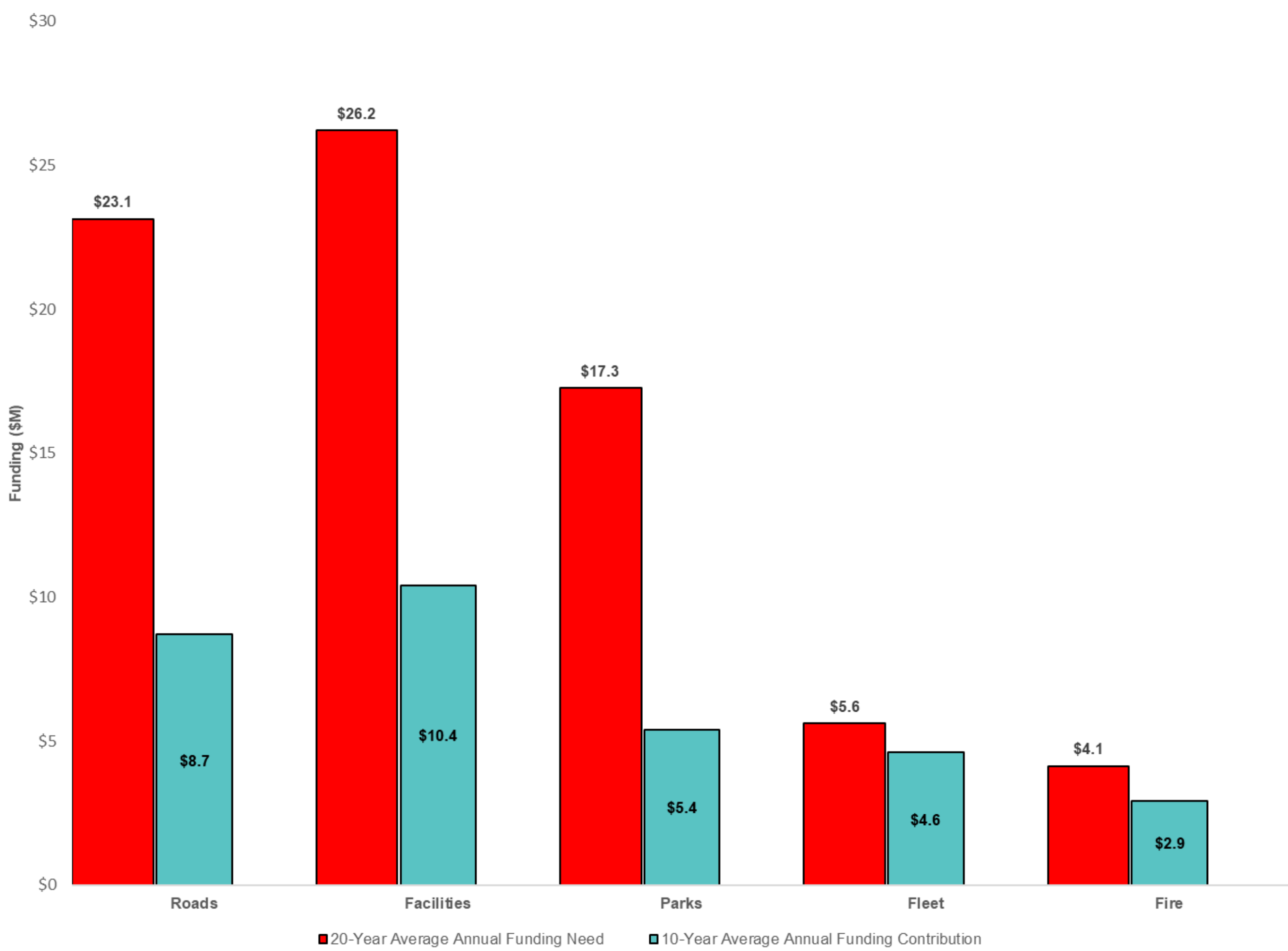


Figure 5-4: Coverage of Average Annual Funding Needs for Tax-Supported Service Areas

Revisiting the timing and scope of capital projects, optimizing the use of existing funding tools and revenue sources, such as debt and dedicated contributions to capital reserves, can help increase the City's capacity to begin to close an infrastructure funding gap.

5.4 Growth-related Assets Funding Need

The City completed a Long Range Fiscal Plan (LRFP) in 2022, which included a model to support planning to meet Parks infrastructure needs as the City's communities continue to grow. This model analyzed the city-wide infrastructure needs to identify the required infrastructure that will meet future servicing demands. The model assessed the existing and future servicing needs and provides servicing recommendations to meet the City's growth plans. Based on the model, the forecasted funding need estimates for the construction of new Parks assets out to 2031 is illustrated in Error! Reference source not found. with a primary funding source for these needs being Development Charges.

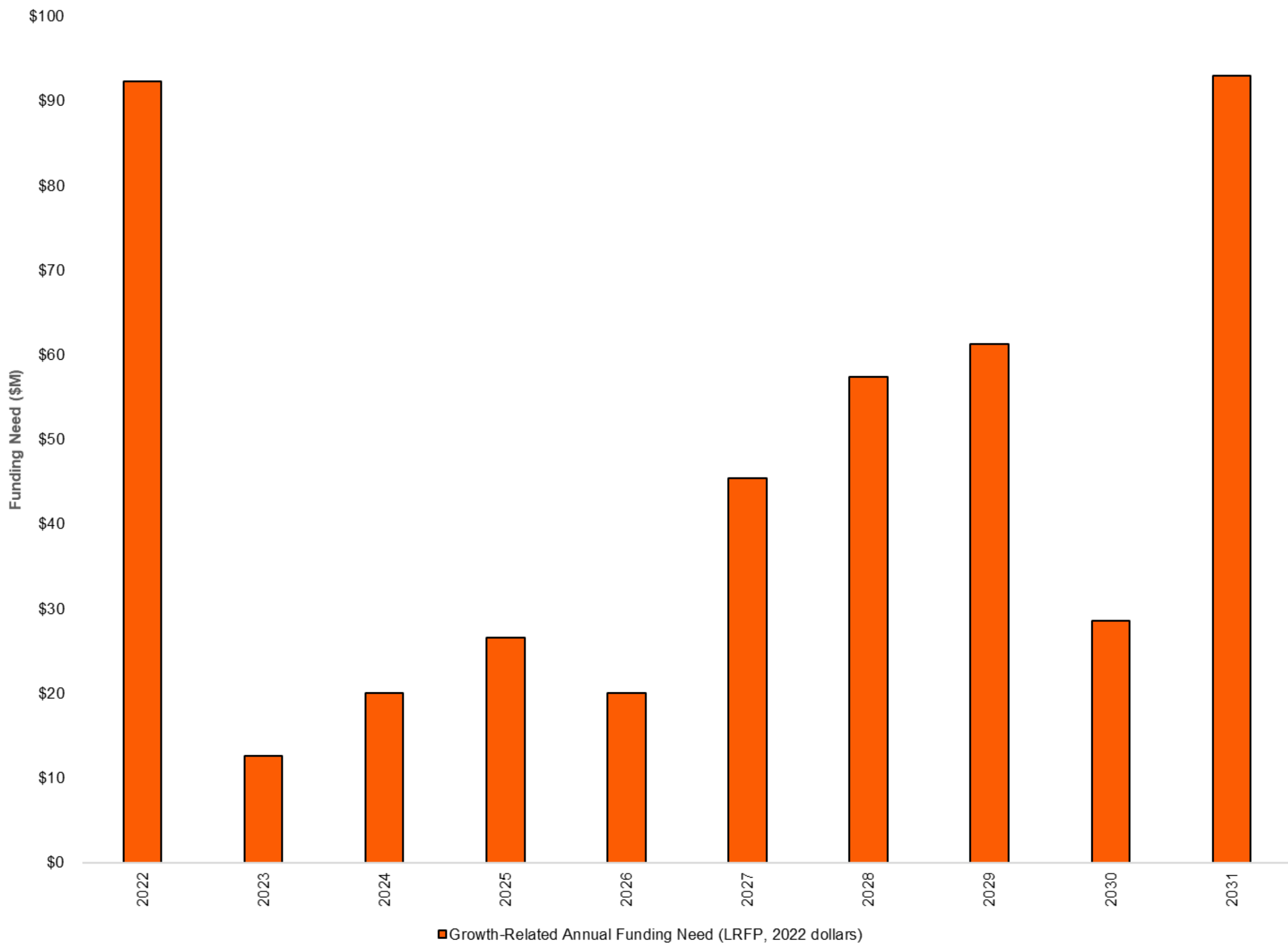


Figure 5-5: Forecasted Funding Needs for Construction of New Parks Assets

One of the next steps in the further development of the LRFP is to apply added detail to the forecasted funding need estimates. This will provide a more refined forecast, which will serve to provide additional guidance for Asset Management planning in the future at the City of Vaughan.

Asset Management Plan

Non-Core Assets
Urban Forestry

City of Vaughan
March 2025

Table of Contents

Figures

Tables

1. Introduction

The City of Vaughan (The City) has conducted a renewal of the City's Asset Management (AM) Plans for all its infrastructure assets, including urban forestry assets.

1.1 Background

The City is one of nine area municipalities located within the Regional Municipality of York. As a lower tier municipality, the City is responsible for providing services such as buildings, fire protection, public works, water distribution, wastewater collection, and parks and recreation.

The next 25 years will see the City transition from a growing suburban municipality to a fully urban space. This type of transition will require long-term thinking about how best to accommodate and make the most of new opportunities. Planning for the future through strategic planning will position the City to deal with the many pressing issues impacting the organization such as community safety, access to health facilities, environment, traffic congestion and issues related to growth and the quality of municipal services.

The City is one of Canada's fastest growing cities, with a population of over 320,000 according to the latest census from Statistics Canada. It is projected that the number of residents will increase to 415,000 by 2031. In addition to its rapidly growing population, the City is home to a well-diversified and expanding employment sector with over 7,800 businesses and 231,000 employees. The City has the largest supply of new employment lands in the Greater Toronto Area (GTA), and it is projected that the number of employees will increase to 271,000 by 2031.

1.2 Objectives

In 2018, by City Council approval, the Corporate Asset Management (AM) Policy for the City came into effect; and, in 2013, the City's first Corporate AM Strategy was published. As identified in the Corporate AM Strategy, the City's first set of AM Plans (AMPs) were developed in 2014.

In early 2021, the City updated its AM Strategy and core infrastructure AMPs, as per Ontario Regulation (O. Reg) 588/17. The purpose of this series of AMPs is to now update the infrastructure assets so as to provide the City with a comprehensive updated AM Plan.

The objective of this AMP is to deliver a financial and technical roadmap for the management of the City's roadway appurtenance assets, and to provide the means for the City to maximize value from its assets, at the lowest overall expense while, at the same time, providing enhanced service levels for its residents and promoting green initiatives.

Organizations that implement good AM practices will benefit from improved business and financial performance, effective investment decisions, and better risk management. Stakeholders can expect lower total asset life cycle costs, higher asset performance, and confidence in sustained future performance.

1.3 AM Provincial Requirements

The Ontario Regulation 588/17 (O. Reg. 588/17) came into effect in 2018 and stipulates specific AM requirements to be in place within Ontario municipalities by certain key dates (**Table 1-1**). The development of this AMP is one of the steps to guide the City towards meeting the July 1st, 2025 deadline.

Table 1-1: O. Reg. 588/17: AM Planning for Municipal Infrastructure

Description: A regulation made under the Infrastructure for Jobs and Prosperity Act, 2015, stating that every municipality shall prepare and update a Strategic AM Policy, and that every municipality shall prepare an AM Plan for its core infrastructure assets by July 1, 2022, and an AM Plan for all other infrastructure assets by July 1, 2024. The regulation outlines several requirements that each AM Plan must follow, such as including current and proposed level of service. Core municipal infrastructure assets include water, wastewater, stormwater, road, and bridge assets.	
Deadline Date	Regulatory Requirement
July 1st, 2019	All municipalities are required to prepare their first Strategic AM Policy.
July 1st, 2022	All municipalities are required to have an AM Plan for its entire core municipal infrastructure (i.e., water, sanitary, stormwater, and transportation).
July 1st, 2024	All municipalities are required to have an AM Plan for infrastructure assets not included under their core assets.
July 1st, 2025	All AM Plans must include information about the levels of service that the municipality proposes to provide, the activities required to meet those level of service, and a strategy to fund activities.

1.4 Scope

This AMP has been developed for the Urban Forestry assets, which are owned and maintained by the City, as shown in **Table 1-2**.

Table 1-2: In-Scope Urban Forestry Assets

Asset Category	Asset Types
Urban Forestry	Street Trees

The following elements are included within the scope of this AMP:

- A summary of the asset inventory, including the replacement cost of the assets, the average age of the assets, the condition of the assets, and the City's approach to assessing the condition of the assets.
- Current levels of service (LoS) based on performance measures.
- Asset lifecycle management strategies to maintain identified current LoS, minimize associated asset risks, and to optimize costs over the whole lifecycle of the asset.

1.5 Approach for Asset Management Plan

The approach used in the renewal of this AM Plan is presented in **Figure 1-1**, and has been selected to ensure that the City can have the confidence to make fact-based and defensible business decisions from reliable and robust information.

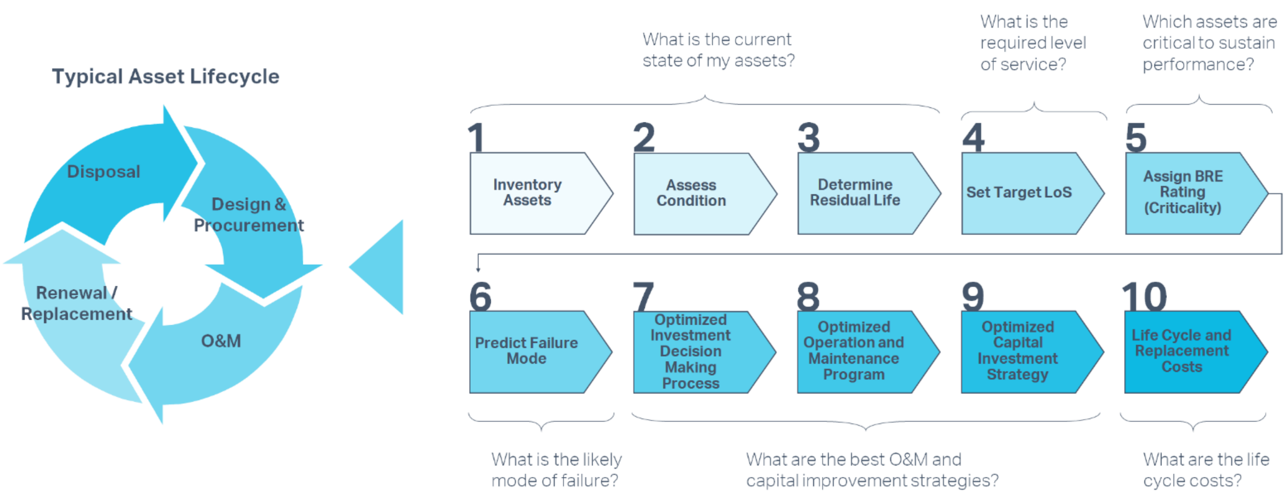


Figure 1-1: AM Plan Approach

2. State of Infrastructure

Urban forests turn the City green, and transform water, nutrients and carbon dioxide into clean air, oxygen, shade, and habitat. The City's Forestry Operations division is responsible for maintaining approximately 130,000 street trees. Unlike other assets, trees are living natural assets and increase in value with age for most of their lifecycle. The City recognizes the significant role that the urban tree canopy plays in providing an improved quality of life. Preserving and protecting the health of trees will help the City achieve its commitment to maintaining and enhancing the urban forest and the environment.

Urban forests at the City bring many benefits including:

- Helping soils absorb stormwater which can substantially reduce stormwater runoff and flooding.
- Providing shade that keeps buildings cooler leading to less energy consumption in summer.
- Absorbing greenhouse gas emissions resulting in climate change mitigation.
- Reducing air temperatures through both shade and evapotranspiration combating the urban heat island effect and helping address extreme heat events.
- Offering a critical form of habitat to species living in urban areas.
- Preventing runoff and erosion, resulting in higher water quality and stable slopes.
- Sequestering pollutants and improves air quality by removing carbon dioxide.
- Improving public health in terms of psychological well-being and mental health, and physical health.
- Reducing noise by providing sound buffering from traffic, construction and other City noises.
- Other values such as benefits to community and add value to land.

Urban forests are always at risk from insects, disease, weather damage and development issues. The development of asset management practices is important to sustain a healthy urban forest asset.

2.1 Asset Inventory and Replacement Value

The asset inventory and its valuation were determined by using the data from the City' GIS database and from consultant reports. **Table 2-1** presents the Urban Forestry inventory and replacement values. The i-Tree Eco method was adopted from the consultant report for studying the total tree species across the City[1]. The replacement values were estimated based on the cost of having to replace a tree with a similar tree and converted to 2024 dollars to represent current value.

Table 2-1: Urban Forestry Inventory and Valuation

Asset Category	Asset Type	Quantity	Unit of Measure
Urban Forestry	Street Trees[1]	133,759	Ea.
Total		**133,759**	

It should be noted that there can be different approaches for tree valuation. Similar to other municipal physical infrastructure assets, one tree can be replaced by another new tree. On the other hand, replacement values for trees can be treated differently than for typical City assets because trees continuously grow and increase in value. Another approach is to value trees based on the service the trees provided, meaning that one large tree should be replaced by many new trees to recover its service level. The determination of tree valuation approach is a decision that can be made differently at different municipalities.

The environmental and other benefits of trees increase exponentially with size, age and health. **Table 2-2** shows the functional values and benefits of the City's urban forestry assets by using i-Tree modeling approach. Please refer to the City's March 2024 Urban Forestry Management Plan for more detail.

Table 2-2: Functional Values and Benefits of The City's Urban Forestry Assets

Asset Type	Benefit Type	Amount	Unit of Measure	Value
Street trees	Pollution removal	11.3	Tons/year	$135,000
	Carbon Storage	24,000	Tons	$5,670,000
	Carbon Sequestration	750	Tons/year	$179,000
	Avoided runoff	55,880,000	Liters/year	$130,000
Total				**$6,114,000**

2.2 Current Asset Replacement Value

The estimated replacement value is the cost of replacing an existing asset in 2024 dollars. These costs are collected from the City's GIS record. Where applicable, a CPI-based inflation rate was used to estimate the 2024 values.

Table 2-3 shows the City owned Street Tree inventory has a replacement value of approximately $120M. The most common species of trees at the City are the Norway Maple, Linden, Honeylocust, and Spruce species.

[1] Vaughan Street Tree Inventory Phase 1 Urban Forest Effects and Values Vaughan Open Space Trees Inventory Phase 2 Urban Forest Effects and Values June 2019

Table 2-3: Urban Forestry Current Replacement Values

Asset Category	Asset Type	New Tree Unit Replacement Cost	Mature Tree Total Replacement Value
Urban Forestry	Street Trees	\$442 - \$524	\$120,412,000
Total			**\$120,412,000**

2.3 Asset Condition

As the City's tree condition information is not available, an age and expected service life-based condition rating approach was applied.

2.3.1 Age-Based Condition Assessment

Two-parameter Weibull distribution function was used to assess the current condition and to project the future condition of the City's urban forestry assets. The Weibull distribution has been used extensively in reliability studies and lifetime prediction models in industries ranging from the automotive to the oil and gas industries; it provides a suitable distribution for this type of analysis.

The Weibull probability distribution provides a left-skewed distribution that rises slowly and diminishes quickly as the population is consumed. The underlying premise of the Weibull-shaped deterioration is that while some assets fail prematurely due to severe conditions or improper installation, other assets are very long-lived and function well beyond their theoretical expected service life. In order to perform a high order network-level analysis, it was assumed that assets would fail (and require replacement) within a deterioration envelope / curve approximated by a Weibull probability distribution. The two-parameter Weibull cumulative distribution has two parameters for scale and shape, as set out in Equation [1]:

$$f(x;\alpha,\beta) = e^{-\left(\frac{x}{\beta}\right)^{\alpha}} \qquad [1]$$

Where: x = Age
α = Shape parameter
β = Scale parameter (or slope)

Table 2-4 presents the condition score ranges and the corresponding range of ESL and total life consumed.

Table 2-4: Age-Based Physical Condition Scale

Condition Score (minimum)	Condition Score (maximum)	Condition Rating	Range % of ESL Consumed	Range of % Operational Life Consumed
1.0	1.5	Very Good	0% – 71%	0% – 47%
1.5	2.2	Good	72% – 84%	48% – 56%
2.2	2.8	Fair	85% – 92%	57% – 60%
2.8	5.0	Poor	93% – 100%	61% – 100%

2.3.2 Condition Summaries

Figure 2-1 presents the condition profile for street trees based on the assumption of 50 years life expectancy. The City has 73% of street trees in Very Good to Good condition. There are approximately 23% of trees in Poor or Very Poor condition meaning that they are approaching the end of their expected service lives, indicating a need for investment in the short to medium term. The remaining 4% of assets are in Fair condition indicating that the trees meet the current need. Attention may be required as these assets continue to age in future years.

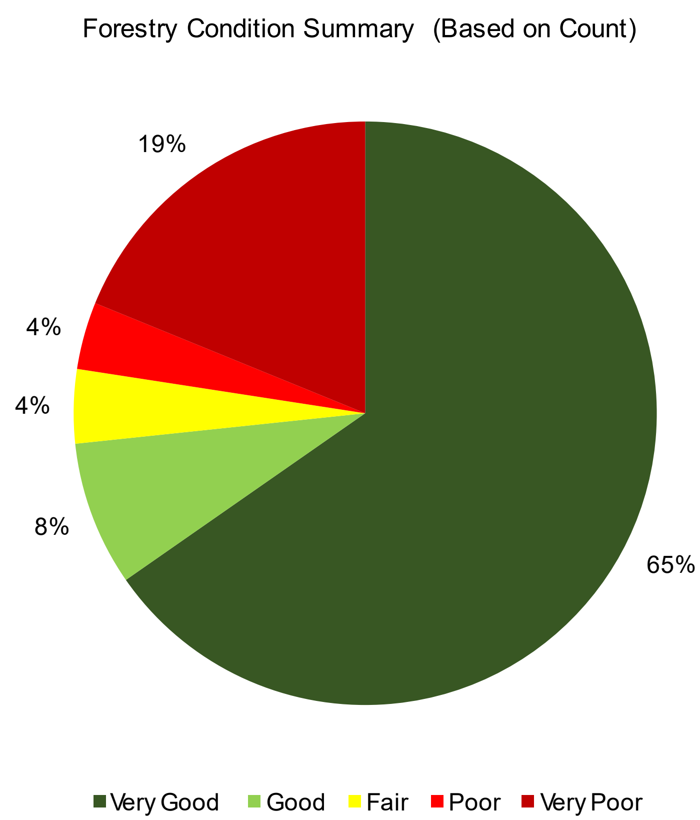


Figure 2-1: Urban Forestry Asset Condition Summary

3. Levels of Service

3.1 Purpose

Levels of Service (LoS) supports every aspect of the overall AM System as shown in **Figure 3-1**. The objective of establishing clearly defined service levels is to help the City meet stakeholder values, achieve its strategic goals, make informed risk-based decisions, and implement effective asset lifecycle activities.

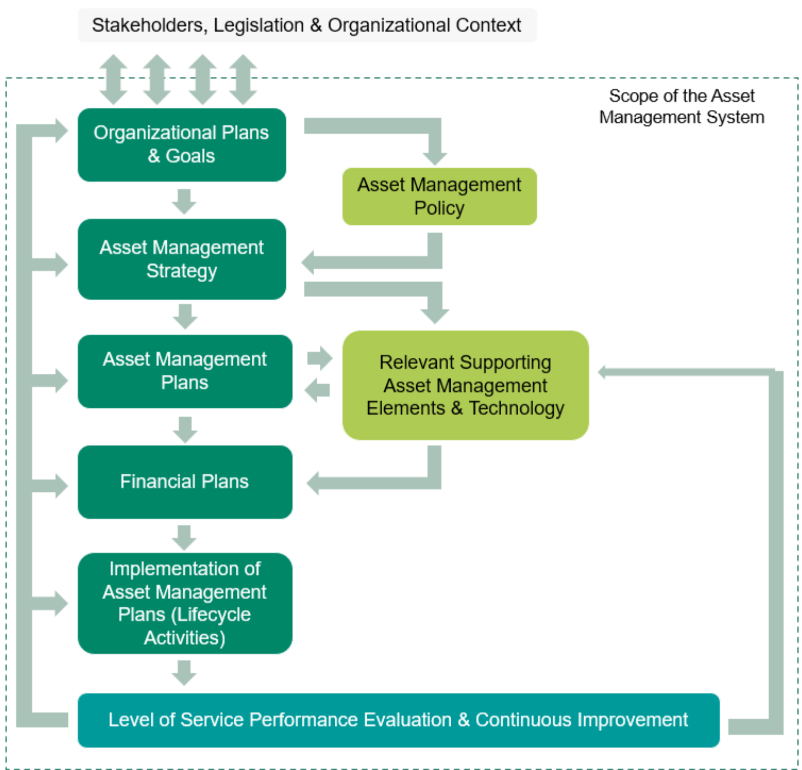


Figure 3-1: LoS within the AM System

In the City's experience, documenting LoS is a proven practice that will enable the City to:

- Link corporate strategic objectives to customer expectations and technical operations.
- Balance customer needs and expectations while evaluating the effectiveness of operations and whether the right LoS is being provided at the right cost.
- Transition from an "Asset Stewardship" approach that focuses on making decisions based on maintaining assets in an acceptable condition to a "Serviceability" approach that is geared towards making decisions based on balancing the costs, risks, and goals for the LoS being provided by the City's assets.
- Communicate the physical nature of infrastructure that the City owns and is financially responsible for while promoting the use of LoS to enable effective consultation with stakeholders regarding alternative funding options according to desired LoS outcomes.
- Make recommendations on strategies that the City can take now to minimize future renewal costs while ensuring that adequate LoS can be delivered without burdening future generations.
- Assess internal (e.g., program changes) and external (e.g., climate change) factors that have the potential to impact the City's ability to deliver services and how these factors may impact the LoS being provided.
- Implement a corporate continuous improvement program to further optimize AM across all service areas.

The O. Reg. 588/17 requires that all AMPs include information about the LoS that the City proposes to provide, the activities required to meet those service levels, and a strategy to fund those activities. The deadline for formalizing these LoS requirements is July 1, 2025 (see **Section 1.3**).

Successful AM programs aim to achieve targeted service levels through customer-based decision making. To achieve this, the City considered a customer-centric approach, where the customer is at the heart of every decision from development to implementation, consultation, and roll-out of the LoS Framework (**Figure 3-2**).

There are two types of LoS measures: Customer LoS (also called "Community" LoS) and Technical LoS. Customer LoS are recorded in a manner that attempts to describe the LoS in terms of what is actually being provided to the customer (i.e., the public) and how the customers experience the service. It is important to note that customers are not concerned with the specific operating requirements of the assets that provide the service, but rather the value they obtain from the operation of the assets. To achieve Customer LoS there needs to be line of sight between the value delivered and how that value is realized. This is the purpose of Technical LoS which attempts to describe how the City will provide and meet the expected Customer LoS.

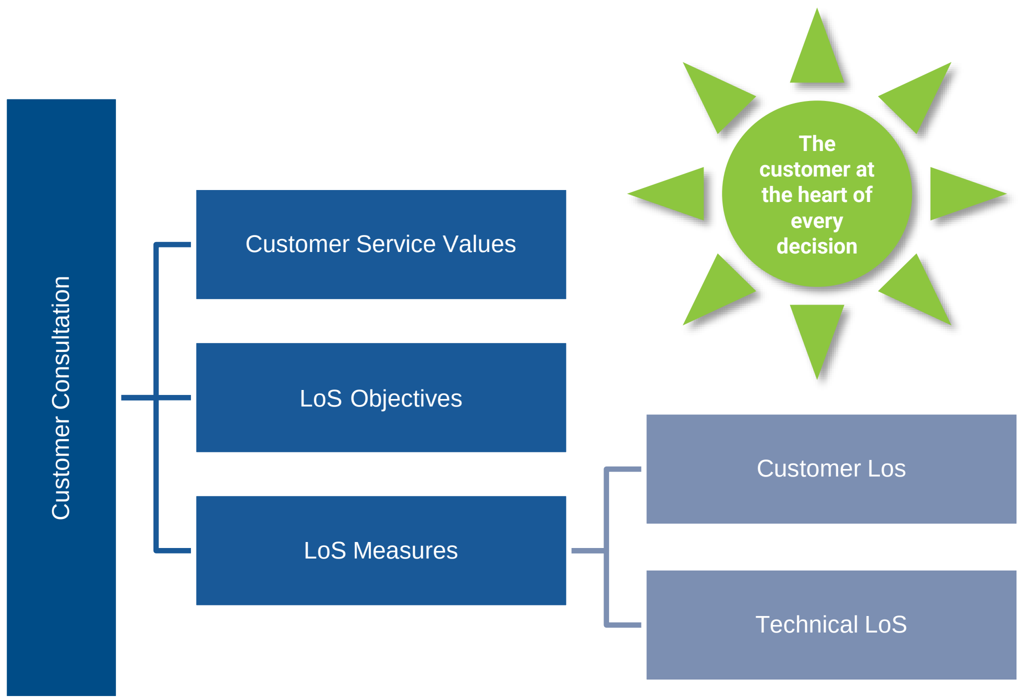


Figure 3-2: The LoS Framework Customer-Centric Approach

The LoS Framework was primarily conceived through a collaborative workshop process. In 2020, four workshops with City staff were conducted across each of the fourteen service areas.

The following outcomes were achieved during each service area workshop:

- Staff were oriented as to the purpose and importance of establishing a consistent LoS Framework;
- Stakeholders were identified, including their expectations, interests, and any regulatory requirements;
- Customer service values were established and reviewed;
- LoS objectives were established for each customer service value;
- Staff provided several performance measures that are currently being tracked as well as those that the City would like to track in the future;
- Where information was available, current performance, targets, and data sources were documented; and
- Growth and shifts in future demand were discussed across the City's service areas.

3.2 Objectives

Defining LoS objectives is important for drawing a line of sight between the City's corporate objectives and the tangible asset performance outcomes. To do so, the LoS objectives must take into consideration stakeholder interests to develop asset performance measures that aim to meet the needs and expectations of the community. By doing this, the City will ensure that their assets are striving towards optimal performance, not only operationally, but economically, socially, and sustainably as well.

Every stakeholder has certain interests in the service being provided and in general, these interests can be categorized into six universal stakeholder values, as shown in **Table 3-1**. Each universal stakeholder value is also assigned a corporate LoS objective.

Table 3-1: The City's Values and LoS Objectives

Customer Value	LoS Objective
Quality and Reliability	The service is delivered with a high standard of excellence, and the service is available when needed.
Affordability	The cost of the service is delivered in a financially sustainable manner and does not burden customers.
Environmental Sustainability	The service is delivered in a manner that does not compromise the ability of future generations to meet their needs.
Access and Capacity	Customers can easily access the service with minimal inconvenience.
Health and Safety	The service is delivered with minimal health and safety impacts.
Responsiveness	Customer service requests are responded to efficiently and in a timely manner.

3.3 Stakeholders and Their Interests

A stakeholder is any person or organization that can affect, be affected by, or perceive themselves to be affected by a decision or an activity. Stakeholder analysis is the process of understanding stakeholder needs, expectations, and perceptions relative to the stakeholder's level-of-interest and level-of-influence over the organization. An organization typically engages with their stakeholders to:

- Establish which activities or services matter most to them.
- Understand their risk appetite and risk threshold.
- Understand their willingness to pay for services.

Stakeholders can take many forms and may be internal (i.e., staff, Council) or external (i.e., the public, regulatory agencies, suppliers, neighbouring municipalities, etc.) to the organization. Historically, only service recipients who pay for City services would be considered customers; however, today customers can take many forms and should include any entity that has a legitimate interest in the service being provided. In addition to service recipients (i.e., the public), this may include:

- **Regulatory Agencies** – Stakeholders that set standards, compliance regulations or other legislation that govern service delivery.
- **Special Interest Groups** – Stakeholders that are affected by or have an interest in the City's Urban Forestry services.
- **Neighbouring Municipalities** – Other communities that are adjacent to the City and are affected by or have an interest in City services.

3.4 Level of Service (LoS) Performance Measures

A documented suite of LoS performance measures enables a common understanding of the service delivery that the City's customers currently receive, and the associated cost of maintaining infrastructure assets to provide the service. Having these performance measures set at the appropriate levels within the City ensures alignment from the corporate vision, to asset investment decisions, and to day-to-day operational activities. When establishing LoS performance measures it is important to keep in mind the "SMART" acronym, as follows:

- **S**pecific, easily evaluated and understood.
- **M**easurable, quantifiable, and easily collectable to ensure ongoing data availability.
- **A**ttainable, so that they work to motivate as opposed to discourage.
- **R**elevant, in that they relate and align with a specific goal.
- **T**ime-Bound, measured over a specific period, which is typically annually for benchmarking.

There are two types of LoS performance measures: Community LoS and Technical LoS. Community LoS are recorded in a manner that attempts to describe the LoS in terms of what is being provided to the community (i.e., the public) and how the customer experiences the service. Community LoS are qualitative, non-technical, and are driven by the municipality's strategic AM objectives. Community LoS are not concerned with the specific operating requirements of the assets that provide the service, but rather the value they obtain from the operation of the assets. To achieve Community LoS, there needs to be line of sight between the value delivered and how that value is realized. This is the purpose of Technical LoS which attempts to describe, quantitively, how the City will provide and meet the expected Community LoS.

3.5 LoS Performance Results

While urban forestry Level of Service (LoS) is not required by Ontario regulation, the City has developed urban forestry LoS metrics. The City's urban forestry LoS performance measure metrics are presented in **Table 3-2.**

Table 3-2: Community and Technical Service Levels

Level of Service	Current Performance	Current Service Level Target	Proposed Service Level Target
Number of New Trees Planted	2,200	2,200	No Change
Proactive Tree Maintenance	16,900	16,900	No Change
Tree Maintenance Calls	5,100	2,000	No Change
Canopy Coverage	20%	25%	No Change
Percentage of Street Trees Pruned/Year	14.8%	14%	No Change

3.6 LoS Performance Targets

Establishing LoS targets is an important part of continual improvement and performance management. Without targets, it is difficult to ascertain whether goals are being met, or the extent of the gap if they are not. Incorporating targets into the City's LoS Framework helps to ensure that targets are reasonable, aligned with customer expectations, and evaluated on an objective basis by considering cost-benefit trade-offs.

One of the key challenges in setting targets in a municipal environment is that they can often become biased and/or politically motivated. Therefore, it is important to review LoS targets with stakeholders. An important aspect of evaluating LoS targets is determining how willing the user is to pay for the service. Regulatory requirements are an exception; however, they only provide the minimum service standard. Cost is still an important parameter to consider when assessing the merits of service improvements.

To deal with the financial realities, it is necessary to:

- Calculate how much the service costs based on current LoS.
- Determine the cost associated with varying the LoS.
- Assess the customers' willingness to pay.

3.7 Future Demand Drivers

Understanding internal and external factors that may impact service delivery (positively or negatively), such as staff resources, climate change, and shifts in population is a critical component for managing desired service levels in a sustainable manner. It is important to proactively develop effective, long-term strategies that are suitable for the City's unique economic, environmental, and social landscape.

By considering potential drivers, as well as any issues that may pose a threat to meeting future demand, the City has the advantage to proactively plan and prepare mitigation strategies.

Approaches for the City to consider include:

- Asset-based solutions (e.g., upgrading existing assets, providing new assets, etc.).
- Non-asset-based solutions (e.g., restricting usage, changing habits through education, providing service alternatives, etc.).

A hybrid solution often works well since every municipality has its own challenges and there is not a "one solution fits all" approach. It is important that the City remains aware of its internal and external situational context and modifies its approach and mitigation strategies in a consistent, periodic, and well documented manner.

4. Asset Lifecycle Strategies

Asset lifecycle management focuses on the specific activities we must undertake during all phases of the asset lifecycle. By considering entire asset lifecycles the City can ensure sound decision making that consider present and future service delivery needs.

The overarching goal of life cycle management is to maximize the long-term benefits and services that our assets deliver while minimizing the associated costs and risks in the long run. Every asset has a life cycle cost, which is the total cost of all the activities undertaken throughout its service life. The following sections describe activities across the life cycle of assets.

4.1 Lifecycle Activities

Any responsible owner of assets such as the City has a desire to preserve the condition of their existing assets for as long as possible, by maintaining or even extending their design lives through routine activities such as maintenance and active intervention. The City is continually acquiring infrastructure assets, but these assets require increased funding for operation and maintenance as they age. The City is also responsible for the replacement of deteriorated assets as long as the service is required. While individual assets may have a useful life that can be predicted in years or decades, the service that the asset provides could be for a substantially longer duration (perhaps in perpetuity). Part of the purpose of the AM planning process is to fully understand and predict the long-range financial requirements for the City's infrastructure to facilitate planning and resource management in the most cost-effective manner possible. **Figure 4-1** illustrates how costs typically accumulate over an asset's life. It is worth noting that the accumulation of the ongoing operations and maintenance, refurbishment and disposal / replacement costs is many multiples of the initial acquisition costs. A key and important take-away from **Figure 4-1** is therefore for the City to fully understand the entire life cycle costs before proceeding with asset acquisition.

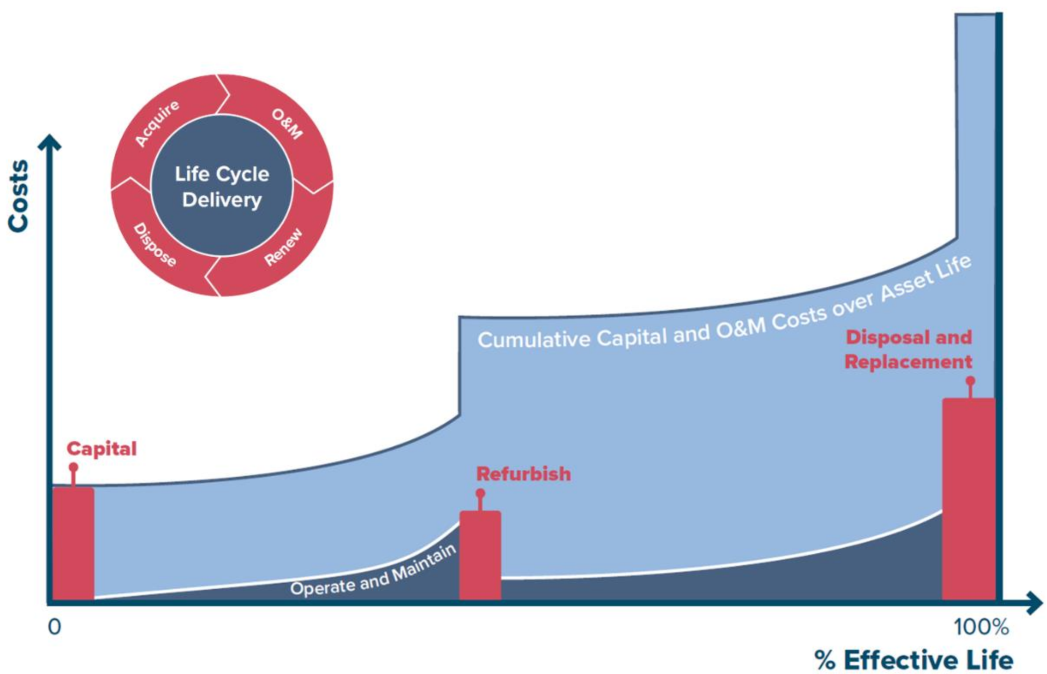


Figure 4-1: Life Cycle Cost Accumulation Over Asset Life

4.2 Asset Acquisition Strategies

When acquiring new assets, the City should evaluate credible alternative design solutions that consider how the asset is to be managed at each of its life cycle stages. Asset management and full life cycle considerations for the acquisition of new assets include, but are not limited to the following:

- The asset's operability and maintainability.
- Staff skill and availability to manage the asset.
- The manner of the asset's eventual disposal.

The City is committed to planting trees for the enhancement of City parks, facilities, and streets. The City is taking a proactive approach to the identification of tree planting opportunities on a citywide basis.

The City acquires trees from developers as new neighborhoods are constructed. When planning trees in new subdivisions, the City's Forestry Operations division is involved in approving the locations of trees. The City will also determine which species to plant in the location to increase the health of the ecosystem by using City established criteria. If the trees are planted properly and in a healthy state, the City will assume the trees as new assets.

Considering tree protection in the initial stages of planning will result in the enhanced protection of trees and where trees are removed will provide for a clear replacement strategy. The City has a Tree Protection Protocol with procedures to maintain and enhance the public's tree canopy through the development approval process.

4.3 Operations and Maintenance Strategies

As new infrastructure is commissioned, the City accepts the responsibility of operating and maintaining the infrastructure according to operation and maintenance (O&M) standards to ensure that the infrastructure is safe and reliable. Operations staff provide the day-to-day support required to operate infrastructure. In few cases, operation costs are minor, but for most there are significant increases.

Maintenance expenses include periodic preventive maintenance to ensure that the infrastructure can provide reliable service throughout the life of the asset and corrective maintenance that is required to repair defective assets as and when needed. Inadequate funding for O&M will have an adverse impact on the lifespan of assets. The O&M resources required in any period is a function of the current inventory of infrastructure and total O&M needs required for each asset. As the inventory of infrastructure grows, total O&M requirements will also grow.

Urban Forestry asset O&M activities consists of two major components: pure urban forestry activities and other urban forestry O&M Activities. **Table 4-1** presents the breakdown activities and five-year average cost for the City's Urban Forestry assets.

The five-year average annual pure urban forestry O&M cost is approximately $1,670,000. The City's Other Urban Forestry O&M Activities cost is approximately $1,512,000.

Table 4-1: Urban Forestry O&M Activities and Five-year Average Costs

O&M Activities	Description	Five-Year Average Cost
Pure O&M activities	Include forest maintenance, forest enhancement, tree mulching, forest management, tree fertilizing, storm clean-up, and invasive species management.	$1,670,000
Other Urban Forestry O&M Activities	Include overhead cost and other activities such as Baker's Woods, Community Tree Planting Events, Uplands Golf Course etc.	$1,512,000
Total		**$3,182,000**

The following sections present the details of tree inspections and tree pruning that are the major urban forestry O&M activity at the City.

4.3.1 Street Trees

The City's O&M activities for urban forestry assets is largely comprised of tree inspections and tree pruning. Tree health and structure can be greatly increased by regular pruning, especially when the trees are young.

Generally, tree pruning brings many benefits to the City's trees including:

- Promoting tree health.
- Preventing insects and disease.
- Removing potential safety hazards.
- Making vehicle and pedestrian clearances.
- Reducing storm damage from high winds, snow, and freezing rain.
- Accommodating streetlights, buildings, and utilities.

The City prunes trees according to species, age and, in some cases, location and uses different types of pruning:

- Crown cleaning consists of the removal of dead, dying, diseased, crowded, weakly attached and unhealthy branches from the crown of a tree.
- Crown thinning consists of the selective removal of branches to increase light penetration and air movement through the crown. Thinning opens the foliage of a tree, reduces weight on heavy limbs, reduces water intake, and helps retain the tree's natural shape.
- Crown clearance consists of the selective removal of the branches from the tree to provide clearance for buildings, vehicles, pedestrians, streetlights, traffic signals, road, regulatory signage and sight lines. Specification 2.4 metres (8 feet) over a sidewalk and 4.26 metres over a road.
- Crown reduction reduces the size of a tree, to make room for utility lines. Reducing the height or spread of a tree is best accomplished by pruning back the leaders and branch terminals to lateral branches that are large enough to assume the terminal roles. This method maintains the form and structural integrity of the tree.
- Crown restoration removes damaged limbs to restore an appropriate stable form to the tree. This is often necessary following storm damage.
- Crown complete is the holistic pruning of a tree that encompasses, cleaning and clearance.
- Crown establishment is the selective pruning of the crown of newly planted trees to promote an aesthetically and structurally sound branching system.

After being pruned, a tree might look rather bare. It will begin to look normal during the next growing season, with a healthier and more attractive form and structure.

The City's current tree pruning activities include:

- Proactive tree pruning activities.
  - Rotational tree pruning. City staff examines the urban forest in a block pattern for possible hazards and tree health problems. The rotational pruning cycle was a 20- or 22-year cycle, and now the City is aiming to reduce the cycle of proactive pruning for all street trees to a seven-year cycle. These activities would result in a reduction in emergency pruning calls. Additionally, the City staff can find problems that would not have been reported by residents, such as an insect that needs to be controlled. The block pruning method can also focus on certain tree species that may require more attention.
  - Structural pruning for early age trees. Structural pruning is a type of pruning that aims to develop long-lived, low-risk, stable trees. The City believes that structural pruning for new assets is very critical which could effectively lessen the overall maintenance as trees growing. Immature trees that are left unpruned can develop many structural problems such as weak branch structure, crossing branches, and co-dominant leaders. As growth defects usually begin to develop at an early age and tend to become worse as trees mature. Prioritizing strategic structural pruning while a tree is young is important because it can help correct any problems before they progress far. Structural pruning can help promote proper trunk development, encourage good branching structure and establish permanent branches. Other pruning strategies can include removing branches that cross and correcting double leader. Most urban trees should only have one leader but can develop more if not managed properly.
- Reactive tree pruning activities. The City performs tree pruning to keep sidewalks safe and keep streets open. The tree cleaning work is performed on as per request basis including cleaning for stop signs, elevation of trees, sidelines, streetlights clearance, etc. Parks operations performs very limited pruning to allow winter operation vehicles on sidewalks. Parks will perform an assessment and then either pair with urban forestry or put a request to take care of the pruning that is required.

4.4 Renewal and Replacement Strategies

The third portion or phase of full life cycle costing relates to the renewal and replacement of infrastructure that has deteriorated to the point where it no longer provides the required service. Renewal cost is sometimes incurred during the life of an asset where an investment is made to improve the condition and / or functionality of the asset. Disposal and replacement costs are incurred at the end of an asset's life when it is disposed of and replaced by a fully new asset. It is vital that communities fully understand the looming obligations of infrastructure renewal or replacement and develop a strategy to respond in a manner that is fair and affordable.

The majority of tree planting activities is related to replacing trees. The City's renewal and replacement activities include tree removals and plantings. The trees are monitored, and problems are addressed when triggered by staff observations and public feedback.

Most of the City's tree purchasing is for replacing existing trees. When the City purchases trees, the trees should meet the City's criteria related to species, structure of the tree, DBH size, etc. in the contract. For street trees, there is a process of tree purchasing from contractors. The process starts from inspection work order as requested from the residents. Then, the City inspects and determines if the trees can be replaced. After that, the City compiles a list and contacts the contractors. Currently, tree purchase cost will include a two-year warranty period. During the warranty period, contactors are responsible for mulching, pruning, and regular watering. The purchased trees are actively patrolled by one of the City's forestry inspectors.

4.5 Disposal and Decommissioning Strategies

For street trees, when tree removal is considered necessary, disposal activities include tree brush and wood removal, stump removal, site restoration to prepare for replacement.

4.6 Capital Planning

Capital investment is to address community growth or changes, or to renew existing assets to maintain service levels. For the actual funding needs analysis, please refer to **Section 5**.

- **Life Cycle Cost Analysis Approach**. The City's analysis enables optimized decision making and mathematical deterioration modelling of infrastructure assets and the development of short, medium and long-term forecasts of renewal and replacement costs of a number of decision criteria and the ability to compare different intervention options to find the optimal solution in terms of timing and the intervention option chosen.

- **Forecast Periods.** The City aims to develop Short- to Medium-Term and Long-Term capital plans. Typically, short to medium-term capital plan identifies the activities required to meet current and future demand, the cost of those activities and a financing approach. It is developed or renewed every three to five years and should coincide with regulations on short to medium-term expenditure planning. A long-term plan can serve as part of Strategic Asset Management Plan, which indicates what will be spent, by service areas, over a set period of time. Long-term plans tend to focus only on costs.

  Consistent with the approach of other asset management plans, the analysis periods for funding need assessments are 20 years.

4.7 Asset Prioritization

4.7.1 Risk Assessment

Infrastructure-related risk exposure is assessed based on the combined consideration of probability and consequences of an asset failure, which is used to drive the selection and prioritization of appropriate action, based on risk tolerance thresholds and funding availability. Understanding the risk exposure for a given set of assets allows the City to identify where they are most exposed to risk, and to target their investments to most effectively reduce that exposure.

In addressing risk for infrastructure assets, the first step in the analysis is to identify assets that are most critical to the business. Critical assets are those that will potentially have the greatest impact on service delivery should they fail. It should be noted that the parameters, criteria and weighting factors area starting point, and should be reviewed and modified to reflect the priorities of the City on an ongoing basis.

The fundamental principle of consequence (or criticality) models is that they evaluate the relative importance of assets based on select criteria. The approach to risk analysis within this project utilizes a triple-bottom-line assessment approach utilizing the following four criticality indices:

- **Economic** – influence of the asset's failure on monetary resources
- **Operational** – influence of the asset's failure on operational ability
- **Social** – influence of the asset's failure on society
- **Environmental** – influence of the asset's failure on the environment

By applying specific indices, the risk assessment framework generates a risk (or priority) score for each asset. The risk score is a rating of the asset based on the detailed assessment of the likelihood and consequence of failure based on a number of key parameters. All parameters are then equated using equation [4].

$$\textit{Risk} = \textit{Likelihood of Failure} \times \textit{Consequence of Failure} \qquad [4]$$

Based on this principal, the risk associated with a given asset's failure can be managed by limiting the likelihood of this occurring, or the impact realized, should it occur.

Consequences of Failure (CoF) reflect the relative "impact" of a given asset's failure. While traditionally these have been looked at as purely economic terms (i.e. repair cost, loss of revenue, etc.), the truth is that investment decisions are often driven by non-economic factors. Understanding both the economic and non-economic impacts associated with loss or limitation of service help in categorizing an asset's "criticality" and justifying infrastructure decisions in a consistent, defensible manner.

4.7.2 Analytical Logic to Sequence Interventions

The asset criticality score can be used to prioritize projects within a funding constrained environment. **Figure 4-2** illustrates this logic of carrying unfunded needs to the next year in the period where they receive a higher probability of receiving funds based on their criticality score.

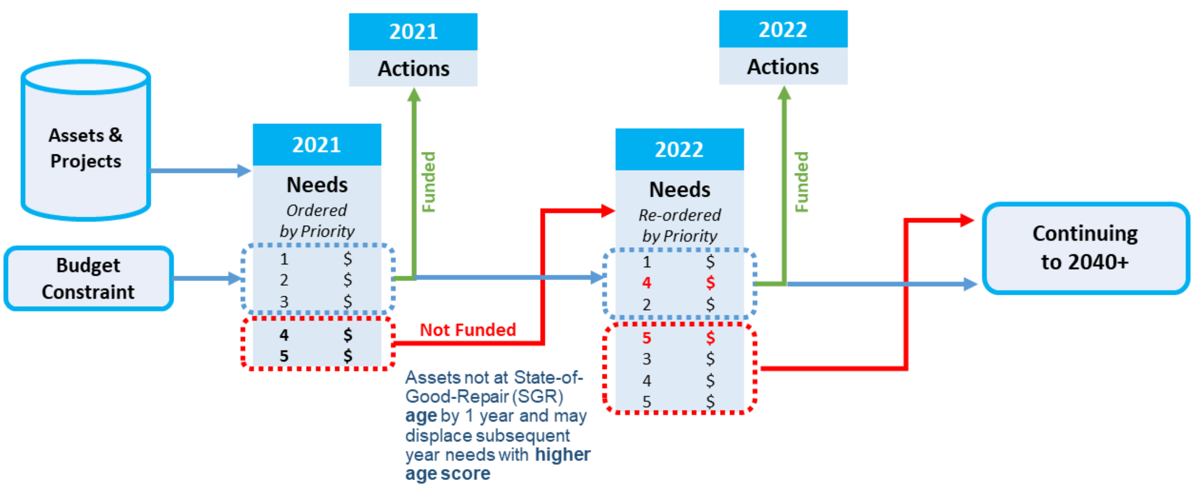


Figure 4-2: The Role of Criticality to Prioritize Projects Within A Funding Constrained Environment

4.8 Financial Planning

4.8.1 Financial Policies

The City has taken the initiative to establish financial asset management policies in 2018, which provides directions on how financial principles apply to assets to ensure that service goals are met. The policy aligns the business model of AM with the City's financial planning, financial reporting, cost management, treasury and taxation functions. The City will integrate findings from the AM Plans into its long-term financial planning and budgeting processes. Sound financial analysis will be encompassed in AM planning in order for the AM Plan to be a sought-after guide for employees in budgeting and financial planning.

4.8.2 Financial Analysis

Financial analysis activities for asset management is centered on two essential quantities: revenues and expenditures. Revenues can come from many sources. Through asset operations, the City generate its own source revenues from taxes, development charges, etc. Expenditures are all the direct and indirect costs associated with capital, operating and maintaining, and disposing of assets.

Assessing the financial implications supports in the decision-making when there are competing priorities and trade-offs between projects. Financial analysis provides a better picture of how to fund the capital plan and make critical decisions about service delivery while providing the greatest benefit for the community at the lowest cost.

4.8.3 Aligning the Financial and Non-Financial Functions of AM

ISO 55010[2] identifies the that the financial and non-financial functions of AM within organizations are generally inadequately aligned, as follows:

- **Financial Accounting Functions:** Focused on retrospective reporting of accounting / regulatory financial activities. However, there is a growing awareness in organizations of the need to focus on providing a managerial costing approach in order to support decision-making for the future.
- **Non-Financial Functions:** Have a limited understanding of financial accounting functions but are recognizing the need to improve their understanding of the financial implications of their activities.

The lack of alignment between financial and non-financial functions can be attributed to silos in an organization, including reporting structures, functional / operational business processes, and related technical data. Silos generally bring forth the necessary level of specialization. However, with a lack a communication between the silos, organizations are at risk of inefficiencies and errors in AM results, or AM failures due to a lack of alignment between AM staff and senior management. Financial and non-financial alignment needs to work both “vertically” and “horizontally”, as follows:

- **Vertical Alignment:** Financial and non-financial asset-related directives by management are informed by accurate upward information flows, effectively implemented across the appropriate levels of the organization.
- **Horizontal alignment:** Financial and non-financial information that flows between departments (conducting functions such as operations, engineering, maintenance, financial accounting and management) uses the same terminology and refers to the assets identified in the same way.

[2] International Organization for Standardization (2019): ISO 55010 - Asset management — Guidance on the alignment of financial and non-financial functions in asset management

Figure 4-3 presents the key elements in a framework to address the need to achieve the alignment.

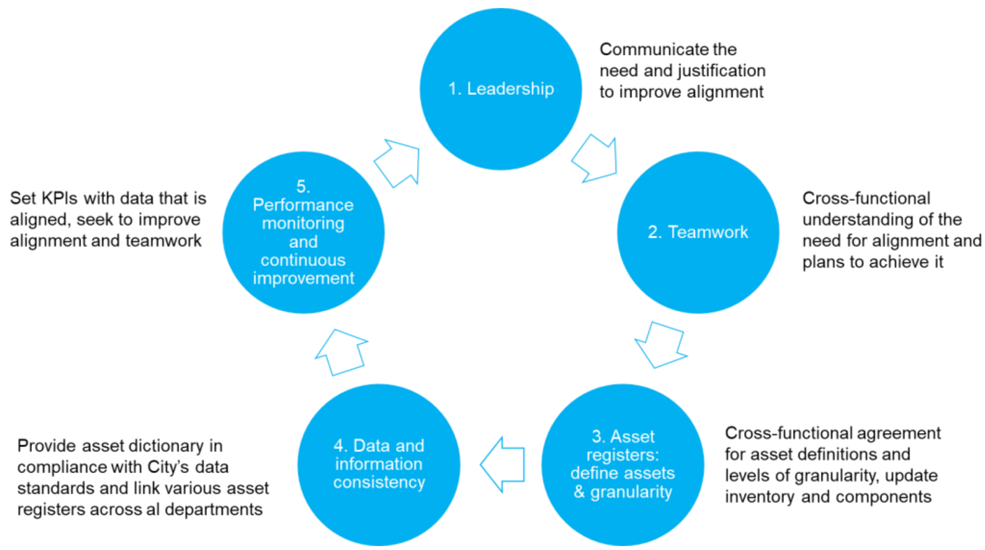


Figure 4-3: Key Elements of a Framework to Achieve Financial and Non-Financial Alignment

4.8.4 Long-Term Financial Planning

Strengthening the City's Asset Management planning according to the recommendations in Asset Management Strategy will improve the City's long-term financial planning, by accounting for whole life cycle costs as presented in **Section 4.1**. This includes all capital, annual operation and maintenance, and disposal costs over the planning timeframe, thereby aligning financial requirements with long-term level of service objectives.

The challenge is often one of agreeing on a timeframe for such planning, recognizing that the AM perspective is ideally focused on the asset life cycle, versus the political / election cycle that could be as short as a three to four-year Council term. Accordingly, financial and non-financial staff, as well as top management and politicians, should agree on a long enough timeframe to provide useful forward planning information that aligns the financial and non-financial perspectives, as presented in **Figure 4-4**.

Figure 4-4: AM Planning Alignment Across the Organization

The City should have an appropriate long-term financial planning process that achieves the following:

- Stimulates long-term strategic thinking and perspective for stakeholders and decision-makers.
- Can be used as a tool to prevent or predict future financial shocks and demonstrate financial sustainability.
- Demonstrates to internal and external stakeholders that the organization has a financial strategy in place to meet their demands, now and in the future.

The long-term financial planning process needs to involve financial and non-financial staff working together to combine the important elements of strategy development, asset management planning and financial forecasting (**Figure 4-3** and **Figure 4-4**).

5. Funding Need Analysis

The lifecycle analysis was implemented in an MS Excel Asset Lifecycle Model, which integrated asset inventory, age, ESL, replacement values, and condition to create a theoretical asset replacement cycle for each Urban Forestry asset. The asset reinvestment forecasts prepared for this assessment are estimates of what it will cost over the next 20 years to sustain the City's Urban Forestry assets.

The annual reinvestment needs for the Urban Forestry assets were based on age and ESL (i.e., replacing assets that have exceeded their ESL) in 2024 dollars. Where the installation date data is not available, an annual change-out rate is applied to estimate the asset replacement need.

It should be noted that the nature of this type of analysis is based on a wide range of data inputs, currently available information, and a number of assumptions, and is therefore at best a high-level estimate of future funding needs.

5.1 20-Year Reinvestment Funding Need

The average annual reinvestment rate for the City's urban forestry service is $2.41M over the next 20 years in 2024 dollars. This is equivalent to a total of approximately $48.2M over the next 20-year period, as presented in **Figure 5-1**.

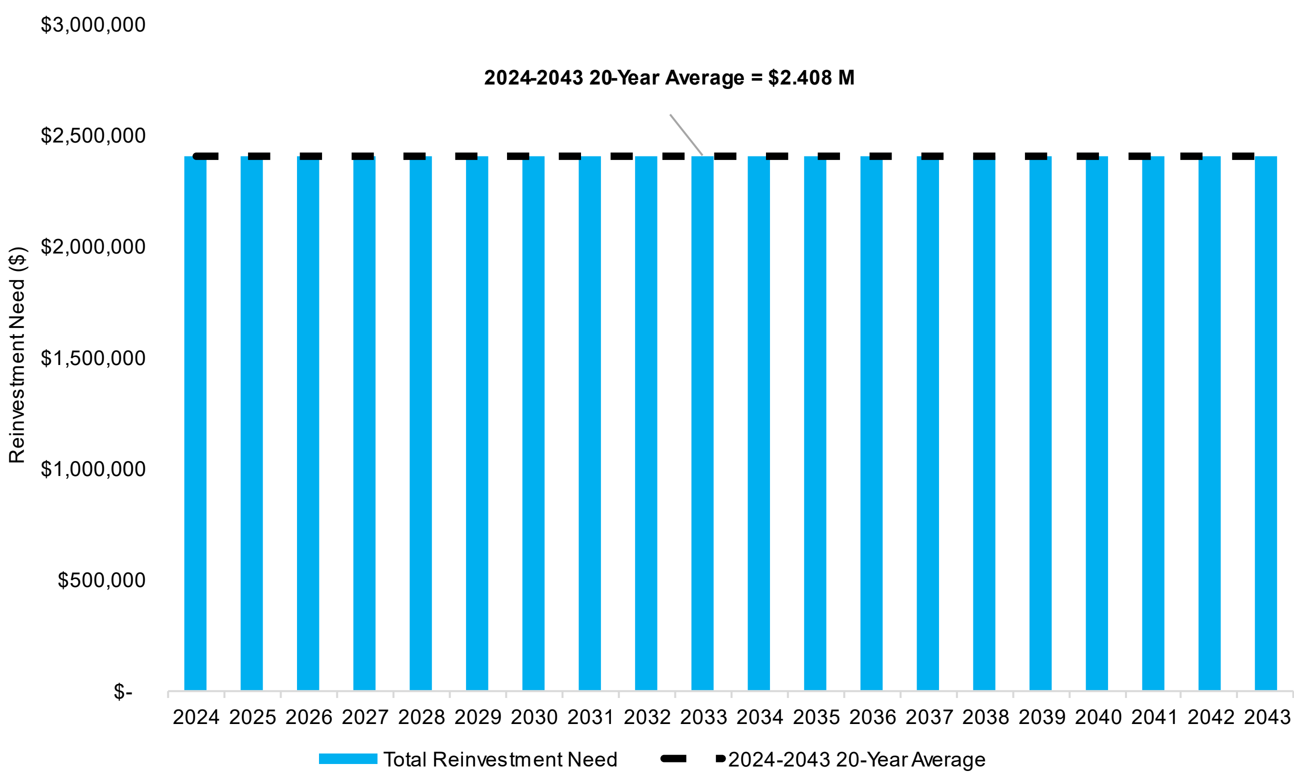


Figure 5-1: Urban Forestry 20-Year Reinvestment Need

Figure 5-2 shows a full picture of the City's Urban Forestry funding need forecast over the next 20 years, which provides the City the full funding requirements in order to perform effective financial planning activities.

Urban Forestry assets requires approximately $63.6M O&M cost over the next 20 years, equivalent to approximately $3.18M per year in 2024 dollars.

Unlike other service areas, urban forestry development costs in the last five years were close to zero as the new development trees were mostly acquired from developers. As such, with the addition of O&M, the total average annual reinvestment rate for the City's urban forestry assets increases to approximately $5.59M annually, for a total of $111.8M over the next 20-year period, as presented in **Figure 5-2**.

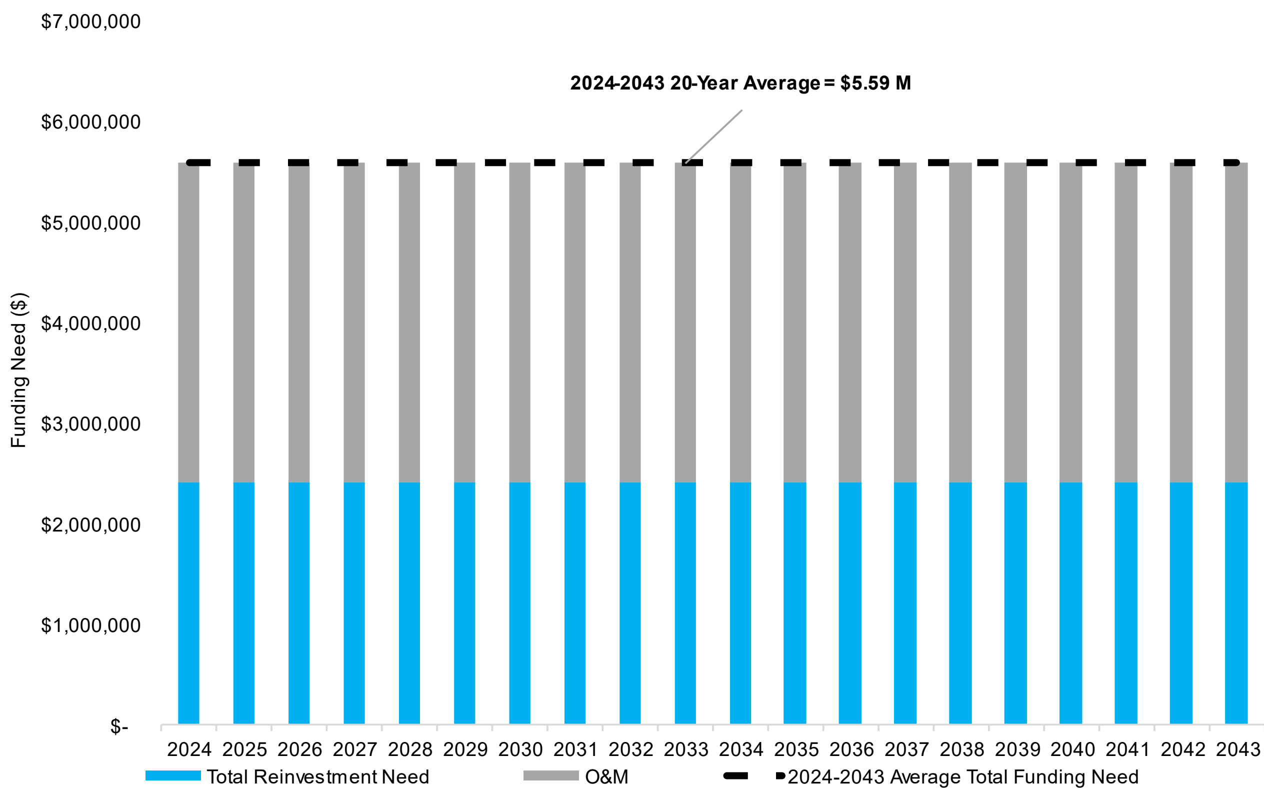


Figure 5-2: Urban Forestry 20-Year Reinvestment Need Details

5.2 Infrastructure Reserves Funding Forecast

Reserve funds are important tools in the planning and management of the City's financial resources and provide a strong indicator of the City's overall financial health and are fundamental to the City's long-term financial sustainability. The City is committed to maintaining healthy reserve fund balances which are collected through various means (i.e., development charges, contributions, dedications, taxation, etc.).

There are specific infrastructure reserves for the tax-supported service areas of Roads, Facilities, Parks, Fleet and Fire (funds for Urban Forestry assets are supported from the Parks infrastructure reserve). These reserves contain funds set aside through annual contributions from taxation to help pay for the repair and replacement of infrastructure assets. Like many municipalities across Canada, Vaughan is facing increased costs associated with maintaining aging infrastructure. Corporate Asset Management Plans for both core and non-core assets suggest the City's infrastructure deficit is large and growing. The City has continued with robust strategies and plans by developing a comprehensive Long-Range Fiscal Plan and model, which was used to better inform the 2025 and future budgets by providing information about the financial requirements to sustain growth, delivery of services and the community's infrastructure needs.

Prudent financial planning requires ongoing contributions to Parks reserves to fund the repair and replacement of infrastructure. To achieve this, continued operating and infrastructure investments are critical to ensure the City's Urban Forestry assets remain financially sustainable now and into the future. This objective is supported by continuing to build service area infrastructure reserves. The 2024 reserve contribution for Parks reserves totalled $1.7M with the City being committed to ensuring the financial sustainability of its Urban Forestry assets.

The City's Asset Management Plans assess average reinvestment requirements over the next 20 years for the City's assets, including Urban Forestry infrastructure. Annual reserve contributions should generally be in line with the asset reinvestment requirement to ensure sufficient funds are set aside for asset rehabilitation and replacement needs.

For the Parks service area, the forecasted 20-year average funding need is $17.3M. In comparison, the average annual funding forecasted over the next 10 years is estimated to be $5.4M representing a funding coverage of 31% as illustrated in Error! Reference source not found.. The funding sources in this forecast are limited to annual reserve contributions, capital from taxation and the Canada Community-Building Fund (CCBF is provided from the Federal Government). Other available funding sources not included are debentures and non-CCBF grants, which would mitigate any infrastructure funding gaps.

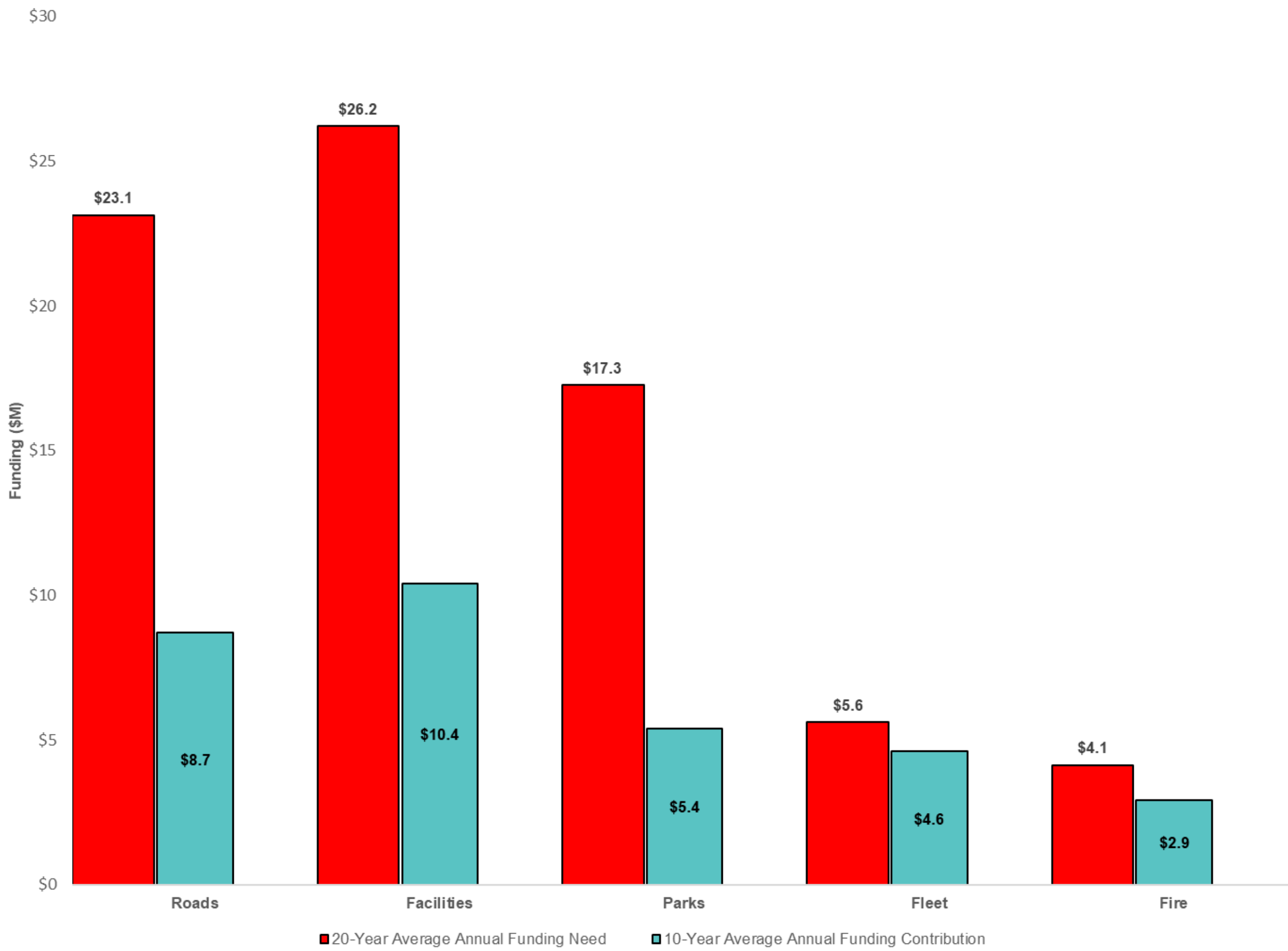


Figure 5-3: Coverage of Average Annual Funding Needs for Tax-Supported Service Areas

Revisiting the timing and scope of capital projects, optimizing the use of existing funding tools and revenue sources, such as debt and dedicated contributions to capital reserves, can help increase the City's capacity to begin to close an infrastructure funding gap.

Asset Management Plan

Non-Core Assets
Active Transportation

City of Vaughan
March 2025

Table of Contents

Figures

Tables

1. Introduction

The City of Vaughan (The City) has conducted a renewal of the City's Asset Management (AM) Plans for all its infrastructure assets, including Active Transportation assets.

1.1 Background

The City is one of nine area municipalities located within the Regional Municipality of York. As a lower tier municipality, the City is responsible for providing services such as buildings, fire protection, public works, water distribution, wastewater collection, and parks and recreation.

The next 25 years will see the City transition from a growing suburban municipality to a fully urban space. This type of transition will require long-term thinking about how best to accommodate and make the most of new opportunities. Planning for the future through strategic planning will position the City to deal with the many pressing issues impacting the organization such as community safety, access to health facilities, environment, traffic congestion and issues related to growth and the quality of municipal services.

The City is one of Canada's fastest growing cities, with a population of over 320,000 according to the latest census from Statistics Canada. It is projected that the number of residents will increase to 415,000 by 2031. In addition to its rapidly growing population, the City is home to a well-diversified and expanding employment sector with over 7,800 businesses and 231,000 employees. The City has the largest supply of new employment lands in the Greater Toronto Area (GTA), and it is projected that the number of employees will increase to 271,000 by 2031.

1.2 Objectives

In 2018, by City Council approval, the Corporate Asset Management (AM) Policy for the City came into effect; and, in 2013, the City's first Corporate AM Strategy was published. As identified in the Corporate AM Strategy, the City's first set of AM Plans (AMPs) were developed in 2014.

In early 2021, the City updated its AM Strategy and core infrastructure AMPs, as per Ontario Regulation (O. Reg) 588/17. The purpose of this series of AMPs is to now update the infrastructure assets so as to provide the City with a comprehensive updated AM Plan.

The objective of this AMP is to deliver a financial and technical roadmap for the management of the City's Active Transportation assets, and to provide the means for the City to maximize value from its assets, at the lowest overall expense while, at the same time, providing enhanced service levels for its residents and promoting green initiatives.

Organizations that implement good AM practices will benefit from improved business and financial performance, effective investment decisions, and better risk management. Stakeholders can expect lower total asset life cycle costs, higher asset performance, and confidence in sustained future performance.

1.3 AM Provincial Requirements

The Ontario Regulation 588/17 (O. Reg. 588/17) came into effect in 2018 and stipulates specific AM requirements to be in place within Ontario municipalities by certain key dates (

Table 1-1). The development of this AMP is one of the steps to guide the City towards meeting the July 1st, 2025 deadline.

Table 1-1: O. Reg. 588/17: AM Planning for Municipal Infrastructure

Description: A regulation made under the Infrastructure for Jobs and Prosperity Act, 2015, stating that every municipality shall prepare and update a Strategic AM Policy, and that every municipality shall prepare an AM Plan for its core infrastructure assets by July 1, 2022, and an AM Plan for all other infrastructure assets by July 1, 2024. The regulation outlines several requirements that each AM Plan must follow, such as including current and proposed level of service. Core municipal infrastructure assets include water, wastewater, stormwater, road, and bridge assets.	
Deadline Date	Regulatory Requirement
July 1st, 2019	All municipalities are required to prepare their first Strategic AM Policy.
July 1st, 2022	All municipalities are required to have an AM Plan for its entire core municipal infrastructure (i.e., water, sanitary, stormwater, and transportation).
July 1st, 2024	All municipalities are required to have an AM Plan for infrastructure assets not included under their core assets.
July 1st, 2025	All AM Plans must include information about the levels of service that the municipality proposes to provide, the activities required to meet those level of service, and a strategy to fund activities.

1.4 Scope

This AMP has been developed for the Active Transportation assets, which are owned and maintained by the City, as shown in **Table 1-2**.

Table 1-2: In-Scope Active Transportation Assets

Asset Category	Asset Types
Pedestrian Facilities	Sidewalks and Walkways.
Cycling Facilities	Painted Bike Lanes and Cycle Tracks. Micromobility devices such as electric bicycles (e-bikes) and kick-style electric scooters (e-scooters) are permitted on all cycling facilities.
Shared-use Facilities	In-boulevard Multi-use Pathways, Multi-use Recreational Trails (Open Spaces).

Table 1-3: Definitions of Active Transportation Asset Types

Asset Type	Definition
Sidewalks	A pedestrian facility for walking, usually concrete, 1.5m-2.0m wide, in-boulevard within a road allowance.
Walkways	A type of pedestrian facility, usually concrete, typically 1.5m-2.5m wide, within its own narrow right-of-way between houses, usually connecting roadside sidewalks to other types of paths.
Painted Bike Lanes	A dedicated one-way cycling facility within the road pavement, delineated by pavement markings and occasionally, light duty separators, such as flexible bollards. Width is typically 1.5m-1.8m excluding physical or painted buffers.
Cycle Tracks	A dedicated cycling facility within the boulevard of the road allowance, separated from the vehicular lane with a curb; composed of asphalt.
In-Boulevard Multi-Use Pathways	A shared-use facility for cyclists and pedestrians within the boulevard of the road allowance. Width is typically 2.0m-4.0m and is usually composed of asphalt.
Multi-Use Recreational Trails (Open Spaces)	A shared-use facility for cyclists and pedestrians within open green spaces. The surface material varies. They are typically crushed limestone, but can also be asphalt, wood chips, or natural earth. Width is typically 2.0m-3.0m.
City-Maintained TRCA Trails	A shared-use facility for cyclists and pedestrians within TRCA property. Includes only specific TRCA trails which are maintained by the City in accordance with a TRCA agreement.
Park Pathways	A shared-use facility for cyclists and pedestrians within formal City parks, composed of asphalt or concrete. Width is typically 1.5m-2.4m

Table 1-4: Active Transportation Asset Types – Ownership and Responsibilities

Asset Type	Ownership and Responsibilities
Sidewalks and Walkways	All owned and operated by the City of Vaughan, including those located within Region of York road allowances
Painted Bike Lanes	Those within Region of York road allowances are not accounted for in this report since they are owned and operated by the Region of York.
Cycle Tracks	Most cycle tracks are on City road allowances, and are owned and operated by the City. The City owns and operates certain specific cycle tracks on Region of York road allowances. Any Cycle Tracks within Region of York road allowances which are owned and operated by the Region of York are not accounted for in this report.
In-Boulevard Multi-Use Pathways	All owned and operated by the City of Vaughan, including those located within Region of York road allowances.
Multi-Use Recreational Trails (Open Spaces)	Those listed in this report are owned and operated by the City of Vaughan. The Region of York does not own or operate any such trails within the City of Vaughan.
City-Maintained TRCA Trails	The Toronto and Region Conservation Authority owns a network of trails within their properties. Only those which are maintained by the City are accounted for in this report.
Park Pathways	All within City-owned parks. All City-owned and operated.

The following elements are included within the scope of this AMP:

- A summary of the asset inventory, including the replacement cost of the assets, the average age of the assets, the condition of the assets, and the City's approach to assessing the condition of the assets.
- Current levels of service (LoS) based on performance measures.
- Asset lifecycle management strategies to maintain identified current LoS, minimize associated asset risks, and to optimize costs over the whole lifecycle of the asset.

1.5 Approach for Asset Management Plan

The approach used in the renewal of this AM Plan is presented in **Figure 1-1**, and has been selected to ensure that the City can have the confidence to make fact-based and defensible business decisions from reliable and robust information.

Figure 1-1: AM Plan Approach

2. State of Infrastructure

The City's current network of active transportation includes approximately 1,300km of pedestrian facilities, cycling facilities, and shared-use facilities which are designed to bring the community together, establish transit connections and get more people moving.

2.1 Asset Inventory and Hierarchy

Table 2-1 presents the City's Active Transportations assets inventory and hierarchy. Active transportations assets are categorized into three pedestrian facilities, cycling facilities, shared-use facilities.

Table 2-1: Active Transportation Asset Inventory and Hierarchy

Asset Category	Asset Type	Quantity	Unit of Measure
Pedestrian Facilities	Sidewalk	1,690,276	m^2
	Walkway	16,449	m^2
Cycling Facilities	Cycle Track	21,013	m
	Painted Bike Lanes[1]	3,682	m
Shared-Use Facilities	Multi-use Pathway (in Boulevard)	40,131	m
	Multi-Use Recreational Trail (Open Space)	53,538	m
	City Maintained TRCA Trail[2]	11,045	m
	Park Pathway[3]	104,636	m

[1]AM planning for Painted Bike Lanes within roadways are included in the AM Plan for Roads.
[2]TRCA Trails are not owned by the City. The quantity shown is only for those TRCA trails which are maintained by the City as per maintenance agreements with the TRCA
[3]AM planning for Park Pathways is included in the AM Plan for Parks.

2.2 Current Asset Replacement Value

The estimated replacement value is the cost of replacing an existing asset in 2024 dollars. These costs are collected from the City's GIS record. Where applicable, a CPI-based inflation rate was used to estimate the 2024 values.

Table 2-2. shows that the City's Active Transportation assets is valued at approximately $235M, with concrete sidewalks and walkways comprising approximately 91% of the total replacement value.

Active Transportation, culverts and bridges are assets of significant value in certain active transportation networks, typically found in in parks and open space trails. These structures are considered core assets. The bridges are included in the Core Asset Management Report for Bridges and the culverts are included in the Core Asset Management Report for Stormwater assets.

Table 2-2: Active Transportation Current Replacement Costs

Asset Category	Asset Type	Unit Cost ($ / Unit)	Replacement Value
Pedestrian Facilities	Sidewalk	$125 / m^2	$211,284,560
	Walkway	$125 / m^2	$2,056,165
Cycling Facilities	Cycle Track	$262 / m	$5,505,295
	Painted Bike Lanes[1]	-	-
Shared-Use Facilities	Multi-use Pathway (in Boulevard)	$262 / m	$10,514,309
	Multi-Use Recreational Trail (Open Space)	$107 / m	$5,728,516
	City Maintained TRCA Trail[2]	-	-
	Park Pathway[3]	-	-
Active Transportation Total			**$235,088,844**

[1]AM planning for Painted Bike Lanes within roadways are included in the AM Plan for Roads.
[2]TRCA Trails are not owned by the City. The quantity shown is only for those TRCA trails which are maintained by the City as per maintenance agreements with the TRCA
[3]AM planning for Park Pathways is included in the AM Plan for Parks.

2.3 Age and Remaining Service Life

The asset age is based on the install year of the assets and the remaining service life (RSL) is estimated by using age and expected service life (ESL) in years. The ESL for each asset is obtained from the City's inventory record.

The ESL is defined as the period over which an asset is available for use and able to provide the required LoS at an acceptable risk (i.e., without unforeseen costs of disruption for maintenance and repair). The actual service life can vary significantly from the ESL. In some instances, a variation in expected vs. actual service life is evident due to the following factors:

- **Operating conditions and demands:** Some assets are operated intermittently or even infrequently or is being operated a lower demand than its design capacity, thus the actual operating "age" of the asset is reduced.
- **Environment:** Some assets are exposed to very aggressive environmental conditions (e.g., corrosive chemicals), while other assets are in relatively benign conditions, thus the deterioration of assets is affected differently.
- **Maintenance:** Assets are maintained through replacement of components, which prolongs the service life of the asset.
- **Technological Obsolescence:** Some assets can theoretically be maintained indefinitely, although considerations such as maintenance cost, energy inefficiency and new technologies are likely to render this approach uneconomical.

Figure 2-1 shows the average asset age and RSL as a proportion of average ESL weighted by replacement value for each asset type. Most of the City's active transportation assets are progressed through more than half of their ESL. The City's cycle tracks are very early in their life cycle. It is noticeable that in general, the multi-use recreational trails have already exceeded their weighted average ESL.

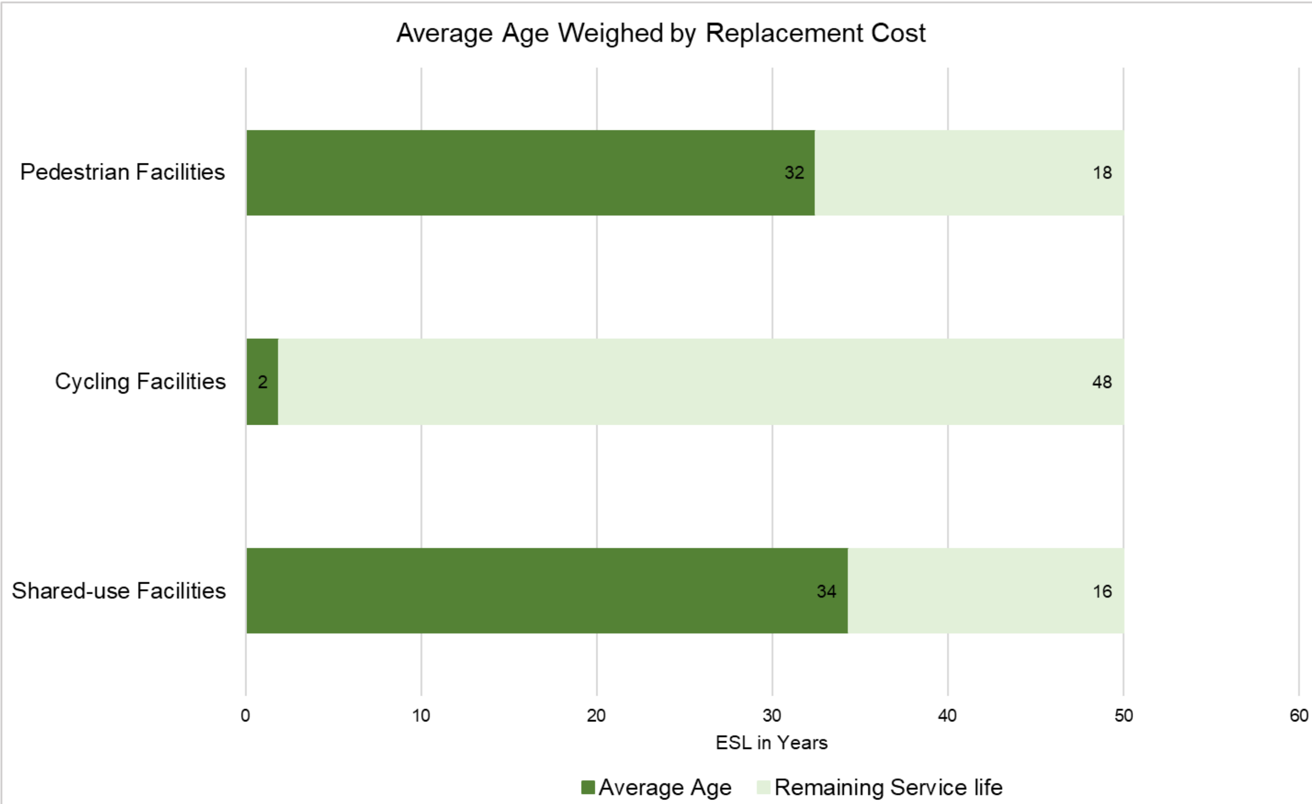


Figure 2-1: Active Transportation Asset Average Age and Remaining Service Life

2.4 Asset Condition

2.4.1 Age-Based Condition Assessment

Two-parameter Weibull distribution function was used to assess the current condition and to project the future condition of the City's Active Transportation. The Weibull distribution has been used extensively in reliability studies and lifetime prediction models in industries ranging from the automotive to the oil and gas industries; it provides a suitable distribution for this type of analysis.

The Weibull probability distribution provides a left-skewed distribution that rises slowly and diminishes quickly as the population is consumed. The underlying premise of the Weibull-shaped deterioration is that while some assets fail prematurely due to severe conditions or improper installation, other assets are very long-lived and function well beyond their theoretical expected service life. In order to perform a high order network-level analysis, it was assumed that assets would fail (and require replacement) within a deterioration envelope / curve approximated by a Weibull probability distribution. The two-parameter Weibull cumulative distribution has two parameters for scale and shape, as set out in Equation [1]:

$$f(x;\alpha,\beta) = e^{-\left(\frac{x}{\beta}\right)^{\alpha}} \quad [1]$$

Where: x = Age
α = Shape parameter
β = Scale parameter (or slope)

Table 2-3 presents the condition score ranges and the corresponding range of ESL and total life consumed.

Table 2-3: Age-Based Physical Condition Scale

Condition Score (minimum)	Condition Score (maximum)	Condition Rating	Range % of ESL Consumed	Range of % Operational Life Consumed
1	1.5	Very Good	0% – 71%	0% – 47%
1.5	2.2	Good	72% – 84%	48% – 56%
2.2	2.8	Fair	85% – 92%	57% – 60%
2.8	5.0	Poor	93% – 100%	61% – 100%

2.4.2 Condition Summaries

The GIS inventory provided by the City was used for the age-based condition assessment. **Figure 2-2** provides a summary of the condition weighted by replacement value for Active Transportation assets. It shows that 87% of the assets are in Good to Very Good condition. However, 6% of the assets are in Very Poor condition indicating that they have reached or exceeded their ESL and require to be renewed or replaced in the short term.

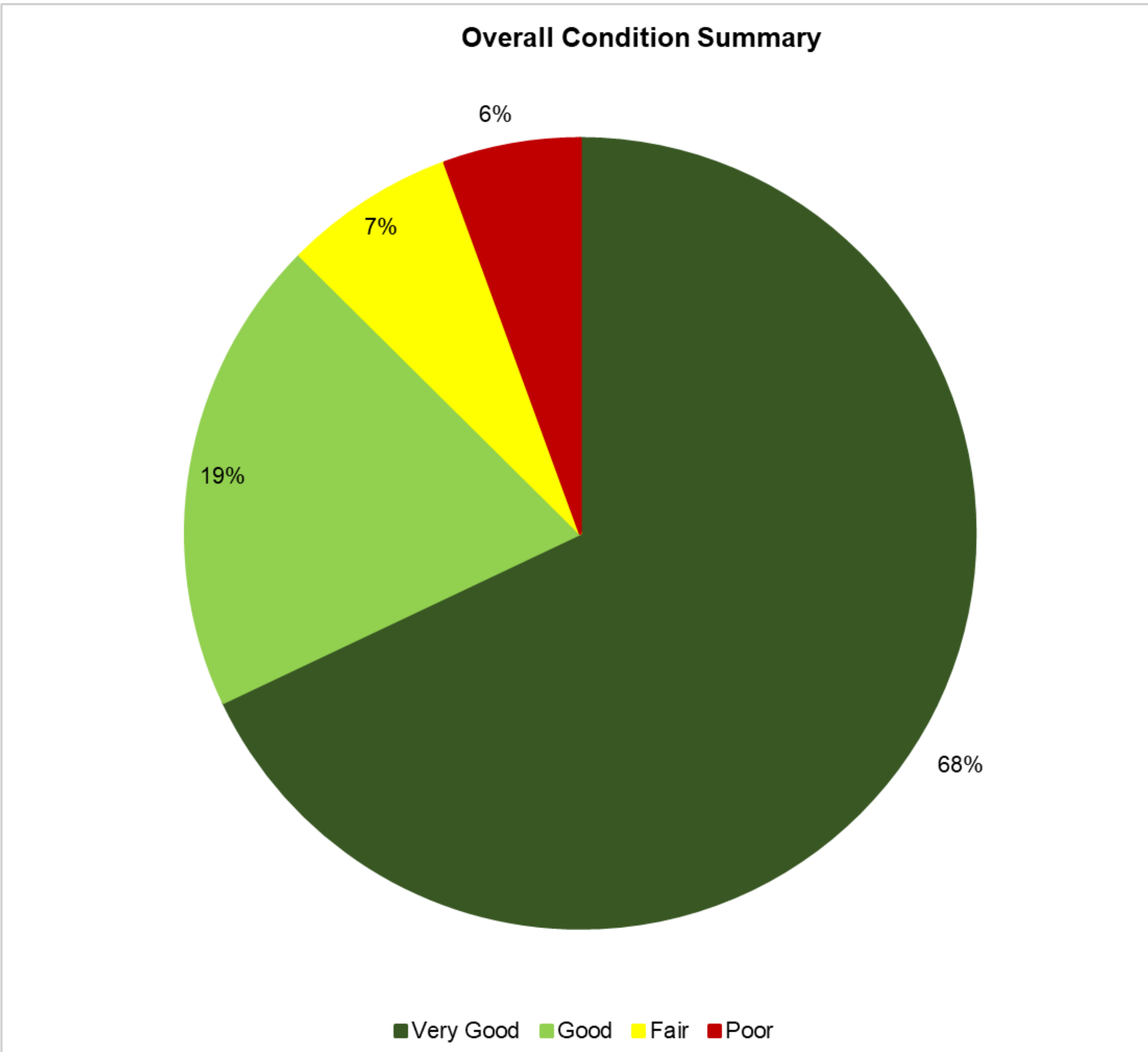


Figure 2-2: Active Transportation Asset Condition Summary

Figure 2-3 presents the condition distribution by Active Transportation asset types weighted by replacement cost. Approximately 65% of the City's pedestrian facility assets is in Very Good condition, while 6% of the pedestrian facility assets are in Poor condition. Cycling facility and shared-use pathways are mostly in Very Good condition.

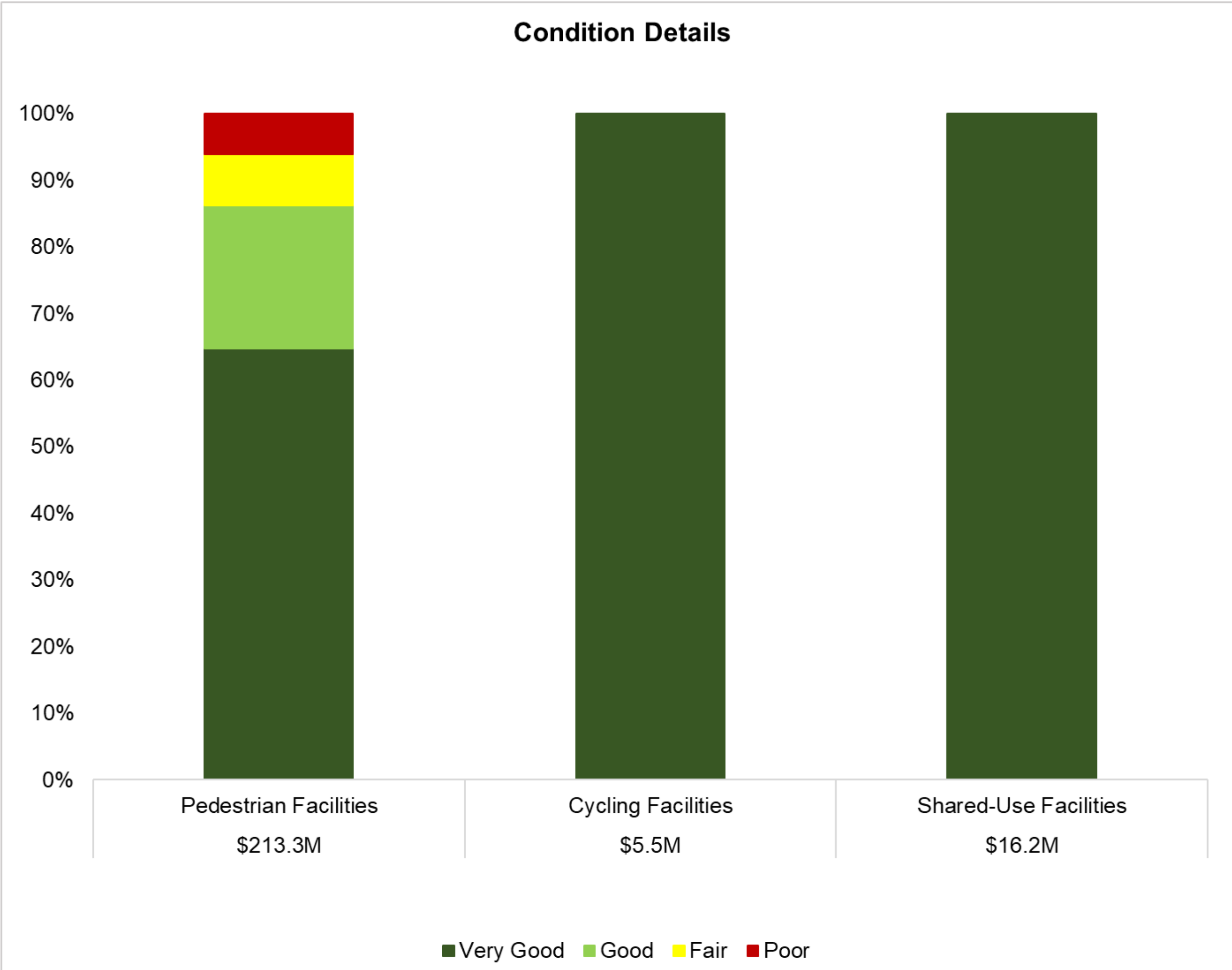


Figure 2-3: Distribution of Active Transportation Asset Condition

3. Levels of Service

3.1 Purpose

LoS supports every aspect of the overall AM System as shown in **Figure 3-1**. The objective of establishing clearly defined service levels is to help the City meet stakeholder values, achieve its strategic goals, make informed risk-based decisions, and implement effective asset lifecycle activities.

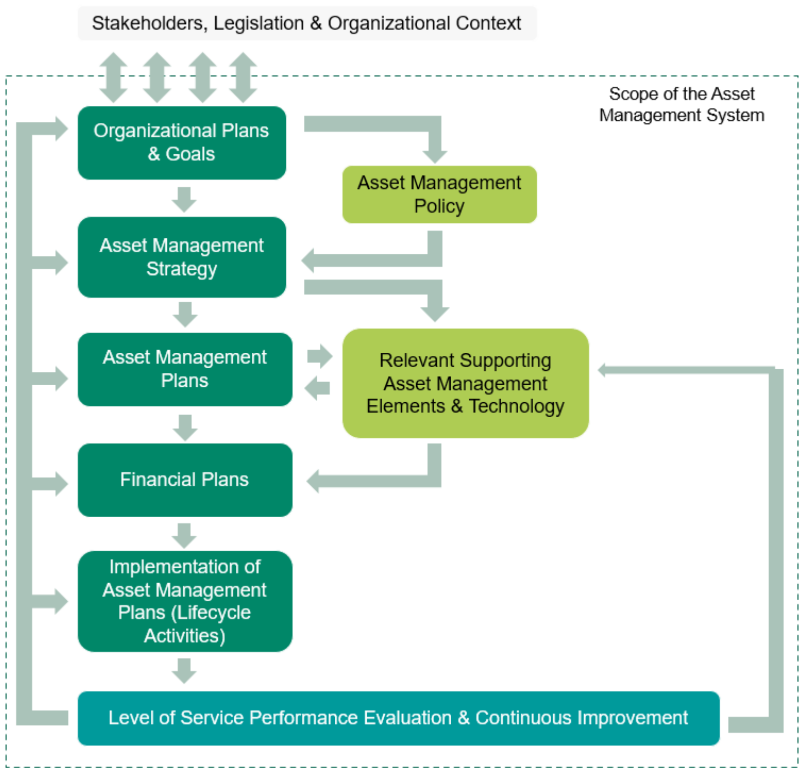


Figure 3-1: LoS within the AM System

In the City's experience, documenting LoS is a proven practice that will enable the City to:

- Link corporate strategic objectives to customer expectations and technical operations.
- Balance customer needs and expectations while evaluating the effectiveness of operations and whether the right LoS is being provided at the right cost.
- Transition from an "Asset Stewardship" approach that focuses on making decisions based on maintaining assets in an acceptable condition to a "Serviceability" approach that is geared towards making decisions based on balancing the costs, risks, and goals for the LoS being provided by the City's assets.
- Communicate the physical nature of infrastructure that the City owns and is financially responsible for while promoting the use of LoS to enable effective consultation with stakeholders regarding alternative funding options according to desired LoS outcomes.
- Make recommendations on strategies that the City can take now to minimize future renewal costs while ensuring that adequate LoS can be delivered without burdening future generations.
- Assess internal (e.g., program changes) and external (e.g., climate change) factors that have the potential to impact the City's ability to deliver services and how these factors may impact the LoS being provided.
- Implement a corporate continuous improvement program to further optimize AM across all service areas.

The O. Reg. 588/17 requires that all AMPs include information about the LoS that the City proposes to provide, the activities required to meet those service levels, and a strategy to fund those activities. The deadline for formalizing these LoS requirements is July 1, 2025 (see **Section 1.3**).

Successful AM programs aim to achieve targeted service levels through customer-based decision making. To achieve this, the City considered a customer-centric approach, where the customer is at the heart of every decision from development to implementation, consultation, and roll-out of the LoS Framework (**Figure 3-2**).

There are two types of LoS measures: Customer LoS (also called "Community" LoS) and Technical LoS. Customer LoS are recorded in a manner that attempts to describe the LoS in terms of what is actually being provided to the customer (i.e., the public) and how the customers experience the service. It is important to note that customers are not concerned with the specific operating requirements of the assets that provide the service, but rather the value they obtain from the operation of the assets. To achieve Customer LoS there needs to be line of sight between the value delivered and how that value is realized. This is the purpose of Technical LoS which attempts to describe how the City will provide and meet the expected Customer LoS.

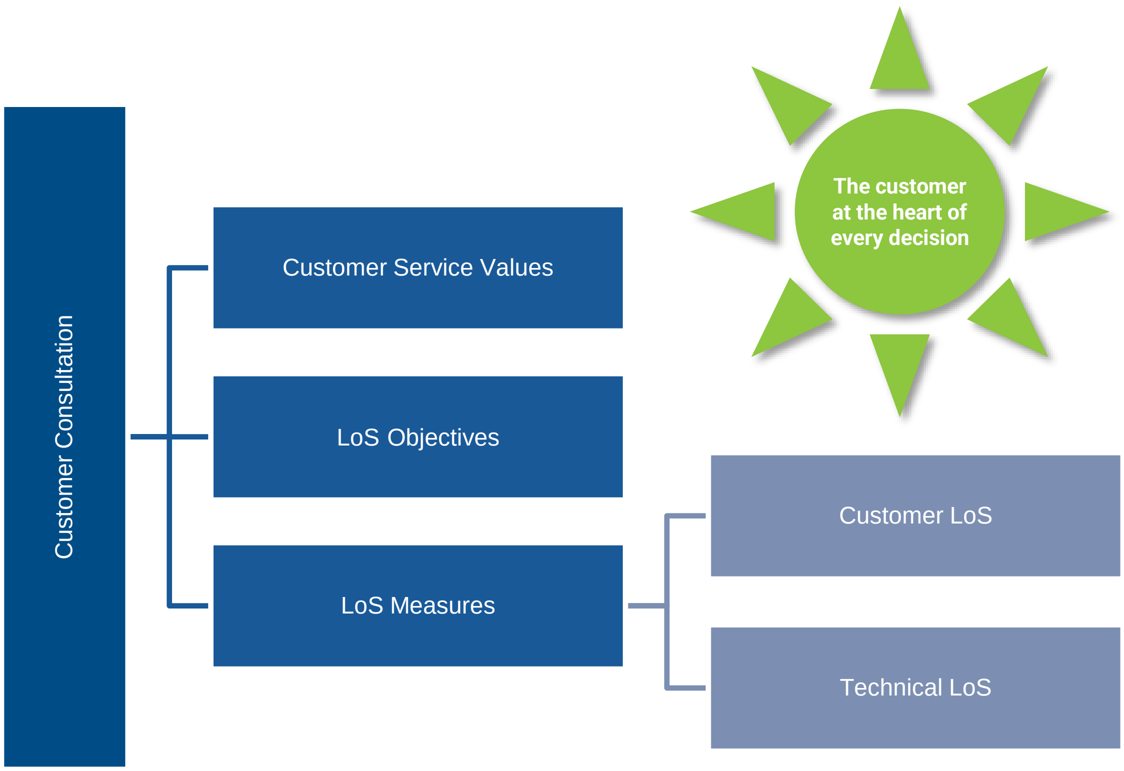


Figure 3-2: The LoS Framework Customer-Centric Approach

The LoS Framework was primarily conceived through a collaborative workshop process. In 2020, four workshops with City staff were conducted across each of the fourteen service areas.

The following outcomes were achieved during each service area workshop:

- Staff were oriented as to the purpose and importance of establishing a consistent LoS Framework;
- Stakeholders were identified, including their expectations, interests, and any regulatory requirements;
- Customer service values were established and reviewed;
- LoS objectives were established for each customer service value;
- Staff provided several performance measures that are currently being tracked as well as those that the City would like to track in the future;
- Where information was available, current performance, targets, and data sources were documented; and
- Growth and shifts in future demand were discussed across the City's service areas.

3.2 Objectives

Defining LoS objectives is important for drawing a line of sight between the City's corporate objectives and the tangible asset performance outcomes. To do so, the LoS objectives must take into consideration stakeholder interests to develop asset performance measures that aim to meet the needs and expectations of the community. By doing this, the City will ensure that their assets are striving towards optimal performance, not only operationally, but economically, socially, and sustainably as well.

Every stakeholder has certain interests in the service being provided and in general, these interests can be categorized into six universal stakeholder values, as shown in **Table 3-1**. Each universal stakeholder value is also assigned a corporate LoS objective.

Table 3-1: The City's Values and LoS Objectives

Customer Value	LoS Objective
Quality and Reliability	The service is delivered with a high standard of excellence, and the service is available when needed.
Affordability	The cost of the service is delivered in a financially sustainable manner and does not burden customers.
Environmental Sustainability	The service is delivered in a manner that does not compromise the ability of future generations to meet their needs.
Access and Capacity	Customers can easily access the service with minimal inconvenience.
Health and Safety	The service is delivered with minimal health and safety impacts.
Responsiveness	Customer service requests are responded to efficiently and in a timely manner.

3.3 Stakeholders and Their Interests

A stakeholder is any person or organization that can affect, be affected by, or perceive themselves to be affected by a decision or an activity. Stakeholder analysis is the process of understanding stakeholder needs, expectations, and perceptions relative to the stakeholder's level-of-interest and level-of-influence over the organization. An organization typically engages with their stakeholders to:

- Establish which activities or services matter most to them.
- Understand their risk appetite and risk threshold.
- Understand their willingness to pay for services.

Stakeholders can take many forms and may be internal (i.e., staff, Council) or external (i.e., the public, regulatory agencies, suppliers, neighbouring municipalities, etc.) to the organization. Historically, only service recipients who pay for City services would be considered customers; however, today customers can take many forms and should include any entity that has a legitimate interest in the service being provided. In addition to service recipients (i.e., the public), this may include:

- **Regulatory Agencies** – Stakeholders that set standards, compliance regulations or other legislation that govern service delivery.
- **Special Interest Groups** – Stakeholders that are affected by or have an interest in the City's roadway services.
- **Neighbouring Municipalities** – Other communities that are adjacent to the City and are affected by or have an interest in City services.

Table 3-2 identifies the key stakeholders as they pertain to the City's Active Transportation asset class. These stakeholders were documented during a collaborative workshop process with the City and is not intended to be an exhaustive list; however, the following groups provide a good starting point for future stakeholder engagement.

Table 3-2: The City's Active Transportation Key Stakeholders & Their Interests

Key Stakeholder Group	Description	Stakeholder Interests / Priorities
User Groups – cyclists, pedestrians, transit users, etc.	These stakeholders are users of the City's active transportation network. Sidewalks, bike lanes, and pathways are important infrastructure to ensure that cyclists and pedestrians move safely and efficiently throughout the transportation network and can easily connect to transit and destinations.	Safety Accessibility Responsiveness Quality
City Departments	Internal stakeholders such as the Public Works Portfolio have an interest in the active transportation network since the maintenance and operation of assetsfall within their responsibility.	Safety Accessibility State of Good Repair Responsiveness
Regulatory Agencies	This stakeholder group includes Ontario regulatory agencies which mandate service level requirements and set minimum maintenance standards (i.e., Accessibility for Ontarians with Disabilities Act).	Legislative Safety Accessibility Responsiveness State of Good Repair
Regional Authorities	This Stakeholder group includes the York Region and the Toronto and Region Conservation Authority (TRCA). Maintenance agreements are in place between the York Region and the City as well as TRCA and the City to ensure active transportation facilities are kept clean and safe regardless of their location.	Safety Responsiveness State of Good Repair

3.4 Level of Service (LoS) Performance Measures

A documented suite of LoS performance measures enables a common understanding of the service delivery that the City's customers currently receive, and the associated cost of maintaining infrastructure assets to provide the service. Having these performance measures set at the appropriate levels within the City ensures alignment from the corporate vision, to asset investment decisions, and to day-to-day operational activities. When establishing LoS performance measures it is important to keep in mind the "SMART" acronym, as follows:

- **S**pecific, easily evaluated and understood.
- **M**easurable, quantifiable, and easily collectable to ensure ongoing data availability.
- **A**ttainable, so that they work to motivate as opposed to discourage.
- **R**elevant, in that they relate and align with a specific goal.
- **T**ime-Bound, measured over a specific period, which is typically annually for benchmarking.

There are two types of LoS performance measures: Community LoS and Technical LoS. Community LoS are recorded in a manner that attempts to describe the LoS in terms of what is being provided to the community (i.e., the public) and how the customer experiences the service. Community LoS are qualitative, non-technical, and are driven by the municipality's strategic AM objectives. Community LoS are not concerned with the specific operating requirements of the assets that provide the service, but rather the value they obtain from the operation of the assets. To achieve Community LoS, there needs to be line of sight between the value delivered and how that value is realized. This is the purpose of Technical LoS which attempts to describe, quantitively, how the City will provide and meet the expected Community LoS.

3.5 LoS Performance Results

A summary of the City's current and proposed community and technical service levels for the Active Transportation assets are documented in **Table 3-3.**

Table 3-3: Community and Technical Service Levels

Level of Service	Current Performance	Current Service Level Target	Proposed Service Level Target
Percentage of Assets with Condition Rating of Fair or Above	94%	94%	No Change
Completion Status of 10-Year Pedestrian and Cycling Infrastructure Implementation Program			
% Existing	24%	24%	No Change
% Under Construction	10%	10%	No Change
% Under Design	12%	12%	No Change
% Planned	49%	49%	No Change
% Under Functional Design	5%	5%	No Change

Measured in the most recent Citizen Satisfaction Survey conducted by Ipsos, the percentage of respondents satisfied with Cycling Infrastructure and Bike Lanes was 68% and regarding Off-road Multi-use and Natural Trails, the percentage was 84%.

Additionally, the Active Transportation network consisting of City-owned assets (with the exception of TRCA trail segments) is illustrated in **Figure 3-3**.

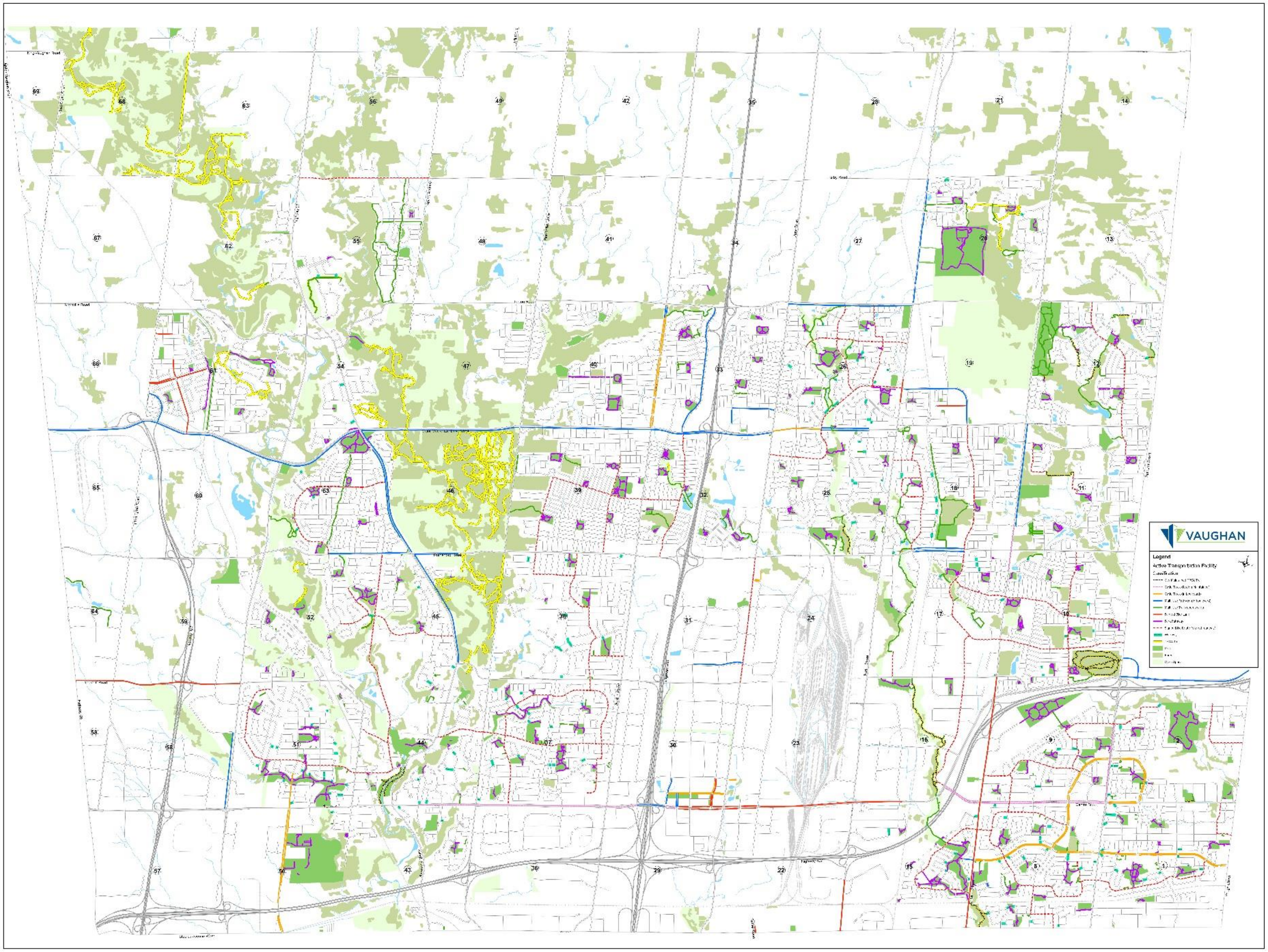


Figure 3-3: Active Transportation Network Map

3.6 LoS Performance Targets

Establishing LoS targets is an important part of continual improvement and performance management. Without targets, it is difficult to ascertain whether goals are being met, or the extent of the gap if they are not. Incorporating targets into the City's LoS Framework helps to ensure that targets are reasonable, aligned with customer expectations, and evaluated on an objective basis by considering cost-benefit trade-offs.

One of the key challenges in setting targets in a municipal environment is that they can often become biased and/or politically motivated. Therefore, it is important to review LoS targets with stakeholders. An important aspect of evaluating LoS targets is determining how willing the user is to pay for the service. Regulatory requirements are an exception; however, they only provide the minimum service standard. Cost is still an important parameter to consider when assessing the merits of service improvements.

To deal with the financial realities, it is necessary to:

- Calculate how much the service costs based on current LoS.
- Determine the cost associated with varying the LoS.
- Assess the customers' willingness to pay.

3.7 Future Demand Drivers

Understanding internal and external factors that may impact service delivery (positively or negatively), such as staff resources, climate change, and shifts in population is a critical component for managing desired service levels in a sustainable manner. It is important to proactively develop effective, long-term strategies that are suitable for the City's unique economic, environmental, and social landscape.

In most cases, the factors presented in

Table 3-4 may result in a negative impact on the City's existing service levels, unless additional funding or resources can be allocated to meet future needs; however, in some instances, such as technological advancements and higher regulation standards, the impact on service delivery may actually improve as a result.

Table 3-4: Potential Future Demand Drivers

Anticipated Issue	Potential Impact on Service Delivery
Population Growth & Development	• The pace of development is increasing and is contributing to a greater demand for infrastructure that support the movement of people and goods across the City's transportation network, particularly via active transportation.
Demographics and Shifting Behaviours	• Demand for safer active transportation infrastructure including separated pedestrian and cycling facilities and multi-use recreational trails has grown in the last ten years and in particular in light of the recent global pandemic. • With the rapid emergence of micromobility usage in Vaughan, the City is considering the opportunity to expand the existing cycling network to accommodate these devices that are not necessarily suitable or safe to use on sidewalks or roads.
Available Funding	• With a finite amount of funding available from Development Charges and the City's tax base, the implementation of active transportation facilities are prioritized against all other infrastructure projects. • In the last ten years, there has been a steady increase in governmental interest, support and understanding of cycling and walking as a viable and healthy mode of transportation and recreational activity as well as contribute to long-term, sustainable, inclusive economic growth. More funding opportunities are becoming available at the Regional, Provincial and Federal Levels. For example, in 2022, the Federal Government announced the first ever national Active Transportation fund that will provide $400 million over five years to support the expansion and enhancement of active transportation infrastructure.

By considering potential drivers, as well as any issues that may pose a threat to meeting future demand, the City has the advantage to proactively plan and prepare mitigation strategies.

Approaches for the City to consider include:

- Asset-based solutions (e.g., upgrading existing assets, providing new assets, etc.).
- Non-asset-based solutions (e.g., restricting usage, changing habits through education, providing service alternatives, etc.).

A hybrid solution often works well since every municipality has its own challenges and there is not a "one solution fits all" approach. It is important that the City remains aware of its internal and external situational context and modifies its approach and mitigation strategies in a consistent, periodic, and well documented manner.

4. Asset Lifecycle Strategies

Asset lifecycle management focuses on the specific activities we must undertake during all phases of the asset lifecycle. By considering entire asset lifecycles the City can ensure sound decision making that consider present and future service delivery needs.

The overarching goal of life cycle management is to maximize the long-term benefits and services that our assets deliver while minimizing the associated costs and risks in the long run. Every asset has a life cycle cost, which is the total cost of all the activities undertaken throughout its service life. The following sections describe activities across the life cycle of assets.

4.1 Lifecycle Activities

Any responsible owner of assets such as the City has a desire to preserve the condition of their existing assets for as long as possible, by maintaining or even extending their design lives through routine activities such as maintenance and active intervention. The City is continually acquiring infrastructure assets, but these assets require increased funding for operation and maintenance as they age. The City is also responsible for the replacement of deteriorated assets as long as the service is required. While individual assets may have a useful life that can be predicted in years or decades, the service that the asset provides could be for a substantially longer duration (perhaps in perpetuity). Part of the purpose of the AM planning process is to fully understand and predict the long-range financial requirements for the City's infrastructure to facilitate planning and resource management in the most cost-effective manner possible. **Figure 4-1** illustrates how costs typically accumulate over an asset's life. It is worth noting that the accumulation of the ongoing operations and maintenance, refurbishment and disposal / replacement costs is many multiples of the initial acquisition costs. A key and important take-away from **Figure 4-1** is therefore for the City to fully understand the entire life cycle costs before proceeding with asset acquisition.

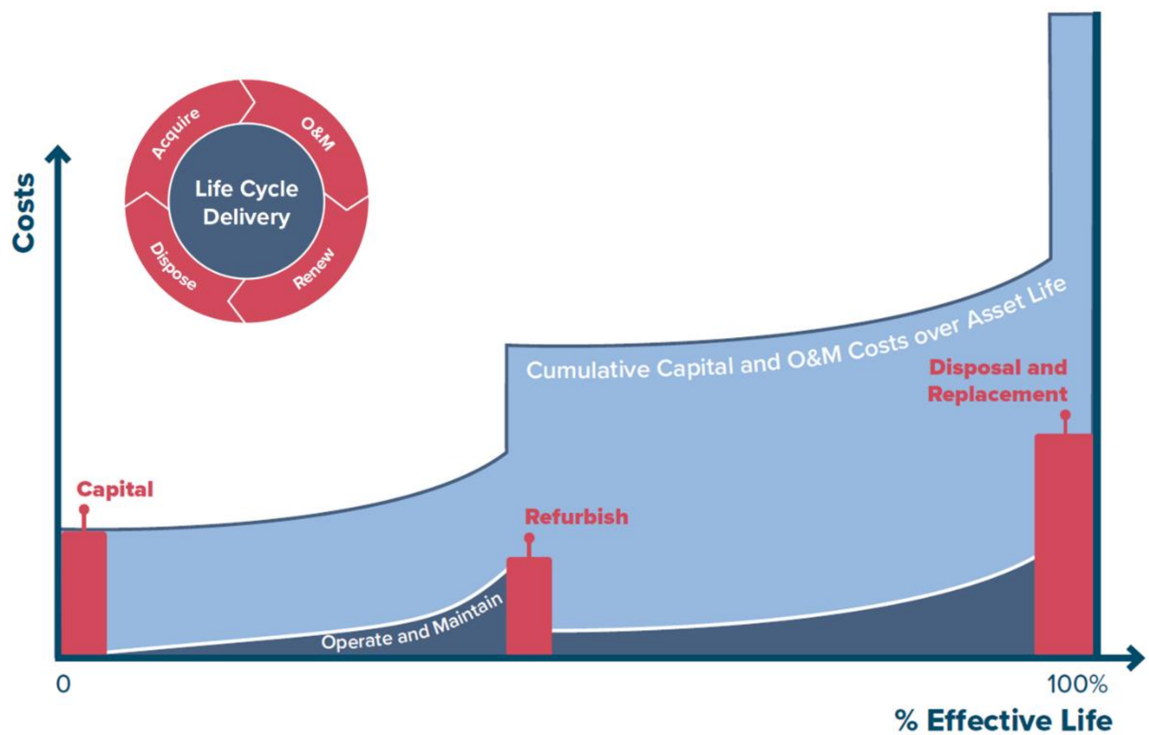


Figure 4-1: Life Cycle Cost Accumulation Over Asset Life

4.2 Asset Acquisition Strategies

The City has made significant investments in the design and acquisition of its municipal infrastructure assets. The creation and acquisition of active transportation assets is driven by master planning. The City envisions to link this to its other strategic and master plans, such as the Pedestrian and Bicycle Master Plan which identifies a two-pronged implementation framework for the purposes of the prioritizing and phasing pedestrian, cycling and multi-use recreational trail infrastructure as shown in **Figure 4-2**.The City leverages capital infrastructure and development projects complimented by a dedicated pedestrian and cycling infrastructure implementation program to implement a cost-effective, yet timely and cohesive AT infrastructure network.

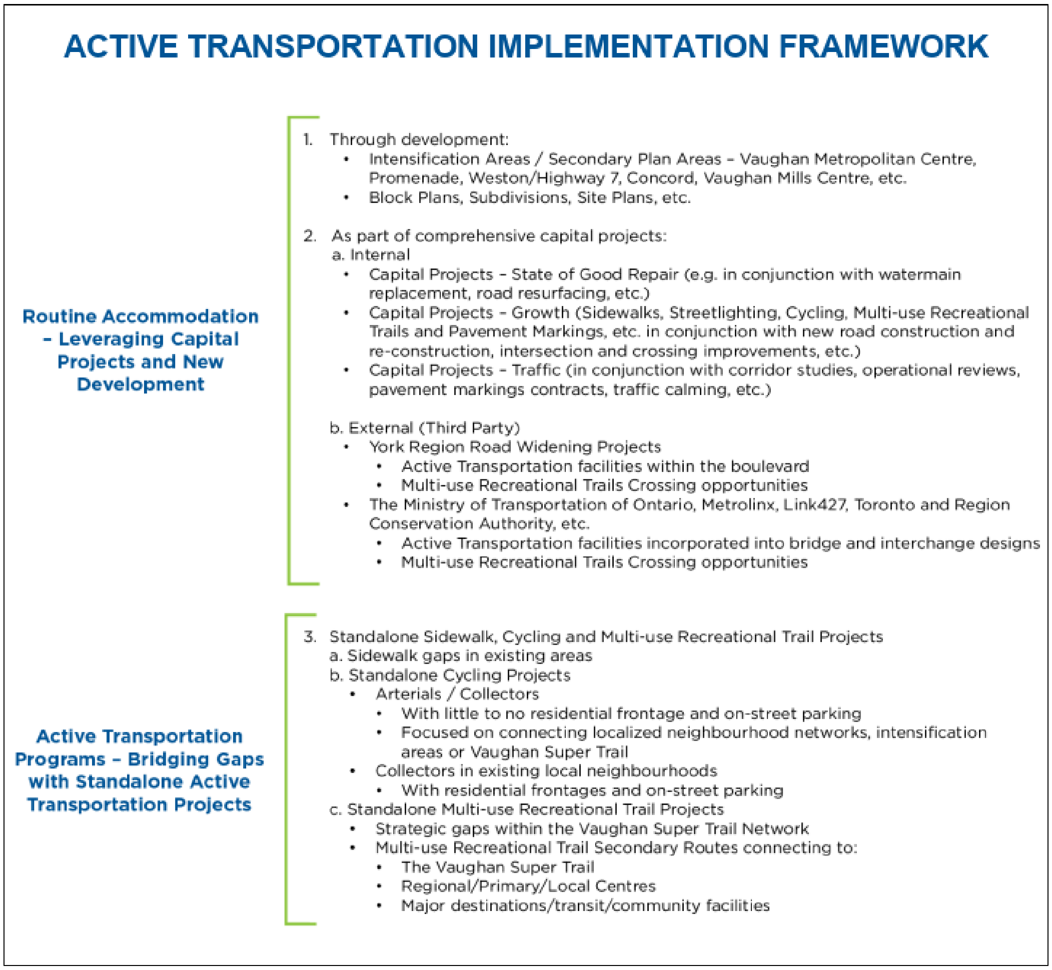


Figure 4-2: Active Transportation Implementation Framework[1]

Looking towards the future, when acquiring new assets, the City should evaluate credible alternative design solutions that consider how the asset is to be managed at each of its life cycle stages.

Asset management and full life cycle considerations for the acquisition of new assets include, but are not limited to, the following:

- The asset's operability and maintainability.
- Availability and management of spares.
- Staff skill and availability to manage the asset.
- The manner of the asset's eventual disposal.

[1] Pedestrian and Bicycle Master Plan

4.3 Operations and Maintenance Strategies

As new infrastructure is commissioned, the City accepts the responsibility of operating and maintaining the infrastructure according to operation and maintenance (O&M) standards to ensure that the infrastructure is safe and reliable. Operations staff provide the day-to-day support required to operate infrastructure. In few cases, operation costs are minor, but for most there are significant increases.

Maintenance expenses include periodic preventive maintenance to ensure that the infrastructure can provide reliable service throughout the life of the asset and corrective maintenance that is required to repair defective assets as and when needed. Inadequate funding for O&M will have an adverse impact on the lifespan of assets. The O&M resources required in any period is a function of the current inventory of infrastructure and total O&M needs required for each asset. As the inventory of infrastructure grows, total O&M requirements will also grow.

The active transportation assets such as sidewalks, in-boulevard multi-use pathways, cycling facilities and multi-use pathways in open spaces and specific TRCA trails are regularly maintained by the Transportation Services, Parks and Forestry Operations staff in accordance with the O. Reg. 239/02 Minimum Maintenance Standards for Municipal Highways, O. Reg. 191/11: Integrated Accessibility Standards and other applicable regulations standards. The City has systems in place to identify, document, and prioritize maintenance activities, these include online reporting (e.g., the Public Works "Service Request Portal") and mapping tools (e.g., "Where is my Snowplow").

The current practices at the City include regular maintenance program, pre-winter O&M activities, snow clearing and salting operations for sidewalks and cycling facilities. The regular maintenance of sidewalks comprises of identification and prioritization of any defects; scheduling of repairs, ranging from saw cutting to the complete removal and replacement of the defective sections of the sidewalks. For regular maintenance of cycling facilities, it includes annual pavement marking program to refresh existing on-road pavement markings on City owned streets. For multi-use recreational trails, the City has a winter maintenance program in place which does not include the trails outside of the road right-of-way. As part of the Pedestrian and Bicycle Master Plan[2], the City aims to expand its O&M program based on the best practice reviews and lessons learnt from other municipalities.

Table 4-1 presents O&M actuals for the past five years and the overall four-year average O&M expenditures was $1.46M.

Table 4-1: Historic Active Transportation O&M Expenditures

Year	Total O&M Actuals
2023	$1,865,084
2022	$1,663,230
2021	$1,154,288
2020	$1,155,772
4-Yr. Average	**$1,459,594**

4.4 Renewal and Replacement Strategies

The third portion or phase of full life cycle costing relates to the renewal and replacement of infrastructure that has deteriorated to the point where it no longer provides the required service. Renewal cost is sometimes incurred during the life of an asset where an investment is made to improve the condition and / or functionality of the asset. Disposal and replacement costs are incurred at the end of an asset's life when it is disposed of and replaced by a fully new asset. It is vital that communities fully understand the looming obligations of infrastructure renewal or replacement and develop a strategy to respond in a manner that is fair and affordable.

For sidewalk and cycling facilities, these treatments can range from patch work and crack sealing to resurfacing and total reconstruction, based on condition, safety risk and available budget. The City has a request-based

[2] Operation and Maintenance Tech Paper_2019-02-11.pdf (vaughan.ca)

sidewalk bay replacement program in place, which historically cost approximately $150,000 annually for sidewalk repair as part of the capital project budget.

4.5 Disposal and Decommissioning Strategies

There will inevitably come a point in time when an asset must be removed from service and, depending on the type of asset, there may be significant costs associated with its decommissioning and disposal. Factors that may influence the decision to remove an asset from service, include changes to legislation that cause the asset to be in non-compliance, the inability of the asset to cope with increased service levels, technology advances that render the asset obsolete, the cost of retaining the asset is greater than the benefit gained, or the current risk associated with the asset's failure is not tolerable. The current practices at the City look at disposal of Active Transportation at the end of their useful life.

Normally, major costs that may be incurred during disposal and decommissioning derive from the environmental impact of the disposal and, if required, the rehabilitation and decontamination of land. In some cases, there will be residual liabilities and risks to consider if a decision is made to partially abandon the asset as opposed to fully disposing of its components (e.g., leaving a non-functioning pipe in the ground, or an inactive building standing). For now, there is no formalized procedures in place at the City to track any environmental costs associated with Active Transportation disposal activities.

4.6 Capital Planning

Capital investment is to address community growth or changes, or to renew existing assets to maintain service levels. For the actual funding needs analysis, please refer to **Section 5**.

- **Life Cycle Cost Analysis Approach**. The City's analysis enables optimized decision making and mathematical deterioration modelling of infrastructure assets and the development of short, medium and long-term forecasts of renewal and replacement costs of a number of decision criteria and the ability to compare different intervention options to find the optimal solution in terms of timing and the intervention option chosen.
- **Forecast Periods.** The City aims to develop Short- to Medium-Term and Long-Term capital plans. Typically, short to medium-term capital plan identifies the activities required to meet current and future demand, the cost of those activities and a financing approach. It is developed or renewed every three to five years and should coincide with regulations on short to medium-term expenditure planning. A long-term plan can serve as part of Strategic Asset Management Plan, which indicates what will be spent, by service areas, over a set period of time. Long-term plans tend to focus only on costs.
  Consistent with the approach of other asset management plans, the analysis periods for funding need assessments are 20 years.

4.7 Asset Prioritization

4.7.1 Risk Assessment

Infrastructure-related risk exposure is assessed based on the combined consideration of probability and consequences of an asset failure, which is used to drive the selection and prioritization of appropriate action, based on risk tolerance thresholds and funding availability. Understanding the risk exposure for a given set of assets allows the City to identify where they are most exposed to risk, and to target their investments to most effectively reduce that exposure.

In addressing risk for infrastructure assets, the first step in the analysis is to identify assets that are most critical to the business. Critical assets are those that will potentially have the greatest impact on service delivery should they fail. It should be noted that the parameters, criteria and weighting factors area starting point, and should be reviewed and modified to reflect the priorities of the City on an ongoing basis.

The fundamental principle of consequence (or criticality) models is that they evaluate the relative importance of assets based on select criteria. The approach to risk analysis within this project utilizes a triple-bottom-line assessment approach utilizing the following four criticality indices:

- **Economic** – influence of the asset's failure on monetary resources
- **Operational** – influence of the asset's failure on operational ability
- **Social** – influence of the asset's failure on society
- **Environmental** – influence of the asset's failure on the environment

By applying specific indices, the risk assessment framework generates a risk (or priority) score for each asset. The risk score is a rating of the asset based on the detailed assessment of the likelihood and consequence of failure based on a number of key parameters. All parameters are then equated using equation [4].

$$\text{Risk} = \text{Likelihood of Failure} \times \text{Consequence of Failure} \qquad [4]$$

Based on this principal, the risk associated with a given asset's failure can be managed by limiting the likelihood of this occurring, or the impact realized, should it occur.

Consequences of Failure (CoF) reflect the relative "impact" of a given asset's failure. While traditionally these have been looked at as purely economic terms (i.e. repair cost, loss of revenue, etc.), the truth is that investment decisions are often driven by non-economic factors. Understanding both the economic and non-economic

impacts associated with loss or limitation of service help in categorizing an asset's "criticality" and justifying infrastructure decisions in a consistent, defensible manner.

4.7.2 Analytical Logic to Sequence Interventions

The asset criticality score can be used to prioritize projects within a funding constrained environment. **Figure 4-3** illustrates this logic of carrying unfunded needs to the next year in the period where they receive a higher probability of receiving funds based on their criticality score.

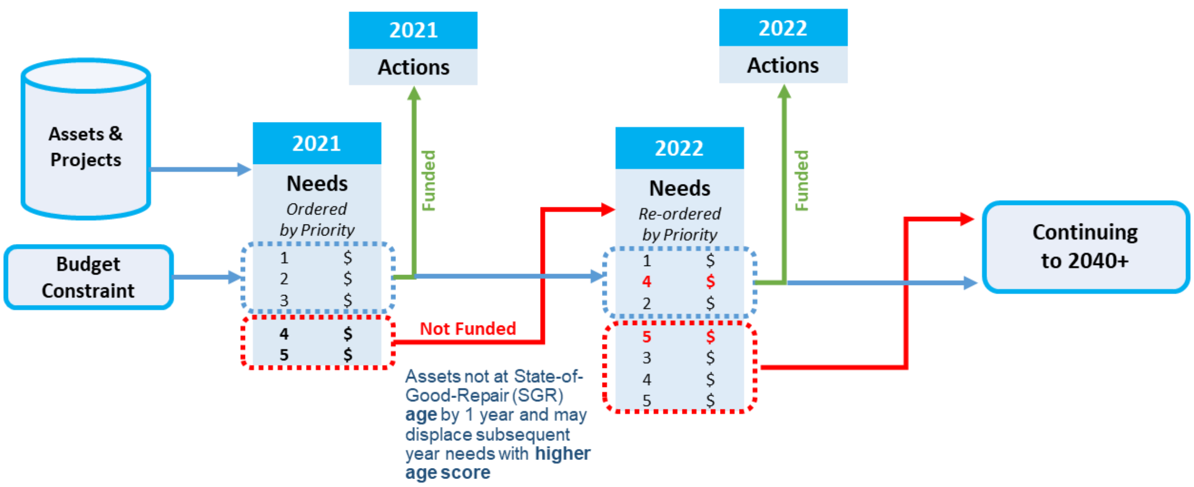


Figure 4-3: The Role of Criticality to Prioritize Projects Within A Funding Constrained Environment

4.8 Financial Planning

4.8.1 Financial Policies

The City has taken the initiative to establish financial asset management policies in 2018, which provides directions on how financial principles apply to assets to ensure that service goals are met. The policy aligns the business model of AM with the City's financial planning, financial reporting, cost management, treasury and taxation functions. The City will integrate findings from the AM Plans into its long-term financial planning and budgeting processes. Sound financial analysis will be encompassed in AM planning in order for the AM Plan to be a sought-after guide for employees in budgeting and financial planning.

4.8.2 Financial Analysis

Financial analysis activities for asset management is centered on two essential quantities: revenues and expenditures. Revenues can come from many sources. Through asset operations, the City generate its own source revenues from taxes, development charges, etc. Expenditures are all the direct and indirect costs associated with capital, operating and maintaining, and disposing of assets.

Assessing the financial implications supports in the decision-making when there are competing priorities and trade-offs between projects. Financial analysis provides a better picture of how to fund the capital plan and make critical decisions about service delivery while providing the greatest benefit for the community at the lowest cost.

4.8.3 Aligning the Financial and Non-Financial Functions of AM

ISO 55010[3] identifies the that the financial and non-financial functions of AM within organizations are generally inadequately aligned, as follows:

- **Financial Accounting Functions:** Focused on retrospective reporting of accounting / regulatory financial activities. However, there is a growing awareness in organizations of the need to focus on providing a managerial costing approach in order to support decision-making for the future.
- **Non-Financial Functions:** Have a limited understanding of financial accounting functions but are recognizing the need to improve their understanding of the financial implications of their activities.

The lack of alignment between financial and non-financial functions can be attributed to silos in an organization, including reporting structures, functional / operational business processes, and related technical data. Silos generally bring forth the necessary level of specialization. However, with a lack a communication between the silos, organizations are at risk of inefficiencies and errors in AM results, or AM failures due to a lack of alignment between AM staff and senior management. Financial and non-financial alignment needs to work both “vertically” and “horizontally”, as follows:

- **Vertical Alignment:** Financial and non-financial asset-related directives by management are informed by accurate upward information flows, effectively implemented across the appropriate levels of the organization.
- **Horizontal alignment:** Financial and non-financial information that flows between departments (conducting functions such as operations, engineering, maintenance, financial accounting and management) uses the same terminology and refers to the assets identified in the same way.

Figure 4-4 presents the key elements in a framework to address the need to achieve the alignment.

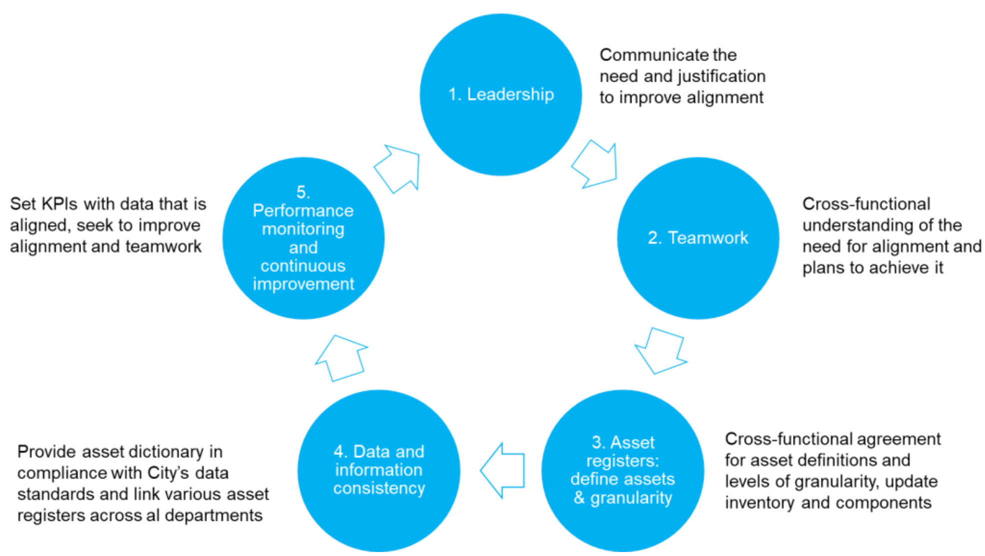


Figure 4-4: Key Elements of a Framework to Achieve Financial and Non-Financial Alignment

4.8.4 Long-Term Financial Planning

Strengthening the City’s Asset Management planning according to the recommendations in Asset Management Strategy will improve the City’s long-term financial planning, by accounting for whole life cycle costs as presented in Section 4.1. This includes all capital, annual operation and maintenance, and disposal costs over the planning timeframe, thereby aligning financial requirements with long-term level of service objectives.

The challenge is often one of agreeing on a timeframe for such planning, recognizing that the AM perspective is ideally focused on the asset life cycle, versus the political / election cycle that could be as short as a three to four-year Council term. Accordingly, financial and non-financial staff, as well as top management and politicians,

[3] International Organization for Standardization (2019): ISO 55010 - Asset management — Guidance on the alignment of financial and non-financial functions in asset management

should agree on a long enough timeframe to provide useful forward planning information that aligns the financial and non-financial perspectives, as presented in **Figure 4-5**.

Figure 4-5: AM Planning Alignment Across the Organization

The City should have an appropriate long-term financial planning process that achieves the following:

- Stimulates long-term strategic thinking and perspective for stakeholders and decision-makers.
- Can be used as a tool to prevent or predict future financial shocks and demonstrate financial sustainability.
- Demonstrates to internal and external stakeholders that the organization has a financial strategy in place to meet their demands, now and in the future.

The long-term financial planning process needs to involve financial and non-financial staff working together to combine the important elements of strategy development, asset management planning and financial forecasting (**Figure 4-4** and **Figure 4-5**).

5. Funding Need Analysis

The lifecycle analysis was implemented in an MS Excel Asset Lifecycle Model, which integrated asset inventory, age, ESL, replacement values, and condition to create a theoretical asset replacement cycle for each Active Transportation asset. The asset reinvestment forecasts prepared for this assessment are estimates of what it will cost over the next 20 and 60 years to sustain the City's Active Transportation assets.

The annual reinvestment need for the Active Transportation assets were based on age and ESL (i.e., replacing assets that has exceeded their ESL) in 2024 dollars.

It should be noted that the nature of this type of analysis is based on a wide range of data inputs, currently available information, and a number of assumptions, and is therefore at best a high-level estimate of future funding needs.

5.1 20-Year Reinvestment Funding Need

The average annual reinvestment rate for the City's existing active transportation assets is $5.4M over the next 20 years in 2024 dollars. This is equivalent to a total of approximately $108M over the next 20-year period, as presented in **Figure 5-1**.

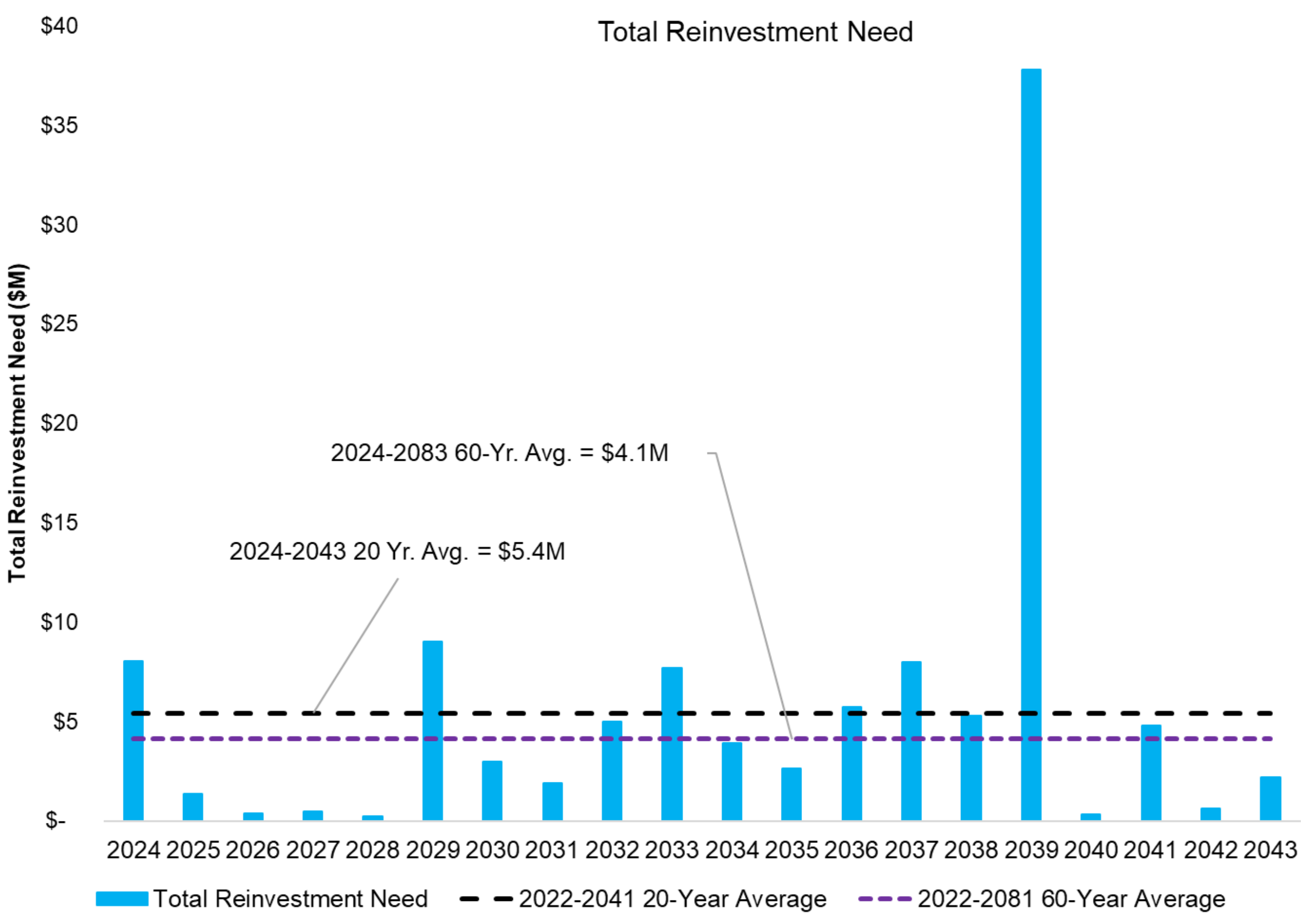


Figure 5-1: Active Transportation 20-Year Reinvestment Need

As shown in **Figure 5-2,** pedestrian facilities (i.e. sidewalks) make up the bulk of the reinvestment needs for the next 20 years Looking ahead to the period starting 2029, and especially the year 2039, the City would be well advised to prepare for the increased level of reinvestment need for pedestrian and shared-use facilities as they continue to age and approach and exceed their ESLs.

The detailed reinvestment needs for pedestrian facilities, cycling facilities, multi-use recreational trail infrastructure, and shared-use pathways assets are presented in **Table 5-1** in 2024 dollars.

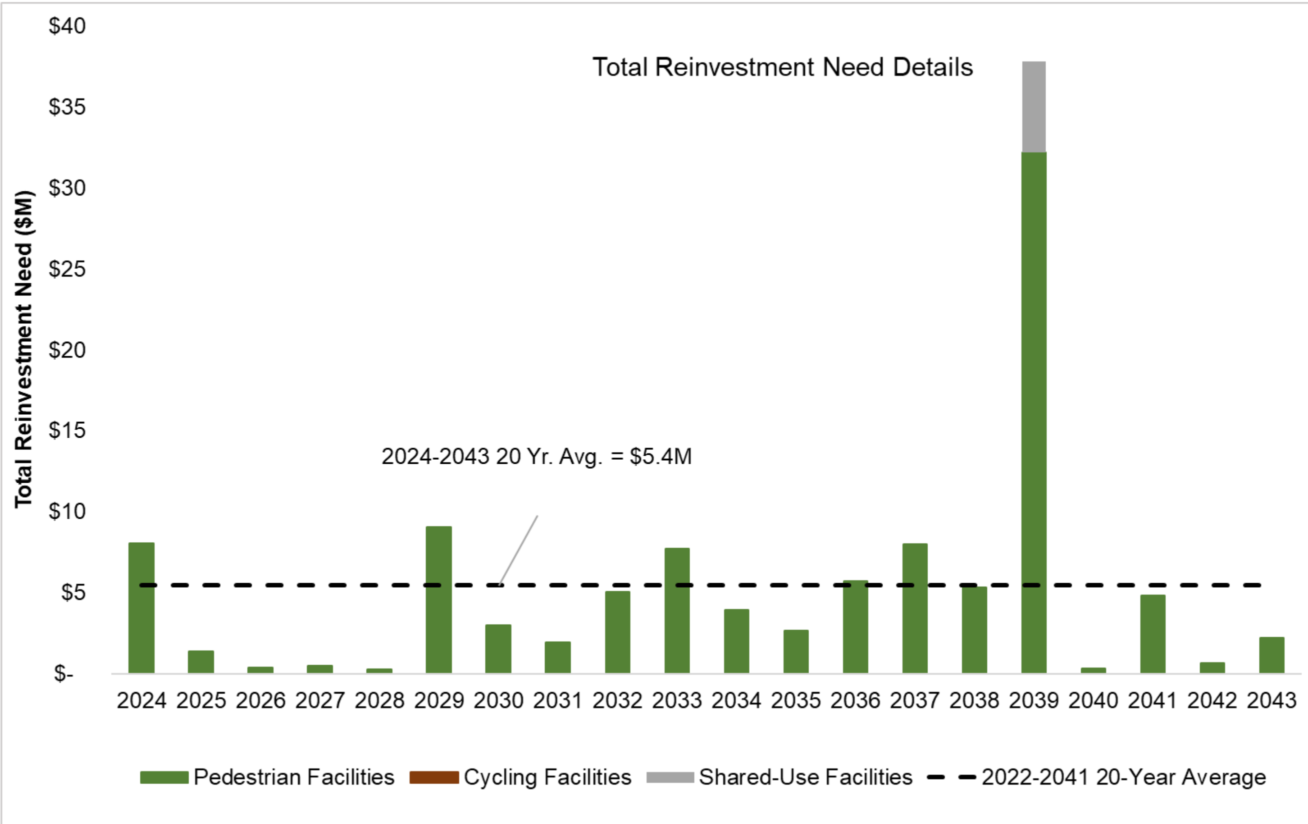


Figure 5-2: Active Transportation 20-Year Reinvestment Need Details

Table 5-1: Active Transportation 20-Year Total and Annual Average Reinvestment Need

	Pedestrian Facilities	Cycling Facilities	Shared-Use Facilities	Total
Annual Average Need	$5,155,000	$-	$281,000	**$5,436,000**
20-Year Total	$103,090,000	$-	$5,614,000	**$108,720,000**

5.2 Full Funding Need Profile

Figure 5-3 shows a full picture of the City's Active Transportation funding need forecast over the next 20 years, which provides the City the full funding requirements to perform effective financial planning activities. The total annual reinvestment rate from **Figure 5-1** was overlaid with the City's Active Transportation O&M cost, in 2024 dollars.

Active Transportation assets require approximately $1.46M annually over the next 20 years for O&M, equivalent to total $29.2M in 2024 dollars. As such, with the addition of O&M, the total average annual funding need for the City's active transportation assets increases to approximately $11.0M annually, for a total of $220M over the next 20-year period.

Staff continually work with York Region staff on the design and implementation of Regional road widening projects throughout the City. As part of this continual process, the coordination of efforts on the design of pedestrian and cycling infrastructure and grade-separated multi-use recreational crossings have led to real successes in developing the active transportation network in Vaughan. Formal operations and maintenance practices for cycling facilities within Regional boulevards are under review and require further discussion with York Region as this may impact the operating budget of the City depending on the resolution.

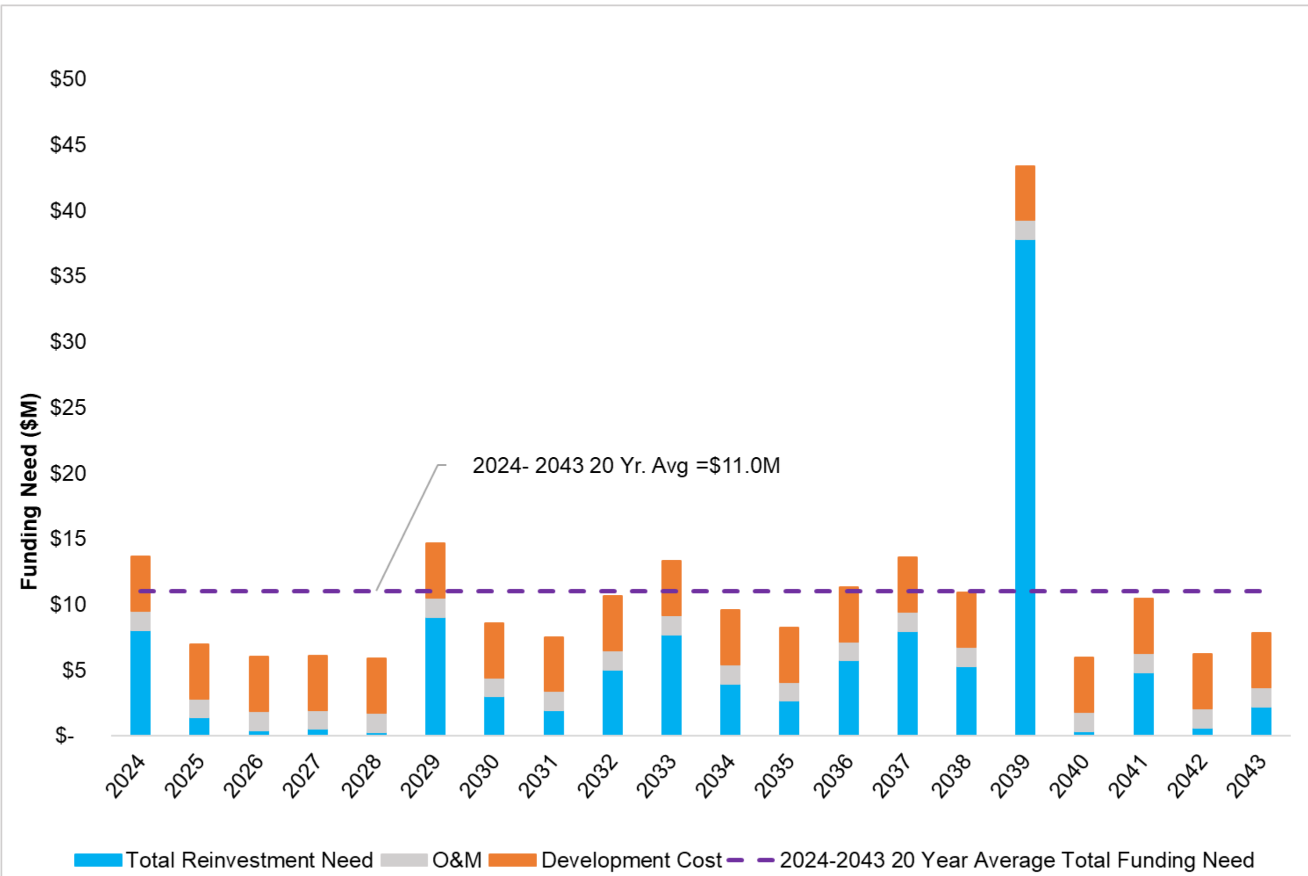


Figure 5-3: Active Transportation 20-Year Capital Investment and O&M Cost Forecast

5.3 Infrastructure Reserves Funding Forecast

Reserve funds are important tools in the planning and management of the City's financial resources and provide a strong indicator of the City's overall financial health and are fundamental to the City's long-term financial sustainability. The City is committed to maintaining healthy reserve fund balances which are collected through various means (i.e., development charges, contributions, dedications, taxation, etc.).

There are specific infrastructure reserves for the tax-supported service areas of Roads, Facilities, Parks, Fleet and Fire (funds for Active Transportation assets are supported from the Roads infrastructure reserve). These reserves contain funds set aside through annual contributions from taxation to help pay for the repair and replacement of infrastructure assets. Like many municipalities across Canada, Vaughan is facing increased costs associated with maintaining aging infrastructure. Corporate Asset Management Plans for both core and non-core assets suggest the City's infrastructure deficit is large and growing. The City has continued with robust strategies and plans by developing a comprehensive Long-Range Fiscal Plan and model, which was used to better inform the 2025 and future budgets by providing information about the financial requirements to sustain growth, delivery of services and the community's infrastructure needs.

Prudent financial planning requires ongoing contributions to Roads reserves to fund the repair and replacement of infrastructure. To achieve this, continued operating and infrastructure investments are critical to ensure the City's Active Transportation assets remain financially sustainable now and into the future. This objective is supported by continuing to build service area infrastructure reserves. The 2024 reserve contribution for Roads reserves totalled $2.0M with the City being committed to ensuring the financial sustainability of its Active Transportation assets.

The City's Asset Management Plans assess average reinvestment requirements over the next 20 years for the City's assets, including Active Transportation infrastructure. Annual reserve contributions should generally be in line with the asset reinvestment requirement to ensure sufficient funds are set aside for asset rehabilitation and replacement needs.

For the Roads service area, the forecasted 20-year average funding need is $23.1M. In comparison, the average annual funding forecasted over the next 10 years is estimated to be $8.7M representing a funding coverage of 38% as illustrated in Error! Reference source not found.. The funding sources in this forecast are limited to annual reserve contributions, capital from taxation and the Canada Community-Building Fund (CCBF is provided from the Federal Government). Other available funding sources not included are debentures and non-CCBF grants, which would mitigate any infrastructure funding gaps.

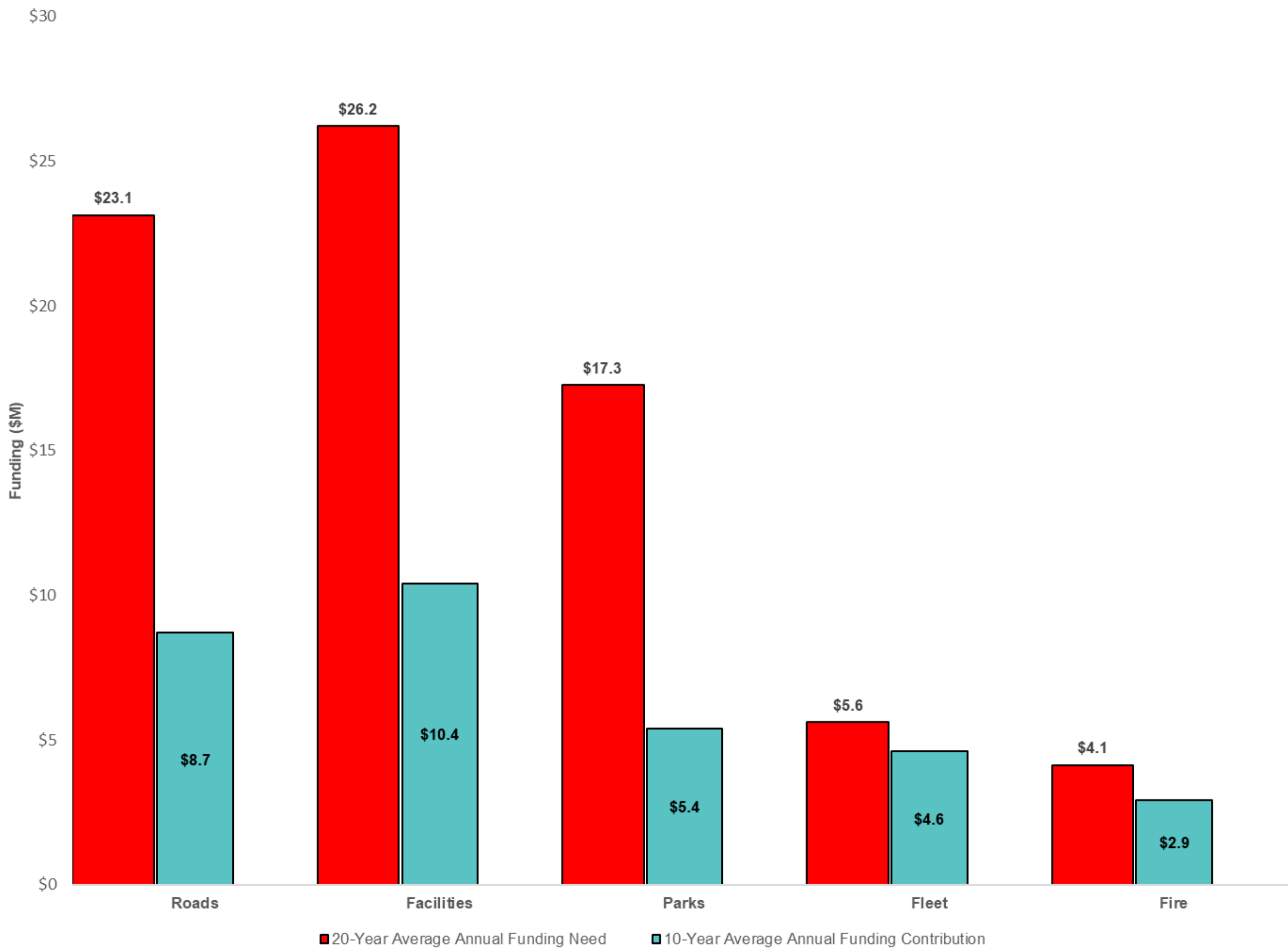


Figure 5-4: Coverage of Average Annual Funding Needs for Tax-Supported Service Areas

Revisiting the timing and scope of capital projects, optimizing the use of existing funding tools and revenue sources, such as debt and dedicated contributions to capital reserves, can help increase the City's capacity to begin to close an infrastructure funding gap.

5.4 Growth-related Assets Funding Need

The City completed the Vaughan Transportation Plan (VTP) study in 2023. The objective of the study was to develop a plan to meet the transportation infrastructure needs as the City's communities continue to grow. This study analyzed the city-wide infrastructure needs to identify the required infrastructure that will meet future servicing demands. The study assessed the existing and future servicing needs and provides servicing recommendations to meet the City's growth plans. Based on the model, the forecasted funding need estimates for the construction of new Active Transportation assets out to 2033 is illustrated in Error! Reference source not found. with a primary funding source for these needs being Development Charges.

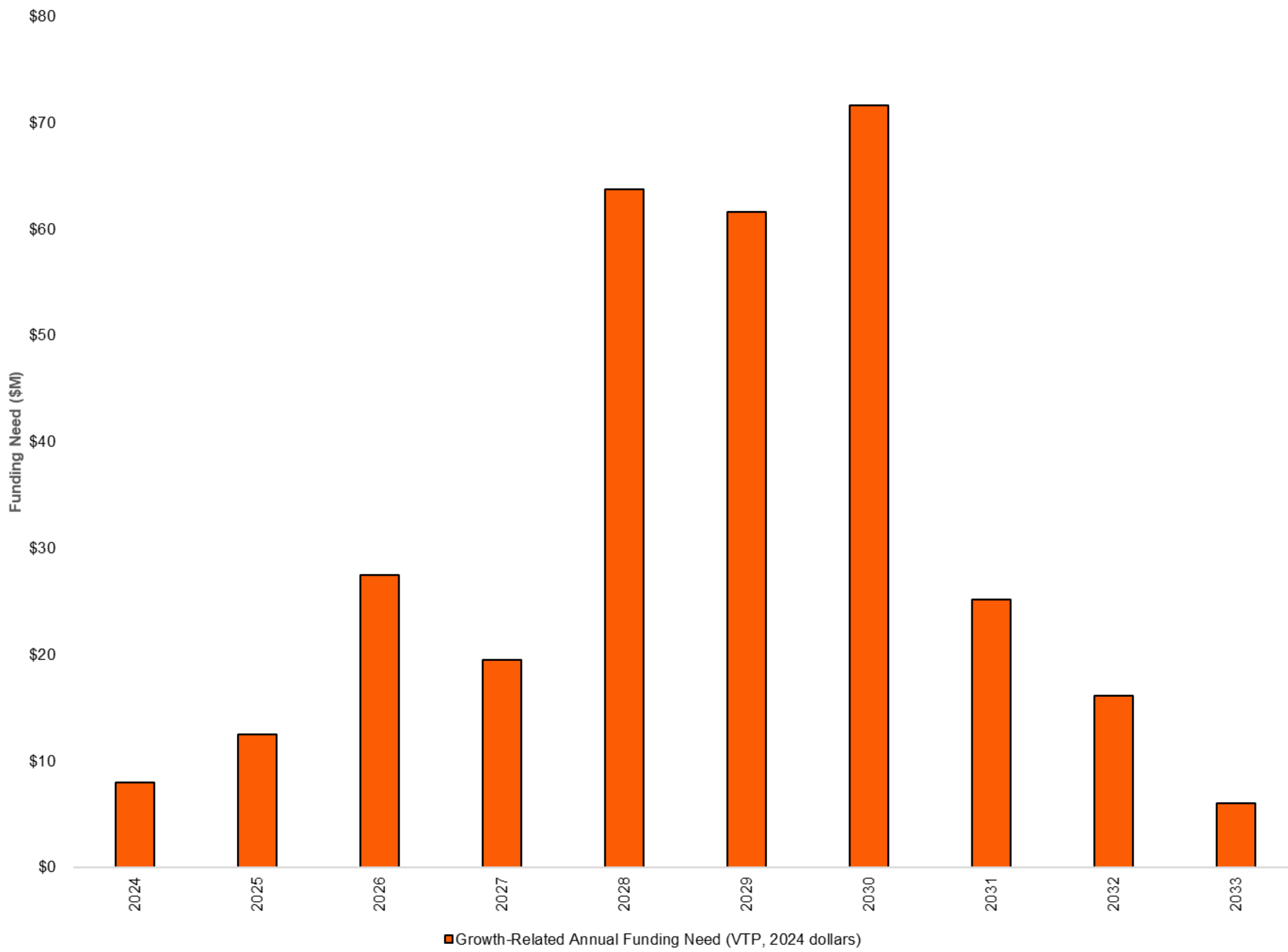


Figure 5-5: Forecasted Funding Needs for Construction of New Active Transportation Assets

One of the next steps in the further development of the VTP is to apply added detail to the forecasted funding need estimates. This will provide a more refined forecast, which will serve to provide additional guidance for Asset Management planning in the future at the City of Vaughan.

Asset Management Plan

Non-Core Assets
Traffic Control and Streetlights

City of Vaughan
March 2025

Table of Contents

Figures

Tables

1. Introduction

The City of Vaughan (The City) has conducted a renewal of the City's Asset Management (AM) Plans for all its infrastructure assets, including traffic assets.

1.1 Background

The City is one of nine area municipalities located within the Regional Municipality of York. As a lower tier municipality, the City is responsible for providing services such as buildings, fire protection, public works, water distribution, wastewater collection, and parks and recreation.

The next 25 years will see the City transition from a growing suburban municipality to a fully urban space. This type of transition will require long-term thinking about how best to accommodate and make the most of new opportunities. Planning for the future through strategic planning will position the City to deal with the many pressing issues impacting the organization such as community safety, access to health facilities, environment, traffic congestion and issues related to growth and the quality of municipal services.

The City is one of Canada's fastest growing cities, with a population of over 320,000 according to the latest census from Statistics Canada. It is projected that the number of residents will increase to 415,000 by 2031. In addition to its rapidly growing population, the City is home to a well-diversified and expanding employment sector with over 7,800 businesses and 231,000 employees. The City has the largest supply of new employment lands in the Greater Toronto Area (GTA), and it is projected that the number of employees will increase to 271,000 by 2031.

1.2 Objectives

In 2018, by City Council approval, the Corporate Asset Management (AM) Policy for the City came into effect; and, in 2013, the City's first Corporate AM Strategy was published. As identified in the Corporate AM Strategy, the City's first set of AM Plans (AMPs) were developed in 2014.

In early 2021, the City updated its AM Strategy and core infrastructure AMPs, as per Ontario Regulation (O. Reg) 588/17. The purpose of this series of AMPs is to now update the infrastructure assets so as to provide the City with a comprehensive updated AM Plan.

The objective of this AMP is to deliver a financial and technical roadmap for the management of the City's roadway appurtenance assets, and to provide the means for the City to maximize value from its assets, at the lowest overall expense while, at the same time, providing enhanced service levels for its residents and promoting green initiatives.

Organizations that implement good AM practices will benefit from improved business and financial performance, effective investment decisions, and better risk management. Stakeholders can expect lower total asset life cycle costs, higher asset performance, and confidence in sustained future performance.

1.3 AM Provincial Requirements

The Ontario Regulation 588/17 (O. Reg. 588/17) came into effect in 2018 and stipulates specific AM requirements to be in place within Ontario municipalities by certain key dates (**Table 1-1**). The development of this AMP is one of the steps to guide the City towards meeting the July 1st, 2025 deadline.

Table 1-1: O. Reg. 588/17: AM Planning for Municipal Infrastructure

Description: A regulation made under the Infrastructure for Jobs and Prosperity Act, 2015, stating that every municipality shall prepare and update a Strategic AM Policy, and that every municipality shall prepare an AM Plan for its core infrastructure assets by July 1, 2022, and an AM Plan for all other infrastructure assets by July 1, 2024. The regulation outlines several requirements that each AM Plan must follow, such as including current and proposed level of service. Core municipal infrastructure assets include water, wastewater, stormwater, road, and bridge assets.	
Deadline Date	Regulatory Requirement
July 1st, 2019	All municipalities are required to prepare their first Strategic AM Policy.
July 1st, 2022	All municipalities are required to have an AM Plan for its entire core municipal infrastructure (i.e., water, sanitary, stormwater, and transportation).
July 1st, 2024	All municipalities are required to have an AM Plan for infrastructure assets not included under their core assets.
July 1st, 2025	All AM Plans must include information about the levels of service that the municipality proposes to provide, the activities required to meet those level of service, and a strategy to fund activities.

1.4 Scope

This AMP has been developed for the traffic control and streetlights assets, which are owned and maintained by the City, as shown in **Table 1-2**.

Table 1-2: In-Scope Traffic Control and Streetlights Assets

Asset Category	Asset Types
Traffic Signal Controls	Traffic Signal Controls
Traffic Signs	Traffic Signs
Traffic Calming	Traffic Calming assets
Streetlights	Streetlight Poles, Streetlight Brackets, Streetlight Nodes, Streetlight Luminaires, Underground Streetlight Cables, and Gateway and Backhaul
Barriers	Barriers and Barrier End Treatments

The following elements are included within the scope of this AMP:

- A summary of the asset inventory, including the replacement cost of the assets, the average age of the assets, the condition of the assets, and the City's approach to assessing the condition of the assets.
- Current levels of service (LoS) based on performance measures.
- Asset lifecycle management strategies to maintain identified current LoS, minimize associated asset risks, and to optimize costs over the whole lifecycle of the asset.

1.5 Approach for Asset Management Plan

The approach used in the renewal of this AM Plan is presented in **Figure 1-1**, and has been selected to ensure that the City can have the confidence to make fact-based and defensible business decisions from reliable and robust information.

Figure 1-1: AM Plan Approach

2. State of Infrastructure

Traffic Control and Streetlights assets are managed by the Traffic Services Division and Roads Operations under Transportation and Fleet Management Services. Traffic Services is responsible for operating and maintaining traffic signal controls, traffic signs, traffic calming, and streetlights assets. Road Operations manage the barriers assets.

2.1 Asset Inventory and Hierarchy

Table 2-1 presents the summary of the City's traffic control and streetlights inventory. The City has a total of 97 traffic signal controls including mid-block signals and independent pedestrian signals. The City-owned streetlights assets are further categorized into poles, luminaires, brackets, nodes, underground cables, and gateway and backhaul. It should be noted that pathway lighting is presented in the Parks asset inventory. Barrier assets range from retaining walls to various barrier end treatments assets such as energy attenuators.

Table 2-1: Traffic Control and Streetlights Asset Inventory and Hierarchy

Asset Category	Asset Type	Quantity	Unit of Measure
Traffic Signal Controls	Traffic Signal Controls	97	Ea.
Traffic Signs	Traffic Signs	23,717	Ea.
Traffic Calming	Traffic Calming Assets	435	Ea.
Streetlights	Streetlight Poles	24,083	Ea.
	Streetlight Brackets	27,084	Ea.
	Streetlight Nodes	27,084	Ea.
	Streetlight Luminaires	27,084	Ea.
	Underground Streetlight Cables	500	km
	Gateway and backhaul	12	Ea.
Barriers	Barriers	23	km
	Barrier End Treatments	209	Ea.

2.2 Current Asset Replacement Value

The estimated replacement value is the cost of replacing an existing asset in 2024 dollars. These costs are collected from the City's GIS record. Where applicable, a CPI-based inflation rate was used to estimate the 2024 values.

The City-owned roadway traffic assets is valued at approximately $232M, as represented in **Table 2-2**. The estimated total replacement value for the streetlights is approximately $188M, which accounts for the largest share (81%) of the total replacement value among the Traffic Control and Streetlights asset categories.

Table 2-2: Traffic Control and Streetlights Current Replacement Costs

Asset Category	Asset Type	Unit Cost ($ / Unit)	Total Replacement Value
Traffic Signal Controls	Traffic Signal Controls	$287,868	$27,924,000
Traffic Signs	Traffic Signs	$367	$8,705,000
Traffic Calming	Traffic Calming	$1,835	$799,000
Streetlights	Streetlight Poles	$ 3,200 - $ 4,800	$99,039,000
	Streetlight Brackets	$ 250 - $ 500	$8,354,000
	Streetlight Nodes	$206	$5,570,000
	Streetlight Luminaires	$ 400 - $ 1,000	$22,277,000
	Underground Cables	$ 105 / m	$52,500,000

Asset Category	Asset Type	Unit Cost ($ / Unit)	Total Replacement Value
	Gateway and backhaul	$12,337	$149,000
Barriers	Barriers	$77 - $1,020 / m	$5,793,000
	Barrier End Treatments	$102 - $5,100	$808,000
Total			$231,912,000

2.3 Age and Remaining Service Life

The asset age is based on the install year of the assets and the remaining service life (RSL) is estimated by using age and expected service life (ESL) in years. The ESL for each asset is obtained from the City's inventory record.

The ESL is defined as the period over which an asset is available for use and able to provide the required LoS at an acceptable risk (i.e., without unforeseen costs of disruption for maintenance and repair). The actual service life can vary significantly from the ESL. In some instances, a variation in expected vs. actual service life is evident due to the following factors:

- **Operating conditions and demands:** Some assets are operated intermittently or even infrequently or is being operated a lower demand than its design capacity, thus the actual operating "age" of the asset is reduced.
- **Environment:** Some assets are exposed to very aggressive environmental conditions (e.g., corrosive chemicals), while other assets are in relatively benign conditions, thus the deterioration of assets is affected differently.
- **Maintenance:** Assets are maintained through replacement of components, which prolongs the service life of the asset.
- **Technological Obsolescence:** Some assets can theoretically be maintained indefinitely, although considerations such as maintenance cost, energy inefficiency and new technologies are likely to render this approach uneconomical.

Figure 2-1 shows the average asset age and RSL as a proportion of average ESL weighted by replacement value for each asset type. Traffic calming assets use apparent age (based on condition) rather than actual age since they were assessed in 2023[1].

There is lack of install date information for traffic signs and barriers; thus, the average age and RSL is not presented in this AMP. It is recommended to collect the install date information for these assets and include in the next iteration of AMP.

[1] Neighbourhood Area Traffic Calming Policy, Design and Speed Management Plan, February 23, 2023

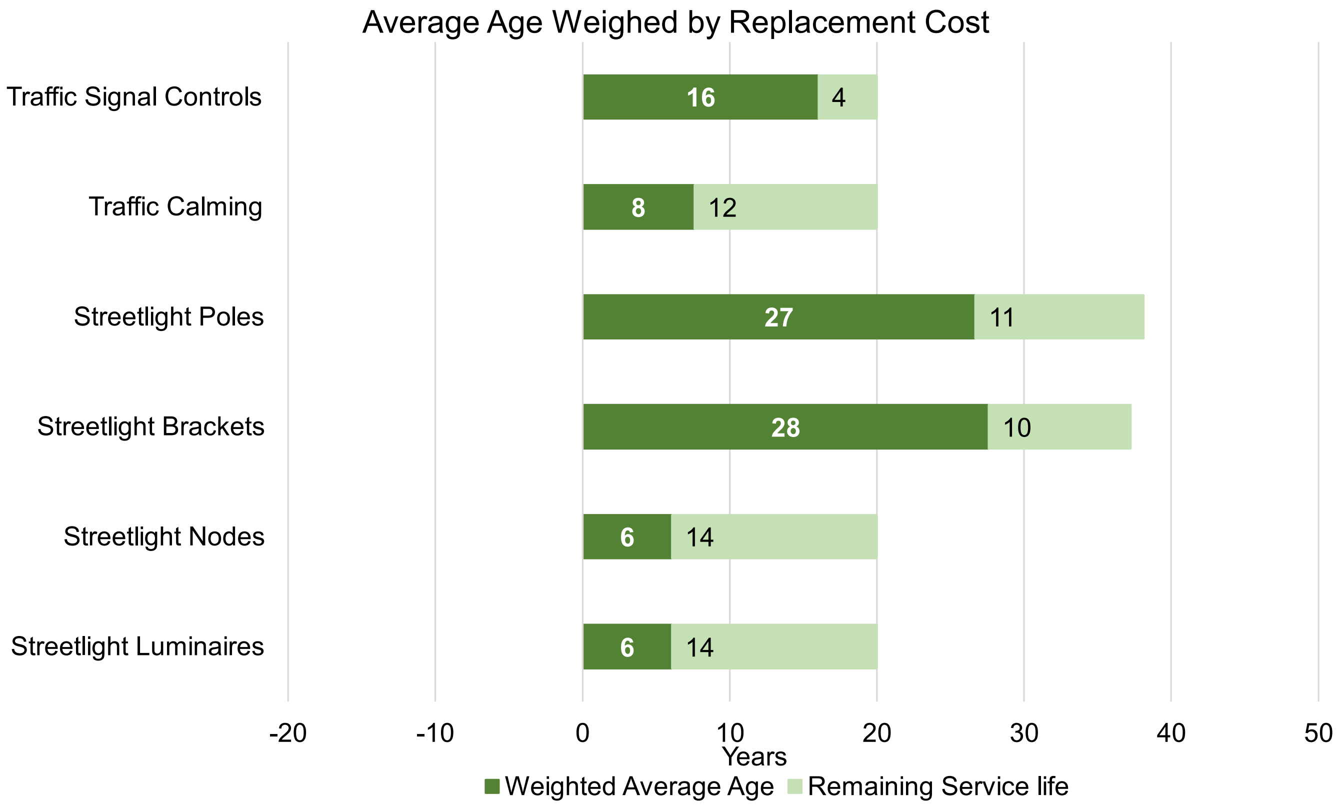


Figure 2-1: Traffic Control and Streetlights Asset Average Age and Remaining Service Life

2.4 Asset Condition

2.4.1 Age-Based Condition Assessment

Two-parameter Weibull distribution function was used to assess the current condition and to project the future condition of the City's traffic control and streetlights. The Weibull distribution has been used extensively in reliability studies and lifetime prediction models in industries ranging from the automotive to the oil and gas industries; it provides a suitable distribution for this type of analysis.

The Weibull probability distribution provides a left-skewed distribution that rises slowly and diminishes quickly as the population is consumed. The underlying premise of the Weibull-shaped deterioration is that while some assets fail prematurely due to severe conditions or improper installation, other assets are very long-lived and function well beyond their theoretical expected service life. In order to perform a high order network-level analysis, it was assumed that assets would fail (and require replacement) within a deterioration envelope / curve approximated by a Weibull probability distribution. The two-parameter Weibull cumulative distribution has two parameters for scale and shape, as set out in Equation [1]:

$$f(x;\alpha,\beta) = e^{-\left(\frac{x}{\beta}\right)^{\alpha}} \quad [1]$$

Where: x = Age
α = Shape parameter
β = Scale parameter (or slope)

Table 2-3 presents the condition score ranges and the corresponding range of ESL and total life consumed.

Table 2-3: Age-Based Physical Condition Scale

Condition Score (minimum)	Condition Score (maximum)	Condition Rating	Range % of ESL Consumed	Range of % Operational Life Consumed
1.0	1.5	Very Good	0% – 71%	0% – 47%
1.5	2.2	Good	72% – 84%	48% – 56%
2.2	2.8	Fair	85% – 92%	57% – 60%
2.8	5.0	Poor	93% – 100%	61% – 100%

2.4.2 Condition Summaries

Figure 2-2 provides a summary of the condition weighted by replacement value for Traffic Control and Streetlights assets. It shows that almost 64% of the assets are in Very Good to Good condition. However, 24% of the Traffic Control and Streetlights assets are in Poor condition indicating that they have reached or exceeded their ESL and require renewal or replacement, most likely, in the short-term.

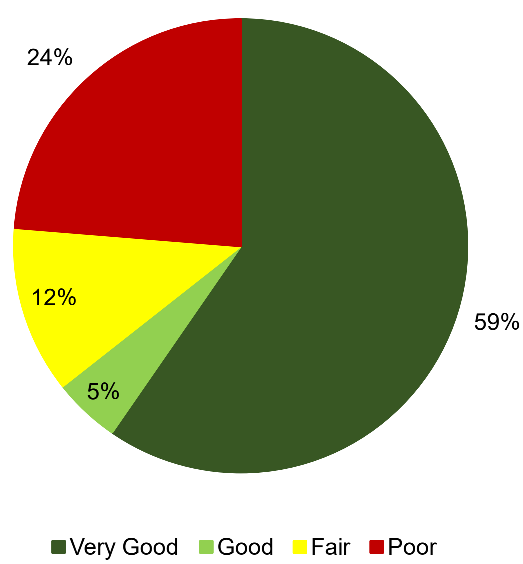


Figure 2-2: Traffic Control and Streetlights Asset Condition Summary

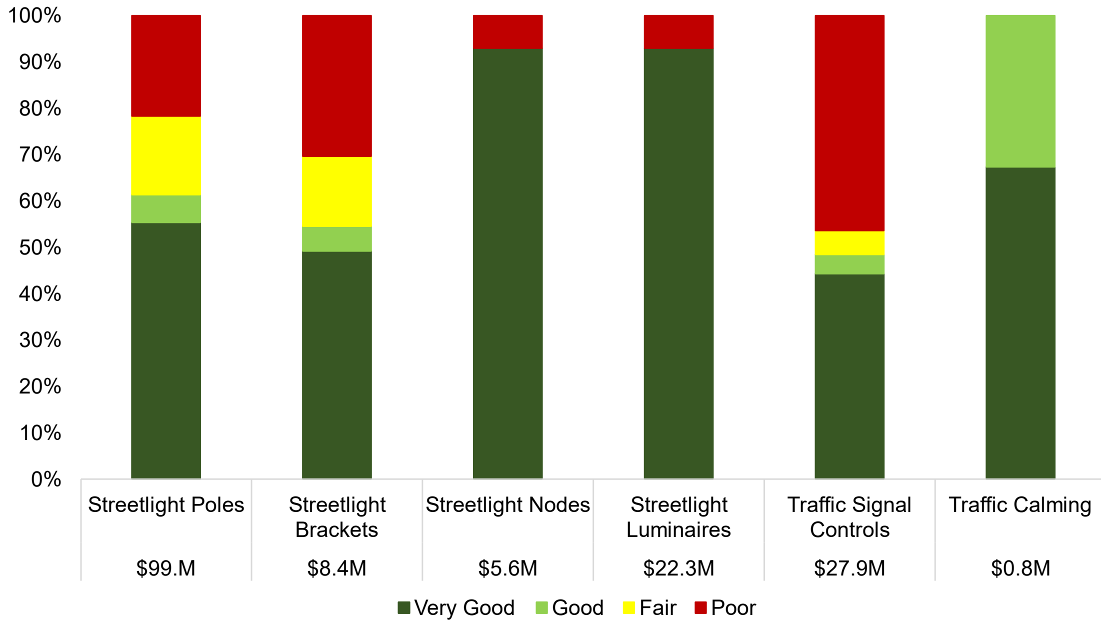


Figure 2-3 presents the condition distribution for each Traffic Control and Streetlights asset type weighted by replacement value. Approximately 61% of the City's streetlight poles are in Very Good to Good condition, while 22% are in Poor condition approaching their expected replacement date. Traffic signal controls are mostly in Poor condition indicating the needs for renewal in the short-term. On the other hand, it should be noted that the condition of traffic signs, underground cables, gateway and backhaul, and barriers assets, are not assessed as there is inadequate information, or for estimating their age. The condition profile for traffic signal controls currently does not include the recent upgrade information and should be updated once the information is available in GIS record.

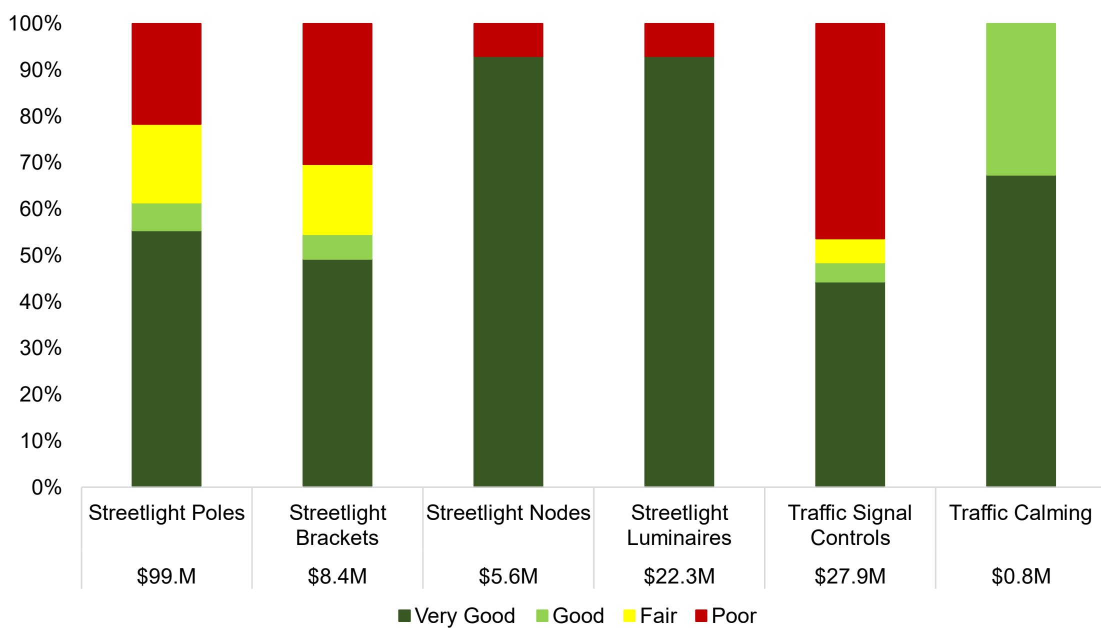


Figure 2-3: Distribution of Traffic Control and Streetlights Asset Condition

3. Levels of Service

3.1 Purpose

Levels of Service (LoS) supports every aspect of the overall AM System as shown in **Figure 3-1**. The objective of establishing clearly defined service levels is to help the City meet stakeholder values, achieve its strategic goals, make informed risk-based decisions, and implement effective asset lifecycle activities.

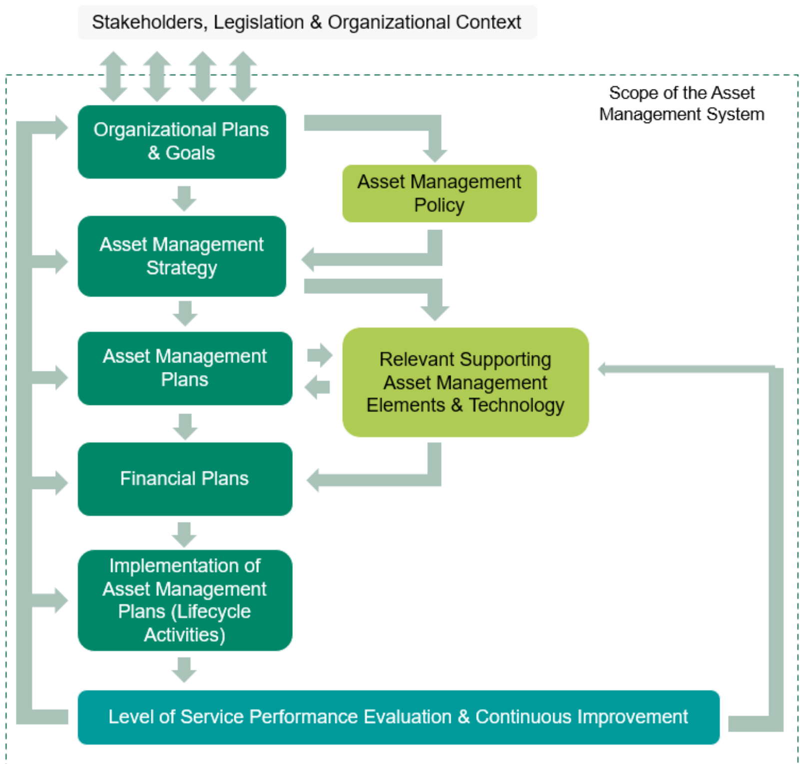


Figure 3-1: LoS within the AM System

In the City's experience, documenting LoS is a proven practice that will enable the City to:

- Link corporate strategic objectives to customer expectations and technical operations.
- Balance customer needs and expectations while evaluating the effectiveness of operations and whether the right LoS is being provided at the right cost.
- Transition from an "Asset Stewardship" approach that focuses on making decisions based on maintaining assets in an acceptable condition to a "Serviceability" approach that is geared towards making decisions based on balancing the costs, risks, and goals for the LoS being provided by the City's assets.
- Communicate the physical nature of infrastructure that the City owns and is financially responsible for while promoting the use of LoS to enable effective consultation with stakeholders regarding alternative funding options according to desired LoS outcomes.
- Make recommendations on strategies that the City can take now to minimize future renewal costs while ensuring that adequate LoS can be delivered without burdening future generations.
- Assess internal (e.g., program changes) and external (e.g., climate change) factors that have the potential to impact the City's ability to deliver services and how these factors may impact the LoS being provided.
- Implement a corporate continuous improvement program to further optimize AM across all service areas.

The O. Reg. 588/17 requires that all AMPs include information about the LoS that the City proposes to provide, the activities required to meet those service levels, and a strategy to fund those activities. The deadline for formalizing these LoS requirements is July 1, 2025 (see **Section 1.3**).

Successful AM programs aim to achieve targeted service levels through customer-based decision making. To achieve this, the City considered a customer-centric approach, where the customer is at the heart of every decision from development to implementation, consultation, and roll-out of the LoS Framework (**Figure 3-2**).

There are two types of LoS measures: Customer LoS (also called "Community" LoS) and Technical LoS. Customer LoS are recorded in a manner that attempts to describe the LoS in terms of what is actually being provided to the customer (i.e., the public) and how the customers experience the service. It is important to note that customers are not concerned with the specific operating requirements of the assets that provide the service, but rather the value they obtain from the operation of the assets. To achieve Customer LoS there needs to be line of sight between the value delivered and how that value is realized. This is the purpose of Technical LoS which attempts to describe how the City will provide and meet the expected Customer LoS.

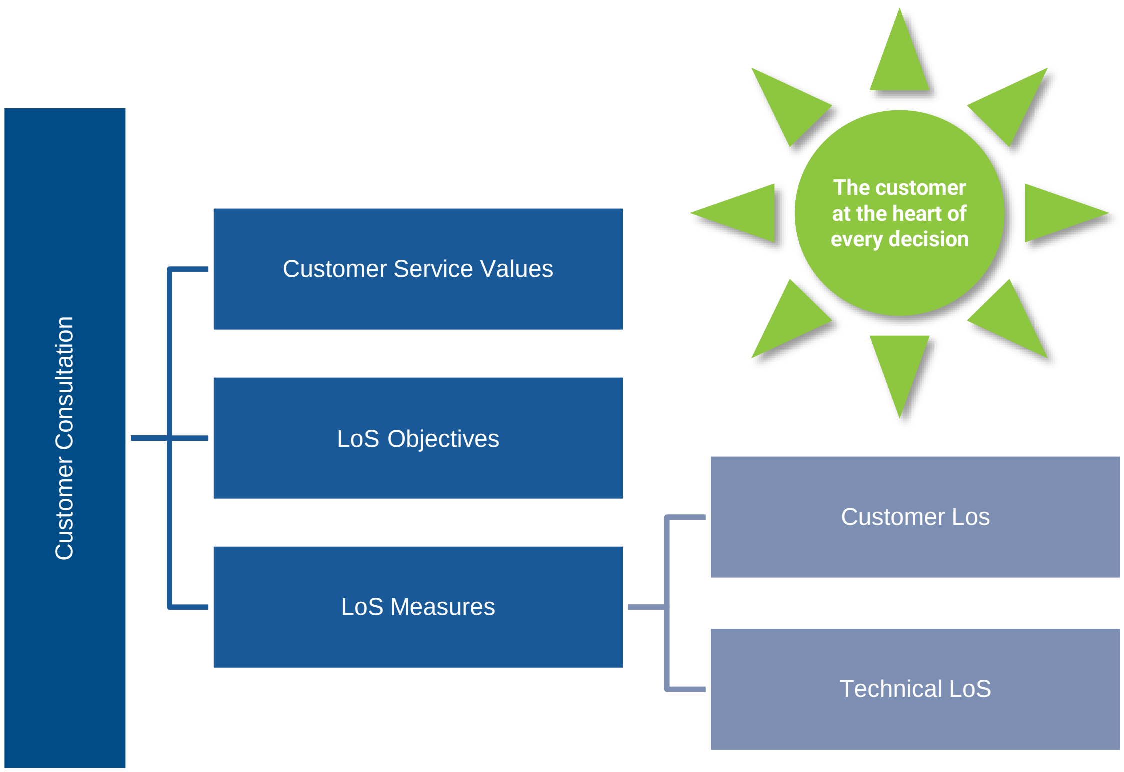


Figure 3-2: The LoS Framework Customer-Centric Approach

The LoS Framework was primarily conceived through a collaborative workshop process. In 2020, four workshops with City staff were conducted across each of the fourteen service areas.

The following outcomes were achieved during each service area workshop:

- Staff were oriented as to the purpose and importance of establishing a consistent LoS Framework;
- Stakeholders were identified, including their expectations, interests, and any regulatory requirements;
- Customer service values were established and reviewed;
- LoS objectives were established for each customer service value;
- Staff provided several performance measures that are currently being tracked as well as those that the City would like to track in the future;
- Where information was available, current performance, targets, and data sources were documented; and
- Growth and shifts in future demand were discussed across the City's service areas.

3.2 Objectives

Defining LoS objectives is important for drawing a line of sight between the City's corporate objectives and the tangible asset performance outcomes. To do so, the LoS objectives must take into consideration stakeholder interests to develop asset performance measures that aim to meet the needs and expectations of the community. By doing this, the City will ensure that their assets are striving towards optimal performance, not only operationally, but economically, socially, and sustainably as well.

Every stakeholder has certain interests in the service being provided and in general, these interests can be categorized into six universal stakeholder values, as shown in **Table 3-1**. Each universal stakeholder value is also assigned a corporate LoS objective.

Table 3-1: The City's Values and LoS Objectives

Customer Value	LoS Objective
Quality and Reliability	The service is delivered with a high standard of excellence, and the service is available when needed.
Affordability	The cost of the service is delivered in a financially sustainable manner and does not burden customers.
Environmental Sustainability	The service is delivered in a manner that does not compromise the ability of future generations to meet their needs.
Access and Capacity	Customers can easily access the service with minimal inconvenience.
Health and Safety	The service is delivered with minimal health and safety impacts.
Responsiveness	Customer service requests are responded to efficiently and in a timely manner.

3.3 Stakeholders and Their Interests

A stakeholder is any person or organization that can affect, be affected by, or perceive themselves to be affected by a decision or an activity. Stakeholder analysis is the process of understanding stakeholder needs, expectations, and perceptions relative to the stakeholder's level-of-interest and level-of-influence over the organization. An organization typically engages with their stakeholders to:

- Establish which activities or services matter most to them.
- Understand their risk appetite and risk threshold.
- Understand their willingness to pay for services.

Stakeholders can take many forms and may be internal (i.e., staff, Council) or external (i.e., the public, regulatory agencies, suppliers, neighbouring municipalities, etc.) to the organization. Historically, only service recipients who pay for City services would be considered customers; however, today customers can take many forms and should include any entity that has a legitimate interest in the service being provided. In addition to service recipients (i.e., the public), this may include:

- **Regulatory Agencies** – Stakeholders that set standards, compliance regulations or other legislation that govern service delivery.
- **Special Interest Groups** – Stakeholders that are affected by or have an interest in the City's roadway services.

Table 3-2 identifies the key stakeholders as they pertain to the City's traffic control and streetlights. These stakeholders were documented during a collaborative workshop process with the City and is not intended to be an exhaustive list; however, the following groups provide a good starting point for future stakeholder engagement.

Table 3-2: The City's Key Traffic Control and Streetlights Stakeholders and Their Interests

Key Stakeholder Group	Description	Stakeholder Interests / Priorities
User Groups - Motorists, cyclists, pedestrians, etc.	These stakeholders are users of the City's transportation network. Traffic signs, signals, and barriers are important infrastructure to ensure motorists, cyclists, and pedestrians move safely and efficiently throughout the transportation network.	• Safety • Accessibility • Responsiveness • Quality
Regulatory Agencies	This stakeholder group includes agencies such as the Electrical Safety Authority (ESA) which regulates the safety for streetlights, as well other Ontario regulations which set minimum maintenance standards.	• Safety • Accessibility • Responsiveness • State of Good Repair
Special Interest Groups	These stakeholders represent special interest groups and advocate for certain requirements such as accessibility for visually impaired community members.	• Safety • Accessibility • Responsiveness

3.4 Level of Service (LoS) Performance Measures

A documented suite of LoS performance measures enables a common understanding of the service delivery that the City's customers currently receive, and the associated cost of maintaining infrastructure assets to provide the service. Having these performance measures set at the appropriate levels within the City ensures alignment from the corporate vision, to asset investment decisions, and to day-to-day operational activities. When establishing LoS performance measures it is important to keep in mind the "SMART" acronym, as follows:

- **S**pecific, easily evaluated and understood.
- **M**easurable, quantifiable, and easily collectable to ensure ongoing data availability.
- **A**ttainable, so that they work to motivate as opposed to discourage.
- **R**elevant, in that they relate and align with a specific goal.
- **T**ime-Bound, measured over a specific period, which is typically annually for benchmarking.

There are two types of LoS performance measures: Community LoS and Technical LoS. Community LoS are recorded in a manner that attempts to describe the LoS in terms of what is being provided to the community (i.e., the public) and how the customer experiences the service. Community LoS are qualitative, non-technical, and are driven by the municipality's strategic AM objectives. Community LoS are not concerned with the specific operating requirements of the assets that provide the service, but rather the value they obtain from the operation of the assets. To achieve Community LoS, there needs to be line of sight between the value delivered and how that value is realized. This is the purpose of Technical LoS which attempts to describe, quantitively, how the City will provide and meet the expected Community LoS.

3.5 LoS Performance Results

A summary of the City's current and proposed community and technical service levels for the Traffic Control and Streetlights assets are documented in **Table 3-3.**

Table 3-3: Community and Technical Service Levels

Level of Service	Current Performance	Current Service Level Target	Proposed Service Level Target
Percentage of Eligible Streetlights that have been converted to LED Technology	99%	99%	No Change
Percentage of Traffic Signs Inspected for Retro-Reflectivity Annually	100%	100%	No Change
Percentage of Traffic Signs that have been replaced due to insufficient Retro-Reflectivity	100%	100%	No Change

Measured in the most recent Citizen Satisfaction Survey conducted by Ipsos, the percentage of respondents satisfied with Streetlighting was 80%.

3.6 LoS Performance Targets

Establishing LoS targets is an important part of continual improvement and performance management. Without targets, it is difficult to ascertain whether goals are being met, or the extent of the gap if they are not. Incorporating targets into the City's LoS Framework helps to ensure that targets are reasonable, aligned with customer expectations, and evaluated on an objective basis by considering cost-benefit trade-offs.

One of the key challenges in setting targets in a municipal environment is that they can often become biased and/or politically motivated. Therefore, it is important to review LoS targets with stakeholders. An important aspect of evaluating LoS targets is determining how willing the user is to pay for the service. Regulatory requirements are an exception; however, they only provide the minimum service standard. Cost is still an important parameter to consider when assessing the merits of service improvements.

To deal with the financial realities, it is necessary to:

- Calculate how much the service costs based on current LoS.
- Determine the cost associated with varying the LoS.
- Assess the customers' willingness to pay.

3.7 Future Demand Drivers

Understanding internal and external factors that may impact service delivery (positively or negatively), such as staff resources, climate change, and shifts in population is a critical component for managing desired service levels in a sustainable manner. It is important to proactively develop effective, long-term strategies that are suitable for the City's unique economic, environmental, and social landscape.

In most cases, the factors presented in **Table 3-4** may result in a negative impact on the City's existing service levels, unless additional funding or resources can be allocated to meet future needs; however, in some instances, such as technological advancements and higher regulation standards, the impact on service delivery may actually improve as a result.

Table 3-4: Potential Future Demand Drivers

Anticipated Issue	Potential Impact on Service Delivery
Population Growth and Development	The pace of development is increasing and contributing to a greater demand for appurtenances that support the movement of people and goods across the City's transportation network, including active modes. The City has plans to develop an Advanced Traffic Management System within the next five years which will take into consideration an Intelligent Transportation System (ITS) to monitor and manage traffic and roadways.
Demographics and Shifting Behaviours	The City is seeing an increase in cyclist and micro-mobility users on the roadways, resulting in a need to expand the cycling infrastructure and traffic control and streetlights accordingly.
Funding	Roads compete with other departments for funding from the City's tax base, and it can be challenging to find financial resources for projects.

By considering potential drivers, as well as any issues that may pose a threat to meeting future demand, the City has the advantage to proactively plan and prepare mitigation strategies.

Approaches for the City to consider include:

- Asset-based solutions (e.g., upgrading existing assets, providing new assets, etc.).
- Non-asset-based solutions (e.g., restricting usage, changing habits through education, providing service alternatives, etc.).

A hybrid solution often works well since every municipality has its own challenges and there is not a "one solution fits all" approach. It is important that the City remains aware of its internal and external situational context and modifies its approach and mitigation strategies in a consistent, periodic, and well documented manner.

4. Asset Lifecycle Strategies

Asset lifecycle management focuses on the specific activities we must undertake during all phases of the asset lifecycle. By considering entire asset lifecycles the City can ensure sound decision making that consider present and future service delivery needs.

The overarching goal of life cycle management is to maximize the long-term benefits and services that our assets deliver while minimizing the associated costs and risks in the long run. Every asset has a life cycle cost, which is the total cost of all the activities undertaken throughout its service life. The following sections describe activities across the life cycle of assets.

4.1 Lifecycle Activities

Any responsible owner of assets such as the City has a desire to preserve the condition of their existing assets for as long as possible, by maintaining or even extending their design lives through routine activities such as maintenance and active intervention. The City is continually acquiring infrastructure assets, but these assets require increased funding for operation and maintenance as they age. The City is also responsible for the replacement of deteriorated assets as long as the service is required. While individual assets may have a useful life that can be predicted in years or decades, the service that the asset provides could be for a substantially longer duration (perhaps in perpetuity). Part of the purpose of the AM planning process is to fully understand and predict the long-range financial requirements for the City's infrastructure to facilitate planning and resource management in the most cost-effective manner possible. **Figure 4-1** illustrates how costs typically accumulate over an asset's life. It is worth noting that the accumulation of the ongoing operations and maintenance, refurbishment and disposal / replacement costs is many multiples of the initial acquisition costs. A key and important take-away from **Figure 4-1** is therefore for the City to fully understand the entire life cycle costs before proceeding with asset acquisition.

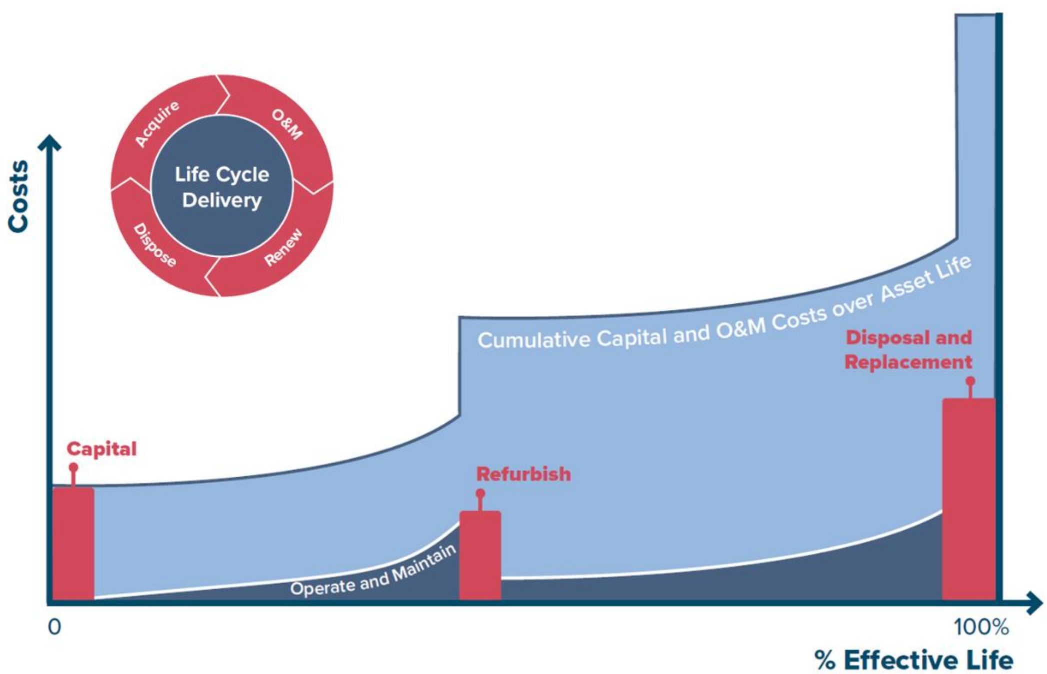


Figure 4-1: Life Cycle Cost Accumulation Over Asset Life

4.2 Asset Acquisition Strategies

The City has made significant investments in the design and acquisition of its municipal infrastructure assets. Traffic signal controls, traffic signs and calming measures, are acquired based on the traffic intersection studies, such as average annual traffic measurements that the City undertakes. Streetlights are acquired through capital projects or through new developments. The other driving factors for purchase of traffic signal controls and barriers include requests from the residents and the number of traffic incidents brought to City's notice.

The City envisions to take a more proactive approach and has developed a MoveSmart Mobility Management Strategy (2022-2026)[2] that aims to improve the efficiency through innovation and technology. The strategy consists of 29 initiatives under the four programs listed in **Table 4-1**.

Table 4-1: MoveSmart Mobility Management Strategy Programs

Programs	Initiatives
Road Safety Program – to increase road safety and raise public awareness	• To bring together key stakeholders to keep the City's streets safer for all road users and help foster a road safety culture. • To take a more proactive approach to road safety by using data and proven statistical procedures and identify additional road safety opportunities.
Mobility Management Program – to improve efficiency through innovation and technology	• To modernize the City's traffic signals system, providing more efficient traffic flow and link to existing and future technologies. • To ensure pedestrians, cyclists, and vehicle traffic continue to move safely and efficiently through signalized intersections and pedestrian crossings using the existing road network.
Traffic Data Management Program – to assure accuracy and availability of traffic data	• To modernize traffic data management with up-to-date traffic data to form the core of the Strategy and support data-driven and evidence-based decision-making. • To have traffic data to allow for ongoing tracking of performance of the transportation system over time.
Sustainable Mobility Program – to support active and sustainable transportation	• To support the development of additional active and sustainable transportation options and ensure that these options focus on the safety of all road users. • To support the expansion of the pedestrian and cycling network through consideration of the operations and maintenance services.

Looking towards the future, when acquiring new assets, the City should evaluate credible alternative design solutions that consider how the asset is to be managed at each of its life cycle stages.

Asset management and full life cycle considerations for the acquisition of new assets include, but are not limited to, the following:

- The asset's operability and maintainability.
- Availability and management of spares.
- Staff skill and availability to manage the asset.
- The manner of the asset's eventual disposal.

4.3 Operations and Maintenance Strategies

As new infrastructure is commissioned, the City accepts the responsibility of operating and maintaining the infrastructure according to operation and maintenance (O&M) standards to ensure that the infrastructure is safe and reliable. Operations staff provide the day-to-day support required to operate infrastructure. In few cases, operation costs are minor, but for most there are significant increases.

Maintenance expenses include periodic preventive maintenance to ensure that the infrastructure can provide reliable service throughout the life of the asset and corrective maintenance that is required to repair defective assets as and when needed. Inadequate funding for O&M will have an adverse impact on the lifespan of assets. The O&M resources required in any period is a function of the current inventory of infrastructure and total O&M needs required for each asset. As the inventory of infrastructure grows, total O&M requirements will also grow.

The City inspects its traffic signs and pavement markings regularly in accordance with the maintenance standards identified in the Ontario Traffic Manual (Provincial legislation). The streetlights are regularly inspected

[2] MoveSmart Mobility Management Strategy (vaughan.ca)

by the City staff for any outages and repairs, whereas the unassumed streetlights in sub-divisions under construction are maintained by the developers. **Table 4-2** presents an overall five-year average O&M actual cost of $7.57M and **Table 4-3** provides a breakdown of the O&M activities for traffic signal controls, traffic signs, traffic calming and streetlights.

Table 4-2: Historic Traffic O&M Expenditures

Year	Total O&M Actuals
2024	$8,045,000
2023	$8,237,000
2022	$7,175,000
2021	$7,371,000
2020	$7,006,000
5-Yr. Average	**$7,567,000**

Table 4-3: Traffic Signal Controls, Traffic Signs, Traffic Calming and Streetlights O&M Activities and Five-year Average Costs

O&M Activities	Description	Five-Year Average Cost
Pure O&M activities	Pavement markings, railway crossing signal maintenance, traffic signal maintenance, streetlight maintenance, etc.	$4,606,000
Overhead	All overhead costs (e.g., traffic engineering admin costs, Crossing guards, utility coordination Bell FTTH related projects.)	$2,961,000
Total		**$7,567,000**

4.4 Renewal and Replacement Strategies

The third portion or phase of full life cycle costing relates to the renewal and replacement of infrastructure that has deteriorated to the point where it no longer provides the required service. Renewal cost is sometimes incurred during the life of an asset where an investment is made to improve the condition and / or functionality of the asset. Disposal and replacement costs are incurred at the end of an asset's life when it is disposed of and replaced by a fully new asset. It is vital that communities fully understand the looming obligations of infrastructure renewal or replacement and develop a strategy to respond in a manner that is fair and affordable. For this analysis, the Traffic Control and Streetlights assets renewal need is based on age and ESLs.

4.5 Disposal and Decommissioning Strategies

There will inevitably come a point in time when an asset must be removed from service and, depending on the type of asset, there may be significant costs associated with its decommissioning and disposal. Factors that may influence the decision to remove an asset from service, include changes to legislation that cause the asset to be in non-compliance, the inability of the asset to cope with increased service levels, technology advances that render the asset obsolete, the cost of retaining the asset is greater than the benefit gained, or the current risk associated with the asset's failure is not tolerable. The current practices at the City look at disposal of its traffic control and streetlights at the end of their useful life.

Normally, major costs that may be incurred during disposal and decommissioning derive from the environmental impact of the disposal and, if required, the rehabilitation and decontamination of land. In some cases, there will be residual liabilities and risks to consider if a decision is made to partially abandon the asset as opposed to fully disposing of its components (e.g., leaving a non-functioning pipe in the ground, or an inactive building standing). For now, there is no formalized procedures in place at the City to track any environmental costs associated with Traffic Control and Streetlights disposal activities.

4.6 Capital Planning

Capital investment is to address community growth or changes, or to renew existing assets to maintain service levels. For the actual funding needs analysis, please refer to **Section 5**.

- **Life Cycle Cost Analysis Approach**. The City's analysis enables optimized decision making and mathematical deterioration modelling of infrastructure assets and the development of short, medium and long-term forecasts of renewal and replacement costs of a number of decision criteria and the ability to compare different intervention options to find the optimal solution in terms of timing and the intervention option chosen.
- **Forecast Periods.** The City aims to develop Short- to Medium-Term and Long-Term capital plans. Typically, short to medium-term capital plan identifies the activities required to meet current and future demand, the cost of those activities and a financing approach. It is developed or renewed every three to five years and should coincide with regulations on short to medium-term expenditure planning. A long-term plan can serve as part of Strategic Asset Management Plan, which indicates what will be spent, by service areas, over a set period of time. Long-term plans tend to focus only on costs.

  Consistent with the approach of other asset management plans, the analysis periods for funding need assessments are 20 years.

4.7 Asset Prioritization

4.7.1 Risk Assessment

Infrastructure-related risk exposure is assessed based on the combined consideration of probability and consequences of an asset failure, which is used to drive the selection and prioritization of appropriate action, based on risk tolerance thresholds and funding availability. Understanding the risk exposure for a given set of assets allows the City to identify where they are most exposed to risk, and to target their investments to most effectively reduce that exposure.

In addressing risk for infrastructure assets, the first step in the analysis is to identify assets that are most critical to the business. Critical assets are those that will potentially have the greatest impact on service delivery should they fail. It should be noted that the parameters, criteria and weighting factors area starting point, and should be reviewed and modified to reflect the priorities of the City on an ongoing basis.

The fundamental principle of consequence (or criticality) models is that they evaluate the relative importance of assets based on select criteria. The approach to risk analysis within this project utilizes a triple-bottom-line assessment approach utilizing the following four criticality indices:

- **Economic** – influence of the asset's failure on monetary resources
- **Operational** – influence of the asset's failure on operational ability
- **Social** – influence of the asset's failure on society
- **Environmental** – influence of the asset's failure on the environment

By applying specific indices, the risk assessment framework generates a risk (or priority) score for each asset. The risk score is a rating of the asset based on the detailed assessment of the likelihood and consequence of failure based on a number of key parameters. All parameters are then equated using equation [4].

$$\textit{Risk} = \textit{Likelihood of Failure} \times \textit{Consequence of Failure} \qquad [4]$$

Based on this principal, the risk associated with a given asset's failure can be managed by limiting the likelihood of this occurring, or the impact realized, should it occur.

Consequences of Failure (CoF) reflect the relative "impact" of a given asset's failure. While traditionally these have been looked at as purely economic terms (i.e. repair cost, loss of revenue, etc.), the truth is that investment decisions are often driven by non-economic factors. Understanding both the economic and non-economic impacts associated with loss or limitation of service help in categorizing an asset's "criticality" and justifying infrastructure decisions in a consistent, defensible manner.

4.7.2 Analytical Logic to Sequence Interventions

The asset criticality score can be used to prioritize projects within a funding constrained environment. **Figure 4-2** illustrates this logic of carrying unfunded needs to the next year in the period where they receive a higher probability of receiving funds based on their criticality score.

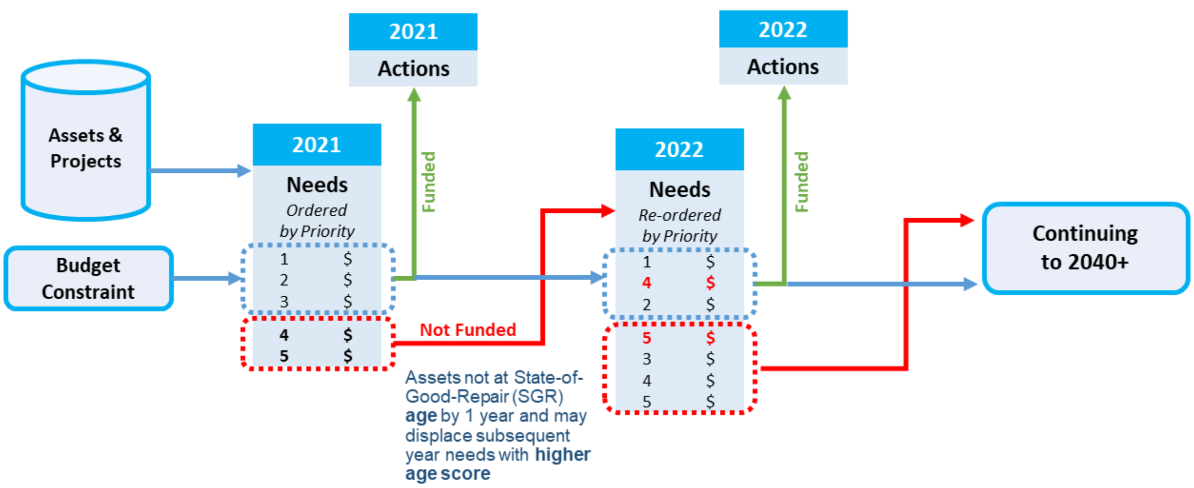


Figure 4-2: The Role of Criticality to Prioritize Projects Within A Funding Constrained Environment

4.8 Financial Planning

4.8.1 Financial Policies

The City has taken the initiative to establish financial asset management policies in 2018, which provides directions on how financial principles apply to assets to ensure that service goals are met. The policy aligns the business model of AM with the City's financial planning, financial reporting, cost management, treasury and taxation functions. The City will integrate findings from the AM Plans into its long-term financial planning and budgeting processes. Sound financial analysis will be encompassed in AM planning in order for the AM Plan to be a sought-after guide for employees in budgeting and financial planning.

4.8.2 Financial Analysis

Financial analysis activities for asset management is centered on two essential quantities: revenues and expenditures. Revenues can come from many sources. Through asset operations, the City generate its own source revenues from taxes, development charges, etc. Expenditures are all the direct and indirect costs associated with capital, operating and maintaining, and disposing of assets.

Assessing the financial implications supports in the decision-making when there are competing priorities and trade-offs between projects. Financial analysis provides a better picture of how to fund the capital plan and make critical decisions about service delivery while providing the greatest benefit for the community at the lowest cost.

4.8.3 Aligning the Financial and Non-Financial Functions of AM

ISO 55010[3] identifies the that the financial and non-financial functions of AM within organizations are generally inadequately aligned, as follows:

- **Financial Accounting Functions:** Focused on retrospective reporting of accounting / regulatory financial activities. However, there is a growing awareness in organizations of the need to focus on providing a managerial costing approach in order to support decision-making for the future.
- **Non-Financial Functions:** Have a limited understanding of financial accounting functions but are recognizing the need to improve their understanding of the financial implications of their activities.

The lack of alignment between financial and non-financial functions can be attributed to silos in an organization, including reporting structures, functional / operational business processes, and related technical data. Silos generally bring forth the necessary level of specialization. However, with a lack a communication between the silos, organizations are at risk of inefficiencies and errors in AM results, or AM failures due to a lack of alignment between AM staff and senior management. Financial and non-financial alignment needs to work both "vertically" and "horizontally", as follows:

- **Vertical Alignment:** Financial and non-financial asset-related directives by management are informed by accurate upward information flows, effectively implemented across the appropriate levels of the organization.
- **Horizontal alignment:** Financial and non-financial information that flows between departments (conducting functions such as operations, engineering, maintenance, financial accounting and management) uses the same terminology and refers to the assets identified in the same way. **Figure 4-3** presents the key elements in a framework to address the need to achieve the alignment.

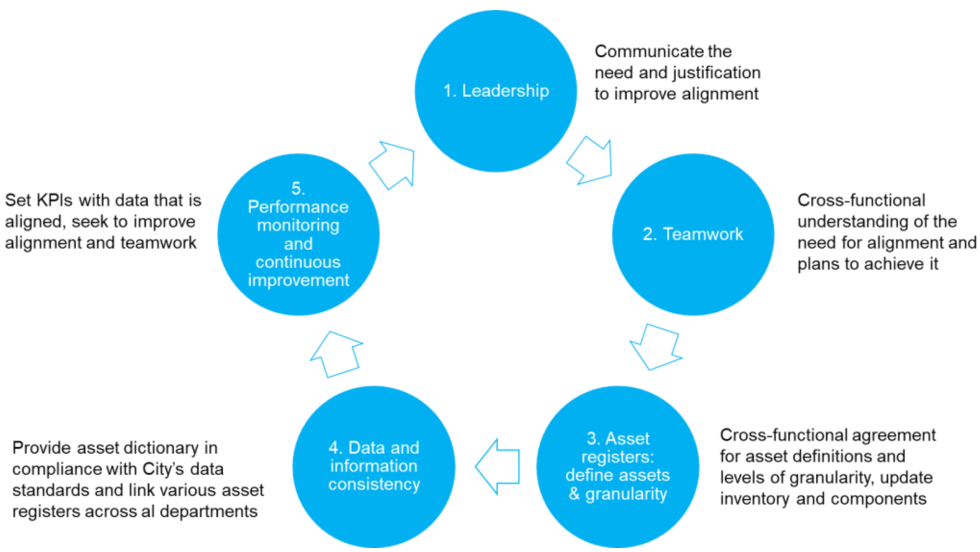


Figure 4-3: Key Elements of a Framework to Achieve Financial and Non-Financial Alignment

4.8.4 Long-Term Financial Planning

Strengthening the City's Asset Management planning according to the recommendations in Asset Management Strategy will improve the City's long-term financial planning, by accounting for whole life cycle costs as presented in **Section 4.1**. This includes all capital, annual operation and maintenance, and disposal costs over the planning timeframe, thereby aligning financial requirements with long-term level of service objectives.

The challenge is often one of agreeing on a timeframe for such planning, recognizing that the AM perspective is ideally focused on the asset life cycle, versus the political / election cycle that could be as short as a three to four-

[3] International Organization for Standardization (2019): ISO 55010 - Asset management — Guidance on the alignment of financial and non-financial functions in asset management

year Council term. Accordingly, financial and non-financial staff, as well as top management and politicians, should agree on a long enough timeframe to provide useful forward planning information that aligns the financial and non-financial perspectives, as presented in **Figure 4-4** .

Figure 4-4: AM Planning Alignment Across the Organization

The City should have an appropriate long-term financial planning process that achieves the following:

- Stimulates long-term strategic thinking and perspective for stakeholders and decision-makers.
- Can be used as a tool to prevent or predict future financial shocks and demonstrate financial sustainability.
- Demonstrates to internal and external stakeholders that the organization has a financial strategy in place to meet their demands, now and in the future.

The long-term financial planning process needs to involve financial and non-financial staff working together to combine the important elements of strategy development, asset management planning and financial forecasting (**Figure 4-3** and **Figure 4-4**).

5. Funding Need Analysis

The lifecycle analysis was implemented in an MS Excel Asset Lifecycle Model, which integrated asset inventory, age, ESL, replacement values, and condition to create a theoretical asset replacement cycle for each Traffic Control and Streetlights assets. The asset reinvestment forecasts prepared for this assessment are estimates of what it will cost over the next 20 and 60 years to sustain the City's each Traffic Control and Streetlights assets.

The annual reinvestment needs for the Traffic Control and Streetlights assets were based on age and ESL (i.e., replacing assets that have exceeded their ESL) in 2024 dollars. Where the installation date data is not available, an annual change-out rate is applied to estimate the asset replacement need. The replacement cost of traffic signs and barriers lacking installation dates and condition scores was distributed across their ESL (28 years for traffic signs, 30 and 60 years for barriers).

It should be noted that the nature of this type of analysis is based on a wide range of data inputs, currently available information, and a number of assumptions, and is therefore at best a high-level estimate of future funding needs.

5.1 20-Year Reinvestment Funding Need

The average annual reinvestment rate for the City's traffic control and streetlights is $7.3M over the next 20 years in 2024 dollars. This is equivalent to a total of approximately $146M over the next 20-year period, as presented in **Figure 5-1**. It should be noted that there are significant backlogs ($37M) for reinvestment on the streetlight assets (**Figure 5-2**) primarily for streetlight poles) that has already exceeded their ESL as shown in the 2024 reinvestment need.

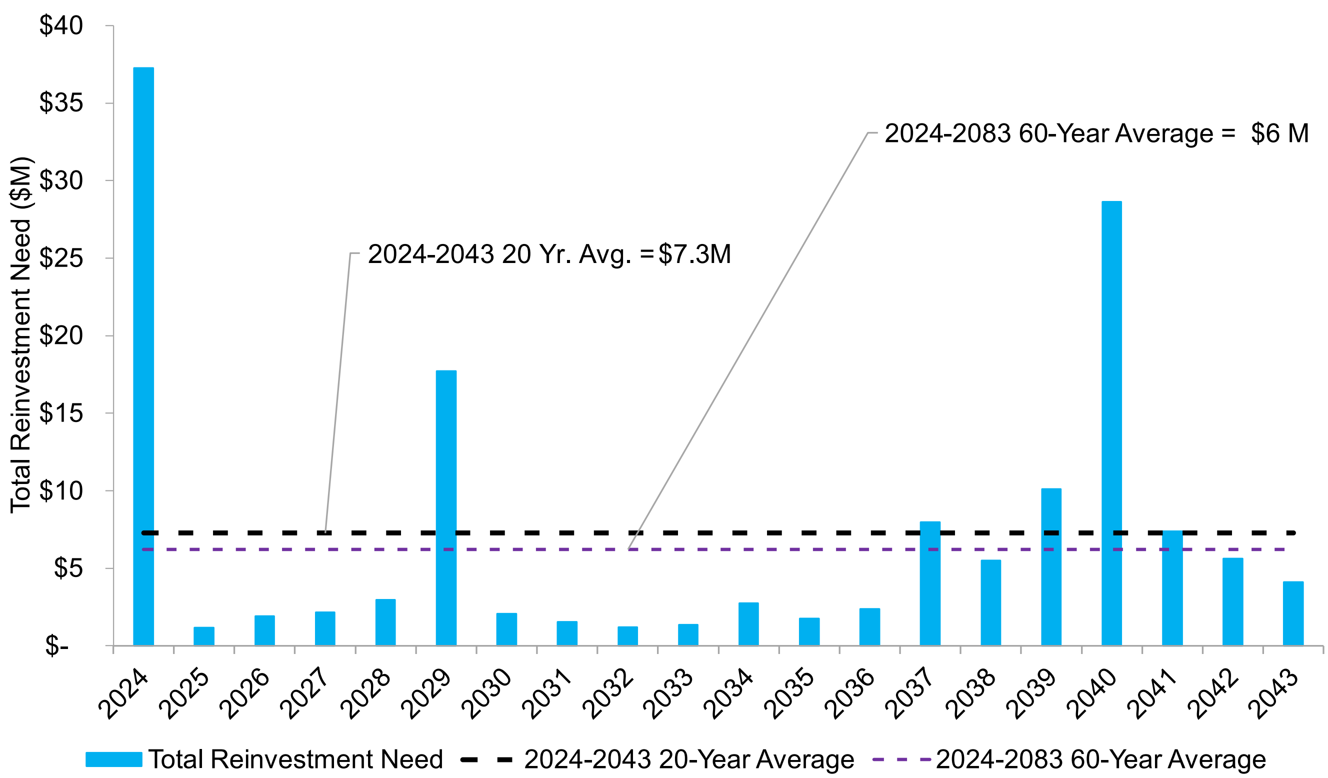


Figure 5-1: Traffic Control and Streetlights 20-Year Reinvestment Need

As shown in **Figure 5-2**, in 2024, the reinvestment needs are primarily from the aged streetlights and traffic signal controls assets.

Looking ahead to the period starting 2040, the City should prepare for the increased reinvestment need as the assets continue to age and approach and exceed their respective ESLs.

The detailed reinvestment needs for streetlights, traffic signal controls, traffic signs, traffic calming, barrier assets are presented in **Table 5-1** in 2024 dollars.

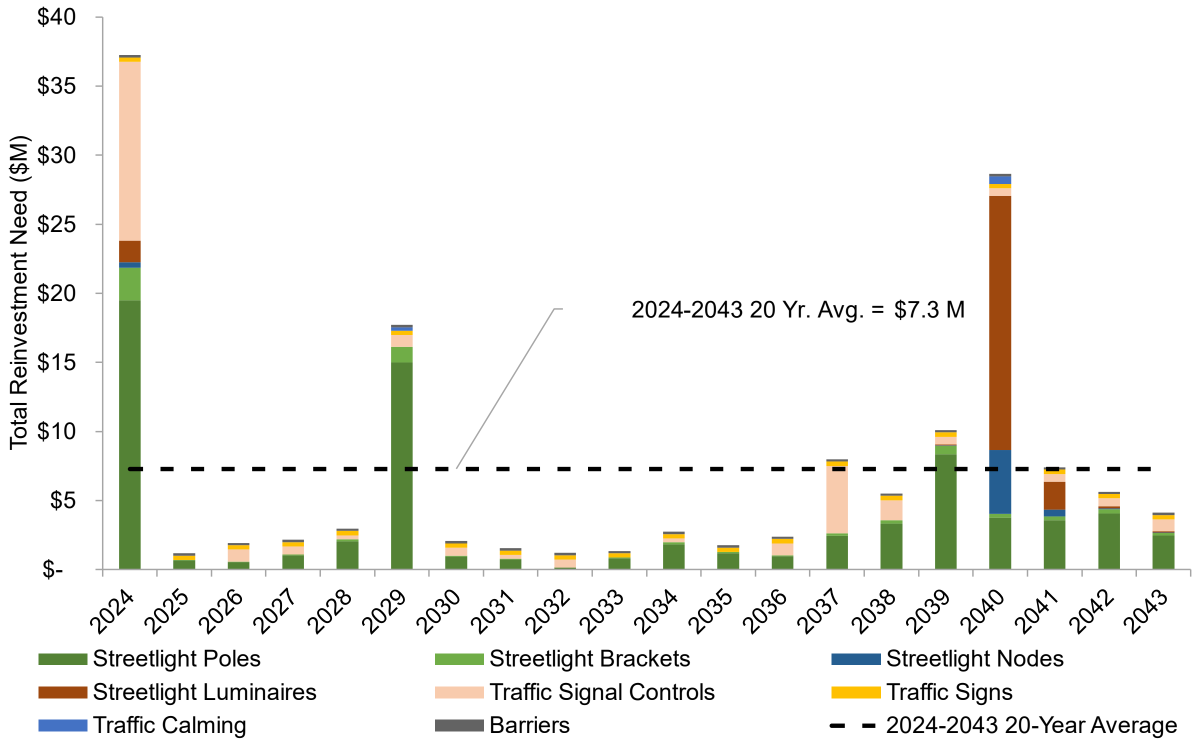


Figure 5-2: Traffic Control and Streetlights 20-Year Reinvestment Need Details

Table 5-1: Traffic Control and Streetlights 20-Year Total and Annual Average Reinvestment Need

	Streetlights	Traffic Signal Controls	Traffic Signs	Traffic Calming	Barriers	Total
Annual Average Need	$5,381,000	$1,382,000	$311,000	$40,000	$168,000	**$7,282,000**
20-Year Total	$107,620,000	$27,640,000	$6,220,000	$800,000	$3,360,000	**$145,640,000**

5.2 Full Funding Need Profile

Figure 5-3 shows a full picture of the City's traffic control and streetlights funding need forecast over the next 20 years, which provides the City the full funding requirements to perform effective financial planning activities. The total annual reinvestment rate from **Figure 5-1** was overlaid with the City's traffic control and streetlights O&M cost, in 2024 dollars.

Traffic Control and Streetlights assets require approximately $7.6M annually over the next 20 years for O&M, equivalent to total $151M in 2024 dollars. As such, with the addition of O&M, the total average annual funding need for the City's Traffic Control and Streetlights assets increases to approximately $14.8M annually, for a total of $297M over the next 20-year period.

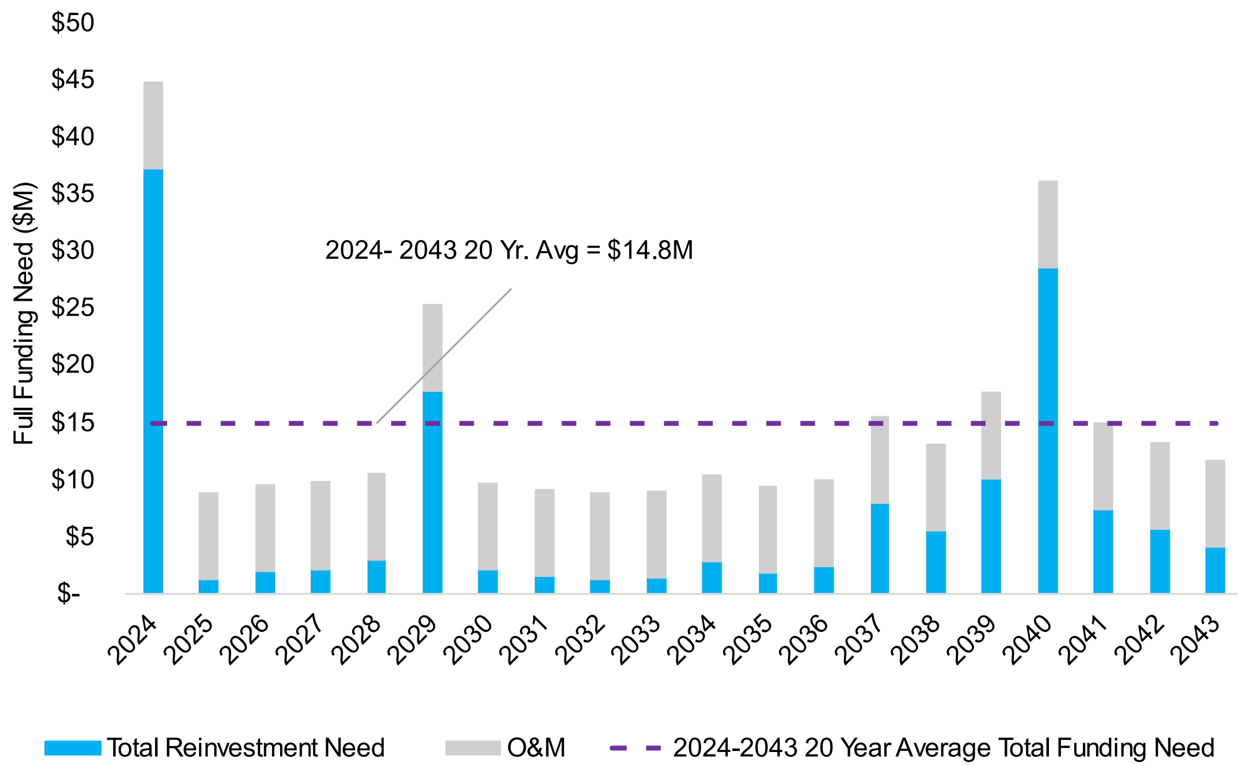


Figure 5-3: Traffic Control and Streetlights 20-Year Capital Investment and O&M Cost Forecast

5.3 Infrastructure Reserves Funding Forecast

Reserve funds are important tools in the planning and management of the City's financial resources and provide a strong indicator of the City's overall financial health and are fundamental to the City's long-term financial sustainability. The City is committed to maintaining healthy reserve fund balances which are collected through various means (i.e., development charges, contributions, dedications, taxation, etc.).

There are specific infrastructure reserves for the tax-supported service areas of Roads, Facilities, Parks, Fleet and Fire (funds for Traffic Control and Streetlights assets are supported from the Roads infrastructure reserve). These reserves contain funds set aside through annual contributions from taxation to help pay for the repair and replacement of infrastructure assets. Like many municipalities across Canada, Vaughan is facing increased costs associated with maintaining aging infrastructure. Corporate Asset Management Plans for both core and non-core assets suggest the City's infrastructure deficit is large and growing. The City has continued with robust strategies and plans by developing a comprehensive Long-Range Fiscal Plan and model, which was used to better inform the 2025 and future budgets by providing information about the financial requirements to sustain growth, delivery of services and the community's infrastructure needs.

Prudent financial planning requires ongoing contributions to Roads reserves to fund the repair and replacement of infrastructure. To achieve this, continued operating and infrastructure investments are critical to ensure the City's Traffic Control and Streetlights assets remain financially sustainable now and into the future. This objective is supported by continuing to build service area infrastructure reserves. The 2024 reserve contribution for Roads reserves totalled $2.0M with the City being committed to ensuring the financial sustainability of its Traffic Control and Streetlights assets.

The City's Asset Management Plans assess average reinvestment requirements over the next 20 years for the City's assets, including Traffic Control and Streetlights infrastructure. Annual reserve contributions should generally be in line with the asset reinvestment requirement to ensure sufficient funds are set aside for asset rehabilitation and replacement needs.

For the Roads service area, the forecasted 20-year average funding need is $23.1M. In comparison, the average annual funding forecasted over the next 10 years is estimated to be $8.7M representing a funding coverage of 38% as illustrated in Error! Reference source not found.. The funding sources in this forecast are limited to annual reserve contributions, capital from taxation and the Canada Community-Building Fund (CCBF is provided from the Federal Government). Other available funding sources not included are debentures and non-CCBF grants, which would mitigate any infrastructure funding gaps.

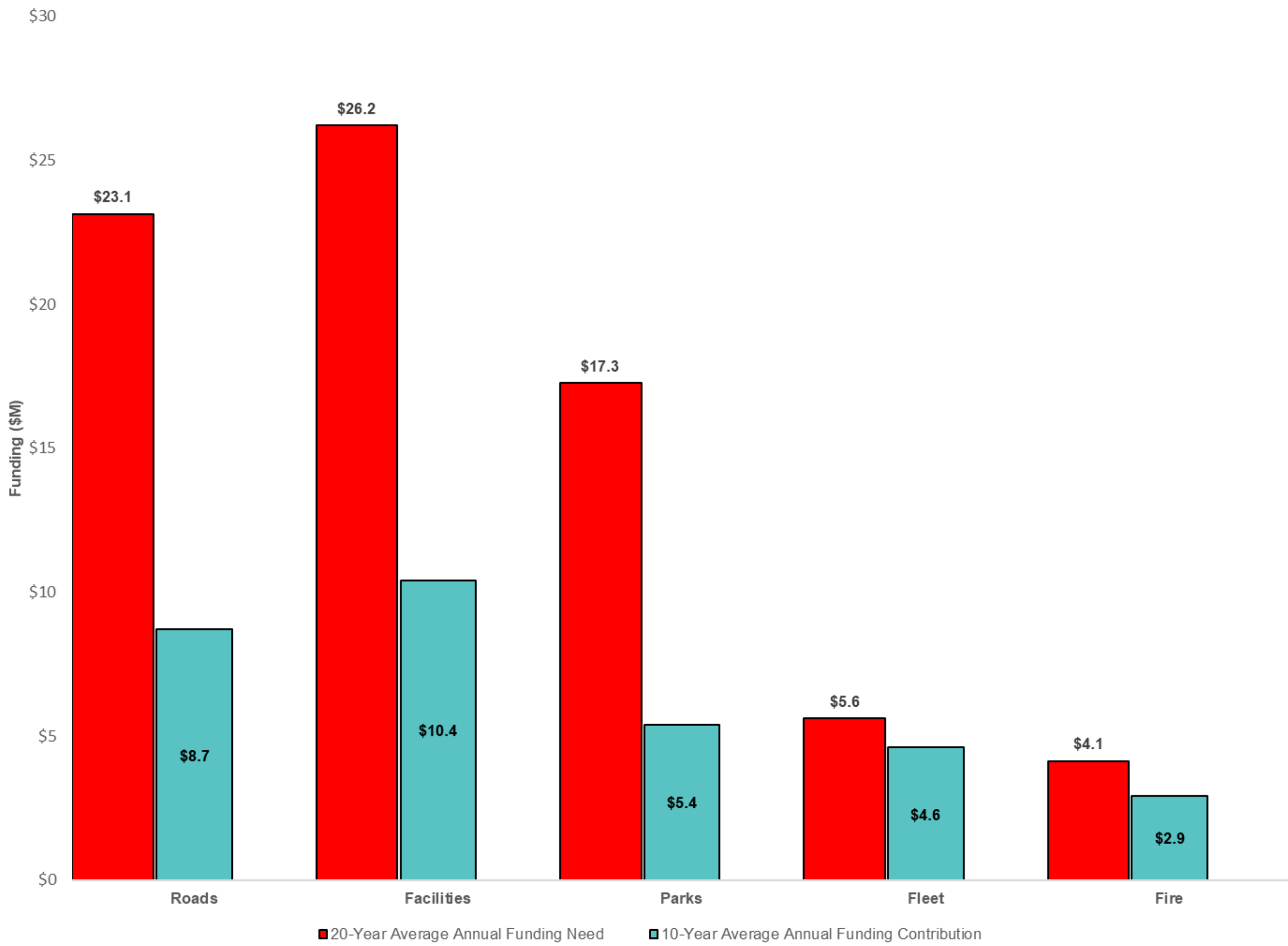


Figure 5-4: Coverage of Average Annual Funding Needs for Tax-Supported Service Areas

Revisiting the timing and scope of capital projects, optimizing the use of existing funding tools and revenue sources, such as debt and dedicated contributions to capital reserves, can help increase the City's capacity to begin to close an infrastructure funding gap.

5.4 Growth-related Assets Funding Need

The City completed a Long Range Fiscal Plan (LRFP) in 2022, which included a model to support planning to meet Traffic Control and Streetlights infrastructure needs as the City's communities continue to grow. This model analyzed the city-wide infrastructure needs to identify the required infrastructure that will meet future servicing demands. The model assessed the existing and future servicing needs and provides servicing recommendations to meet the City's growth plans. Based on the model, the forecasted funding need estimates for the construction of new Traffic Control and Streetlights assets out to 2031 is illustrated in Error! Reference source not found. with a primary funding source for these needs being Development Charges.

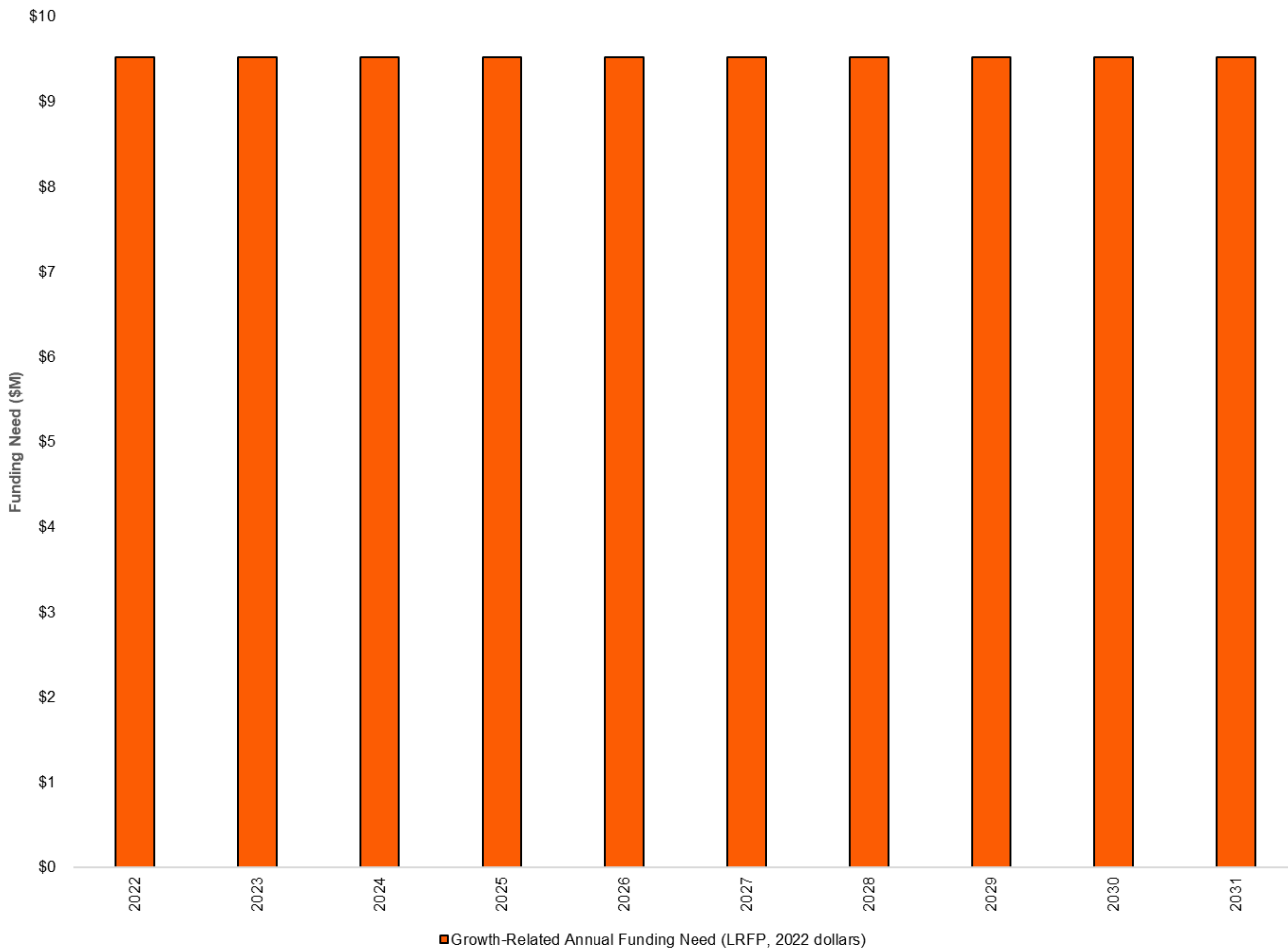


Figure 5-5: Forecasted Funding Needs for Construction of New Traffic Control and Streetlights Assets

One of the next steps in the further development of the LRFP is to apply added detail to the forecasted funding need estimates. This will provide a more refined forecast, which will serve to provide additional guidance for Asset Management planning in the future at the City of Vaughan.

Asset Management Plan

Non-Core Assets
Fleet

City of Vaughan
March 2025

Table of Contents

Figures

Tables

1. Introduction

The City of Vaughan (The City) has conducted a renewal of the City's Asset Management (AM) Plans for all its infrastructure assets, including Fleet assets.

1.1 Background

The City is one of nine area municipalities located within the Regional Municipality of York. As a lower tier municipality, the City is responsible for providing services such as buildings, fire protection, public works, water distribution, wastewater collection, and parks and recreation.

The next 25 years will see the City transition from a growing suburban municipality to a fully urban space. This type of transition will require long-term thinking about how best to accommodate and make the most of new opportunities. Planning for the future through strategic planning will position the City to deal with the many pressing issues impacting the organization such as community safety, access to health facilities, environment, traffic congestion and issues related to growth and the quality of municipal services.

The City is one of Canada's fastest growing cities, with a population of over 320,000 according to the latest census from Statistics Canada. It is projected that the number of residents will increase to 415,000 by 2031. In addition to its rapidly growing population, the City is home to a well-diversified and expanding employment sector with over 7,800 businesses and 231,000 employees. The City has the largest supply of new employment lands in the Greater Toronto Area (GTA), and it is projected that the number of employees will increase to 271,000 by 2031.

1.2 Objectives

In 2018, by City Council approval, the Corporate Asset Management (AM) Policy for the City came into effect; and, in 2013, the City's first Corporate AM Strategy was published. As identified in the Corporate AM Strategy, the City's first set of AM Plans (AMPs) were developed in 2014.

In early 2021, the City updated its AM Strategy and core infrastructure AMPs, as per Ontario Regulation (O. Reg) 588/17. The purpose of this series of AMPs is to now update the infrastructure assets so as to provide the City with a comprehensive updated AM Plan.

The objective of this AMP is to deliver a financial and technical roadmap for the management of the City's Fleet assets, and to provide the means for the City to maximize value from its assets, at the lowest overall expense while, at the same time, providing enhanced service levels for its residents and promoting green initiatives.

Organizations that implement good AM practices will benefit from improved business and financial performance, effective investment decisions, and better risk management. Stakeholders can expect lower total asset life cycle costs, higher asset performance, and confidence in sustained future performance.

1.3 AM Provincial Requirements

The Ontario Regulation 588/17 (O. Reg. 588/17) came into effect in 2018 and stipulates specific AM requirements to be in place within Ontario municipalities by certain key dates (**Table 1-1**). The development of this AMP is one of the steps to guide the City towards meeting the July 1st, 2025 deadline.

Table 1-1: O. Reg. 588/17: AM Planning for Municipal Infrastructure

Description: A regulation made under the Infrastructure for Jobs and Prosperity Act, 2015, stating that every municipality shall prepare and update a Strategic AM Policy, and that every municipality shall prepare an AM Plan for its core infrastructure assets by July 1, 2022, and an AM Plan for all other infrastructure assets by July 1, 2024. The regulation outlines several requirements that each AM Plan must follow, such as including current and proposed level of service. Core municipal infrastructure assets include water, wastewater, stormwater, road, and bridge assets.

Deadline Date	Regulatory Requirement
July 1st, 2019	All municipalities are required to prepare their first Strategic AM Policy.
July 1st, 2022	All municipalities are required to have an AM Plan for its entire core municipal infrastructure (i.e., water, sanitary, stormwater, and transportation).
July 1st, 2024	All municipalities are required to have an AM Plan for infrastructure assets not included under their core assets.
July 1st, 2025	All AM Plans must include information about the levels of service that the municipality proposes to provide, the activities required to meet those level of service, and a strategy to fund activities.

1.4 Scope

This AMP has been developed for the Fleet assets, which are owned and maintained by the City, as shown in **Table 1-2**.

Table 1-2: In-Scope Fleet Assets

Asset Category	Asset Types
Vehicles	Light Vehicles, Medium Vehicles, and Heavy Vehicles.
Equipment	Small Equipment, Medium Equipment, and Large Equipment.
Trailers	Trailers with Plates and Trailer without Plates.
Others	Traffic counters, Motorcycles, Bicycles, and Solar Battery Box.

The following elements are included within the scope of this AMP:

- A summary of the asset inventory, including the replacement cost of the assets, the average age of the assets, the condition of the assets, and the City's approach to assessing the condition of the assets.
- Current levels of service (LoS) based on performance measures.
- Asset lifecycle management strategies to maintain identified current LoS, minimize associated asset risks, and to optimize costs over the whole lifecycle of the asset.

1.5 Approach for Asset Management Plan

The approach used in the renewal of this AM Plan is presented in **Figure 1-1**, and has been selected to ensure that the City can have the confidence to make fact-based and defensible business decisions from reliable and robust information.

Figure 1-1: AM Plan Approach

2. State of Infrastructure

Fleet assets are managed by Fleet Management Services, which provides service for all City vehicles and equipment, except those used by Vaughan Fire and Rescue Service. City departments utilize vehicles/equipment for their day-to-day operation activities, and Fleet Management Services is responsible for maintaining these fleet assets in a timely and efficiently manner to support the continuous delivery of City services.

Fleet Management Services manages over 1,200 assets that range significantly in both complexity and value. Fleet Management Services facilitates all the licensing, registration, and insurance of the vehicles and provides preventative maintenance activities.

2.1 Asset Inventory and Hierarchy

The City owns and manages over 1,200 fleet assets, which are divided into vehicles, equipment, trailers, and others (e.g., Traffic counters, Motorcycles, etc.). In addition, the City may enter into rental agreements and leases on an as-required basis.

There is a wide range of fleet asset types. The asset inventory should be granular enough to identify which individual assets are due for renewal. However, it is important to note the fine balance between adequate granularity to provide the necessary information, and too much granularity that the effort to collect and manage the information outweighs the usefulness of the data itself. A fleet assets hierarchy is developed based on the City's current fleet inventory categorization approach, and in consultation with City staff. Vehicles are categorized by gross weight in kilogram and equipment is classified by size.

Table 2-1 presents the fleet assets hierarchy and asset inventory summary. Vehicles range from standard cars and trucks to chipper trucks with dump body, and road flusher trucks. They are further grouped into light, medium, and heavy vehicles according to their gross weight. Equipment assets are further grouped into small, medium, and large equipment according to their sizes. They range from handheld blowers, line trimmers (small equipment), to aerator and snow plow tractors (medium equipment), to ice re-surfacers and front end loaders (heavy equipment). The Fleet asset management plan (AMP) deals only with the assets of core fleet City services and not the assets of Fire and Rescue, as there is a separate AMP for Fire and Rescue.

Table 2-1: Fleet Asset Inventory and Hierarchy

Asset Category	Asset Type	Quantity	Unit of Measure
Vehicle	Light Vehicles	228	Ea.
	Medium Vehicles	21	Ea.
	Heavy Vehicles	92	Ea.
Equipment	Small Equipment	633	Ea.
	Medium Equipment	17	Ea.
	Large Equipment	108	Ea.
Trailer	Trailer with Plates	54	Ea.
	Trailer w/o Plates	28	Ea.
Others	Bicycle	5	Ea.
	Motorcycle	3	Ea.
	Traffic Counter	13	Ea.
	Solar Battery Box	1	Ea.
Total		**1203**	**Ea.**

2.2 Current Asset Replacement Value

The estimated replacement value is the cost of replacing an existing asset in 2024 dollars. These costs are collected from the City's GIS record. Where applicable, a CPI-based inflation rate was used to estimate the 2024 values.

The City owned fleet assets is valued at approximately $58M, as represented in **Table 2-2**. The estimated total replacement value for the vehicles is approximately $36M, which accounts for the largest share of the total replacement value among the fleet asset categories.

Table 2-2: Fleet Current Replacement Costs

Asset Category	Asset Type	Unit Cost ($ / Unit)	Total Replacement Value
Vehicle	Light Vehicles	$50,000 - $210,000	$15,570,000
	Medium Vehicles	$65,000 - $210,000	$2,665,000
	Heavy Vehicles	$95,000 - $760,000	$17,757,000
Equipment	Small Equipment	$350- $35,000	$2,124,000
	Medium Equipment	$30,200 - $70,000	$618,000
	Large Equipment	$70,000 - $ 350,000	$16,065,000
Trailer	Trailer with Plates	$7,310 - $ 214,000	$1,351,000
	Trailer w/o Plates	$3,400 - $203,000	$1,635,000
Others	Bicycle	$1,500	$8,000
	Motor-cycle	20,000	$62,000
	Traffic Counter	$2,800	$38,000
	Solar Battery Box	$609	$1,000
Fleet Total			**$57,894,000**

2.3 Age and Remaining Service Life

The asset age is based on the install year of the assets and the remaining service life (RSL) is estimated by using age and expected service life (ESL) in years. The ESL for each asset is obtained from the City's inventory record.

The ESL is defined as the period over which an asset is available for use and able to provide the required LoS at an acceptable risk (i.e., without unforeseen costs of disruption for maintenance and repair). The actual service life can vary significantly from the ESL. In some instances, a variation in expected vs. actual service life is evident due to the following factors:

- **Operating conditions and demands:** Some assets are operated intermittently or even infrequently or is being operated a lower demand than its design capacity, thus the actual operating "age" of the asset is reduced.
- **Environment:** Some assets are exposed to very aggressive environmental conditions (e.g., corrosive chemicals), while other assets are in relatively benign conditions, thus the deterioration of assets is affected differently.
- **Maintenance:** Assets are maintained through replacement of components, which prolongs the service life of the asset.
- **Technological Obsolescence:** Some assets can theoretically be maintained indefinitely, although considerations such as maintenance cost, energy inefficiency and new technologies are likely to render this approach uneconomical.

Figure 2-1 shows the average asset age and RSL as a proportion of average ESL weighted by replacement value for each asset type. Most categories of the fleet assets are reaching or exceeding their average ESLs. Most of the assets are approaching their end of service life. Motorcycles and trailers with plates are observed to have exceeded their service life indicating the need to replace in the short term.

It should be noted that the RSL can be refined further when mileage/hour information is reviewed for the vehicles and equipment asset categories.

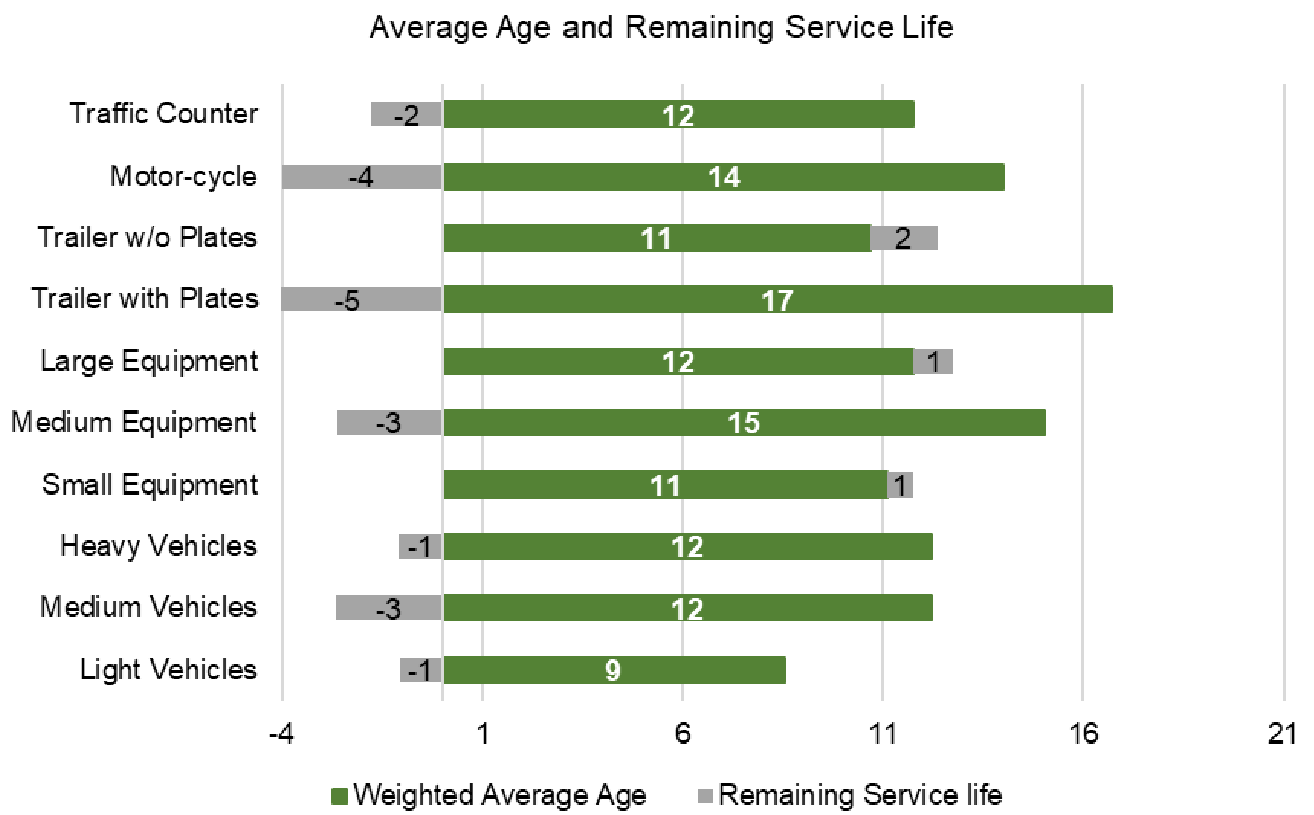


Figure 2-1: Fleet Asset Average Age and Remaining Service Life

2.4 Asset Condition

2.4.1 Age-Based Condition Assessment

Two-parameter Weibull distribution function was used to assess the current condition and to project the future condition of the City's Fleet. The Weibull distribution has been used extensively in reliability studies and lifetime prediction models in industries ranging from the automotive to the oil and gas industries; it provides a suitable distribution for this type of analysis.

The Weibull probability distribution provides a left-skewed distribution that rises slowly and diminishes quickly as the population is consumed. The underlying premise of the Weibull-shaped deterioration is that while some assets fail prematurely due to severe conditions or improper installation, other assets are very long-lived and function well beyond their theoretical expected service life. In order to perform a high order network-level analysis, it was assumed that assets would fail (and require replacement) within a deterioration envelope / curve approximated by a Weibull probability distribution. The two-parameter Weibull cumulative distribution has two parameters for scale and shape, as set out in Equation [1]:

$$f(x;\alpha,\beta) = e^{-\left(\frac{x}{\beta}\right)^{\alpha}} \quad [1]$$

Where: x = Age
α = Shape parameter
β = Scale parameter (or slope)

Table 2-3 presents the condition score ranges and the corresponding range of ESL and total life consumed.

Table 2-3: Age-Based Physical Condition Scale

Condition Score (minimum)	Condition Score (maximum)	Condition Rating	Range % of ESL Consumed	Range of % Operational Life Consumed
1.0	1.5	Very Good	0% – 71%	0% – 47%
1.5	2.2	Good	72% – 84%	48% – 56%
2.2	2.8	Fair	85% – 92%	57% – 60%
2.8	5.0	Poor	93% – 100%	61% – 100%

2.4.2 Condition Summaries

Figure 2-2 provides a summary of the condition weighted by replacement value for fleet owned assets. It shows that approximately 59% of the fleet assets are in Poor condition indicating that they have reached or exceeded their expected service life and require to be renewed or replaced in the short term or long-term depending on their risk profile.

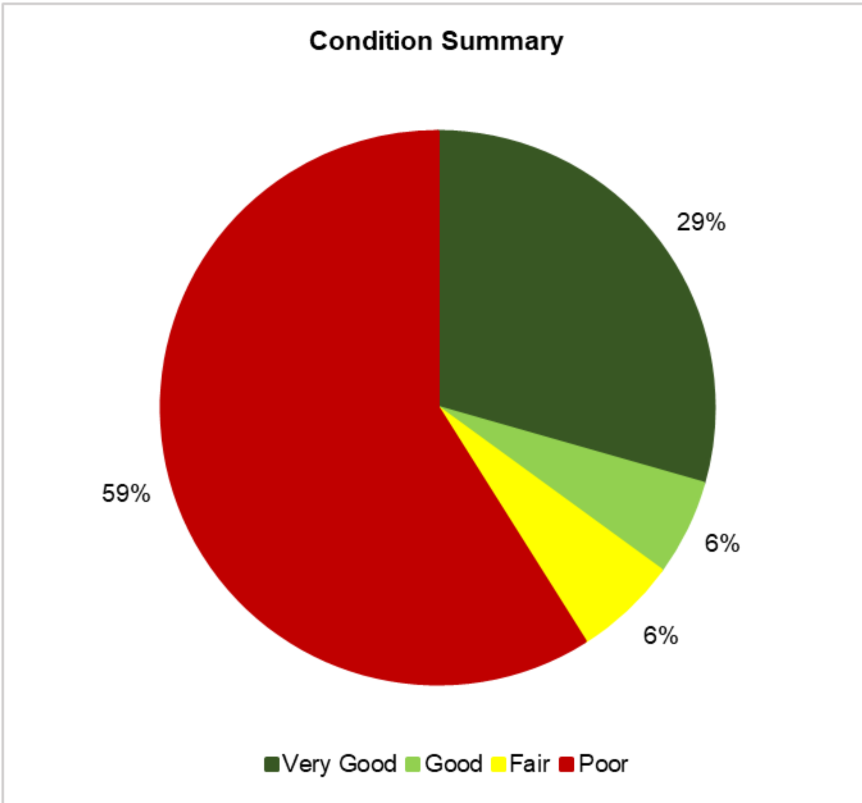


Figure 2-2: Fleet Asset Condition Summary

Figure 2-3 presents the condition distribution by fleet asset types weighted by replacement cost. A substantial portion of the City's fleet assets are in Poor condition, however, there is also a significant portion in Very Good and Good condition.

Approximately 34% of the City's light vehicles are in Very Good condition, while 59% of the light vehicles are in Poor condition approaching their expected replacement date. For medium vehicles, more than 80% are in Poor condition and for heavy vehicles over 62% are in Poor condition, indicating the needs for replacement.

Approximately 70% of the medium equipment is in Poor condition. Large equipment, which account for the largest share of the total equipment replacement value, has approximately 38% of assets in Very Good or Good condition weighted by current replacement cost, and 52% are in Poor Condition.

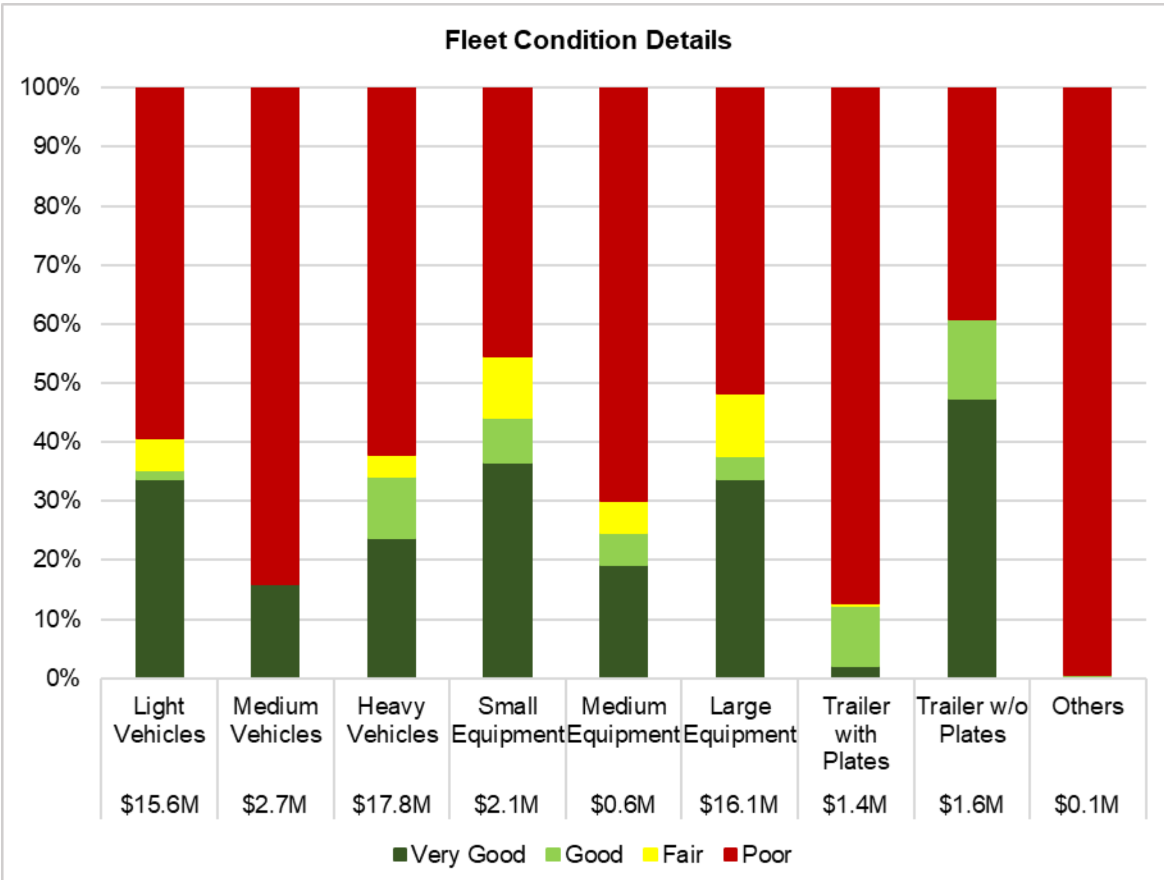


Figure 2-3: Distribution of Fleet Asset Condition

3. Levels of Service

3.1 Purpose

Levels of Service (LoS) supports every aspect of the overall AM System as shown in **Figure 3-1**. The objective of establishing clearly defined service levels is to help the City meet stakeholder values, achieve its strategic goals, make informed risk-based decisions, and implement effective asset lifecycle activities.

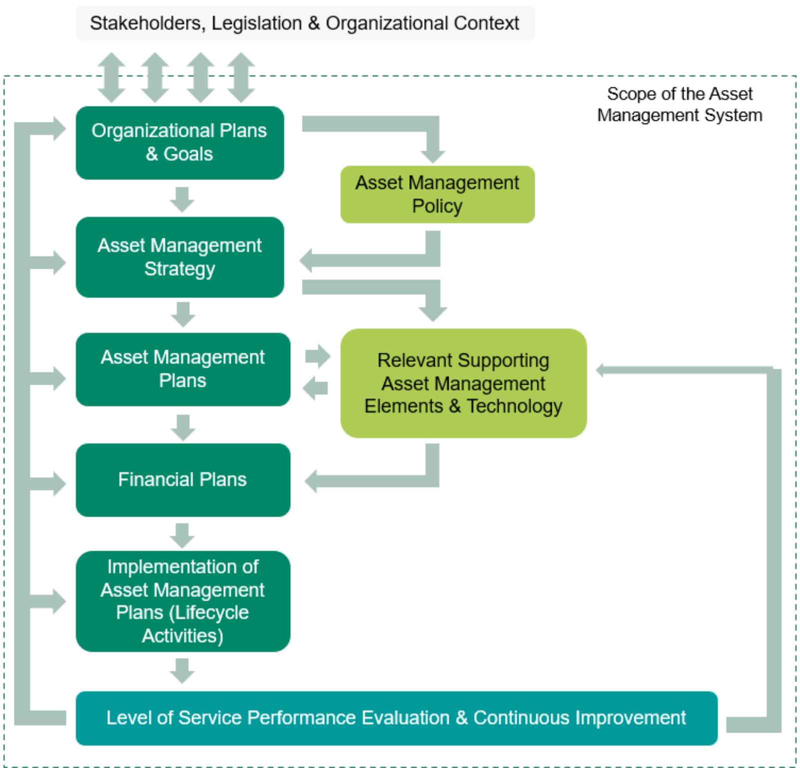


Figure 3-1: LoS within the AM System

In the City's experience, documenting LoS is a proven practice that will enable the City to:

- Link corporate strategic objectives to customer expectations and technical operations.
- Balance customer needs and expectations while evaluating the effectiveness of operations and whether the right LoS is being provided at the right cost.
- Transition from an "Asset Stewardship" approach that focuses on making decisions based on maintaining assets in an acceptable condition to a "Serviceability" approach that is geared towards making decisions based on balancing the costs, risks, and goals for the LoS being provided by the City's assets.
- Communicate the physical nature of infrastructure that the City owns and is financially responsible for while promoting the use of LoS to enable effective consultation with stakeholders regarding alternative funding options according to desired LoS outcomes.
- Make recommendations on strategies that the City can take now to minimize future renewal costs while ensuring that adequate LoS can be delivered without burdening future generations.
- Assess internal (e.g., program changes) and external (e.g., climate change) factors that have the potential to impact the City's ability to deliver services and how these factors may impact the LoS being provided.
- Implement a corporate continuous improvement program to further optimize AM across all service areas.

The O. Reg. 588/17 requires that all AMPs include information about the LoS that the City proposes to provide, the activities required to meet those service levels, and a strategy to fund those activities. The deadline for formalizing these LoS requirements is July 1, 2025 (see **Section 1.3**).

Successful AM programs aim to achieve targeted service levels through customer-based decision making. To achieve this, the City considered a customer-centric approach, where the customer is at the heart of every decision from development to implementation, consultation, and roll-out of the LoS Framework (**Figure 3-2**).

There are two types of LoS measures: Customer LoS (also called "Community" LoS) and Technical LoS. Customer LoS are recorded in a manner that attempts to describe the LoS in terms of what is actually being provided to the customer (i.e., the public) and how the customers experience the service. It is important to note that customers are not concerned with the specific operating requirements of the assets that provide the service, but rather the value they obtain from the operation of the assets. To achieve Customer LoS there needs to be line of sight between the value delivered and how that value is realized. This is the purpose of Technical LoS which attempts to describe how the City will provide and meet the expected Customer LoS.

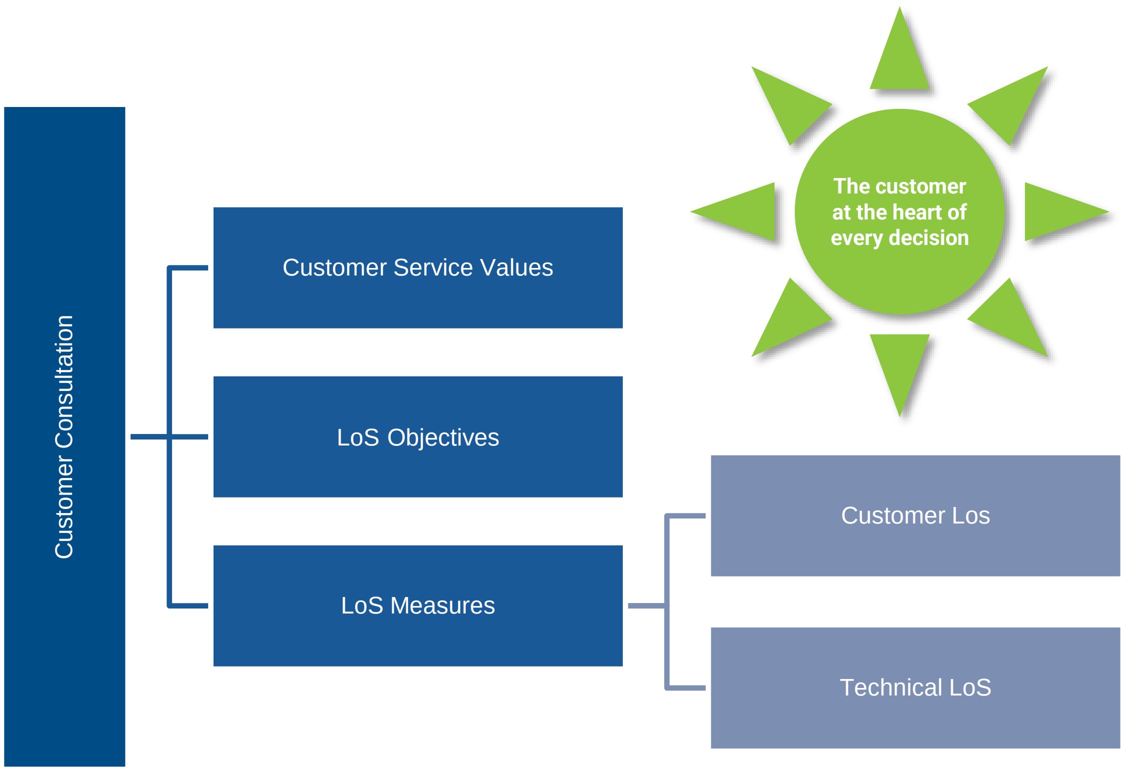


Figure 3-2: The LoS Framework Customer-Centric Approach

The LoS Framework was primarily conceived through a collaborative workshop process. In 2020, four workshops with City staff were conducted across each of the fourteen service areas.

The following outcomes were achieved during each service area workshop:

- Staff were oriented as to the purpose and importance of establishing a consistent LoS Framework;
- Stakeholders were identified, including their expectations, interests, and any regulatory requirements;
- Customer service values were established and reviewed;
- LoS objectives were established for each customer service value;
- Staff provided several performance measures that are currently being tracked as well as those that the City would like to track in the future;
- Where information was available, current performance, targets, and data sources were documented; and
- Growth and shifts in future demand were discussed across the City's service areas.

3.2 Objectives

Defining LoS objectives is important for drawing a line of sight between the City's corporate objectives and the tangible asset performance outcomes. To do so, the LoS objectives must take into consideration stakeholder

interests to develop asset performance measures that aim to meet the needs and expectations of the community. By doing this, the City will ensure that their assets are striving towards optimal performance, not only operationally, but economically, socially, and sustainably as well.

Every stakeholder has certain interests in the service being provided and in general, these interests can be categorized into six universal stakeholder values, as shown in **Table 3-1**. Each universal stakeholder value is also assigned a corporate LoS objective.

Table 3-1: The City's Values and LoS Objectives

Customer Value	LoS Objective
Quality and Reliability	The service is delivered with a high standard of excellence, and the service is available when needed.
Affordability	The cost of the service is delivered in a financially sustainable manner and does not burden customers.
Environmental Sustainability	The service is delivered in a manner that does not compromise the ability of future generations to meet their needs.
Access and Capacity	Customers can easily access the service with minimal inconvenience.
Health and Safety	The service is delivered with minimal health and safety impacts.
Responsiveness	Customer service requests are responded to efficiently and in a timely manner.

3.3 Stakeholders and Their Interests

A stakeholder is any person or organization that can affect, be affected by, or perceive themselves to be affected by a decision or an activity. Stakeholder analysis is the process of understanding stakeholder needs, expectations, and perceptions relative to the stakeholder's level-of-interest and level-of-influence over the organization. An organization typically engages with their stakeholders to:

- Establish which activities or services matter most to them.
- Understand their risk appetite and risk threshold.
- Understand their willingness to pay for services.

Stakeholders can take many forms and may be internal (i.e., staff, Council) or external (i.e., the public, regulatory agencies, suppliers, neighbouring municipalities, etc.) to the organization. Historically, only service recipients who pay for City services would be considered customers; however, today customers can take many forms and should include any entity that has a legitimate interest in the service being provided. In addition to service recipients (i.e., the public), this may include:

- **Regulatory Agencies** – Stakeholders that set standards, compliance regulations or other legislation that govern service delivery.
- **Special Interest Groups** – Stakeholders that are affected by or have an interest in the City's roadway services.

Table 3-2 identifies the key stakeholders as they pertain to the City's fleet asset class. These stakeholders were documented during a collaborative workshop process with the City and is not intended to be an exhaustive list; however, the following groups provide a good starting point for future stakeholder engagement.

Table 3-2: The City's Key Fleet Stakeholders and Their Interests

Key Stakeholder Group	Description	Stakeholder Interests / Priorities
Internal Departments	City departments utilize City assets for their day-to-day operational activities which are maintained through the Fleet Management Services. Parks, Roads, and Bylaw are the top three internal departments that rely on Fleet for their day-to-day operations.	• Safety • Good state of repair • Cleanliness • Responsiveness
Third Party Providers	Third party providers include rental vehicle agencies, insurance providers, and maintenance contractors. The City primarily owns it fleet inventory; however, the City may enter into rental agreements and leases on an as-required basis. As such, the rental or leasing companies may become stakeholders in the City's fleet asset class. Preventive Maintenance (PM) on vehicles and Heavy Equipment is primarily outsourced to Contracted Vendors. The small and medium equipment, specific assets and other repairs are completed in-house whenever possible.	• Safety • Good state of repair • Cleanliness • Service contracts • Timely payments
Regulatory Agencies	Stakeholders such as the Ministry of Transportation (MTO) is a stakeholder in the City's fleet assets, as these assets require mandated safety compliance.	• Safety • Good state of repair

3.4 Level of Service (LoS) Performance Measures

A documented suite of LoS performance measures enables a common understanding of the service delivery that the City's customers currently receive, and the associated cost of maintaining infrastructure assets to provide the service. Having these performance measures set at the appropriate levels within the City ensures alignment from the corporate vision, to asset investment decisions, and to day-to-day operational activities. When establishing LoS performance measures it is important to keep in mind the "SMART" acronym, as follows:

- **S**pecific, easily evaluated and understood.
- **M**easurable, quantifiable, and easily collectable to ensure ongoing data availability.
- **A**ttainable, so that they work to motivate as opposed to discourage.
- **R**elevant, in that they relate and align with a specific goal.
- **T**ime-Bound, measured over a specific period, which is typically annually for benchmarking.

There are two types of LoS performance measures: Community LoS and Technical LoS. Community LoS are recorded in a manner that attempts to describe the LoS in terms of what is being provided to the community (i.e., the public) and how the customer experiences the service. Community LoS are qualitative, non-technical, and are driven by the municipality's strategic AM objectives. Community LoS are not concerned with the specific operating requirements of the assets that provide the service, but rather the value they obtain from the operation of the assets. To achieve Community LoS, there needs to be line of sight between the value delivered and how that value is realized. This is the purpose of Technical LoS which attempts to describe, quantitively, how the City will provide and meet the expected Community LoS.

3.5 LoS Performance Results

A summary of the City's current and proposed community and technical service levels for the Fleet assets are documented in Table 3-3.

Table 3-3: Community and Technical Service Levels

Asset Type	Level of Service	Current Performance	Current Service Level Target	Proposed Service Level Target
All Assets	Percentage of Assets with Condition Rating of Fair or Above	41%	50%	No Change
Vehicles	Percentage of Regulated MTO Maintenance	100%	100%	No Change
Vehicles	Percentage of Inspections Completed	100%	100%	No Change
Vehicles	Number of EVs and Hybrid Vehicles	24	24	No Change

3.6 LoS Performance Targets

Establishing LoS targets is an important part of continual improvement and performance management. Without targets, it is difficult to ascertain whether goals are being met, or the extent of the gap if they are not. Incorporating targets into the City's LoS Framework helps to ensure that targets are reasonable, aligned with customer expectations, and evaluated on an objective basis by considering cost-benefit trade-offs.

One of the key challenges in setting targets in a municipal environment is that they can often become biased and/or politically motivated. Therefore, it is important to review LoS targets with stakeholders. An important aspect of evaluating LoS targets is determining how willing the user is to pay for the service. Regulatory requirements are an exception; however, they only provide the minimum service standard. Cost is still an important parameter to consider when assessing the merits of service improvements.

To deal with the financial realities, it is necessary to:

- Calculate how much the service costs based on current LoS.
- Determine the cost associated with varying the LoS.
- Assess the customers' willingness to pay.

3.7 Future Demand Drivers

Understanding internal and external factors that may impact service delivery (positively or negatively), such as staff resources, climate change, and shifts in population is a critical component for managing desired service levels in a sustainable manner. It is important to proactively develop effective, long-term strategies that are suitable for the City's unique economic, environmental, and social landscape.

In most cases, the factors presented in **Table 3-4** may result in a negative impact on the City's existing service levels, unless additional funding or resources can be allocated to meet future needs; however, in some instances, such as technological advancements and higher regulation standards, the impact on service delivery may actually improve as a result.

Table 3-4: Potential Future Demand Drivers

Anticipated Issue	Potential Impact on Service Delivery
Availability of skilled labour	While the availability of skilled labour is a challenge, the City does not have the physical capacity to complete all of the preventative maintenance and repairs internally. As a result, a select group of assets is sent to third party vendors for preventative maintenance when capacity maximums are reached. The City is currently relying on vendors since they have the resources and required expertise. Furthermore, there are only a handful of vendors with the desired qualifications that the City requires. The City has a large municipal fleet and is finding that only a few vendors are bidding due the commitment required for maintaining a large fleet.
Technological advancements	As equipment becomes more sophisticated, with proprietary technology, the cost and complexity of keeping up with the technology presents an ongoing challenge. Additional space and ongoing technological training is required for servicing these assets in-house.
Fleet Electrification	To achieve carbon neutrality and the carbon resiliency goals laid out in the 2019 Community Sustainability Plan - Green Directions Vaughan, the City is moving towards the electrification of its fleet, where/when feasible. In addition, there is a need for charging infrastructure, dedicated for fleet use, to support this transition.
Funding	Fleet is tasked with replacing vehicles and equipment even when funding is limited. As a result, the department has increased costs to repair vehicles across the City. In addition, the fleet reserve fund is not topped up annually to a level that is on par with the expected service life and replacement needs of the assets. As such, asset replacements are being deferred each year, putting additional stress on day-to-day operations.

By considering potential drivers, as well as any issues that may pose a threat to meeting future demand, the City has the advantage to proactively plan and prepare mitigation strategies.

Approaches for the City to consider include:

- Asset-based solutions (e.g., upgrading existing assets, providing new assets, etc.).
- Non-asset-based solutions (e.g., restricting usage, changing habits through education, providing service alternatives, etc.).

A hybrid solution often works well since every municipality has its own challenges and there is not a “one solution fits all” approach. It is important that the City remains aware of its internal and external situational context and modifies its approach and mitigation strategies in a consistent, periodic, and well documented manner.

4. Asset Lifecycle Strategies

Asset lifecycle management focuses on the specific activities we must undertake during all phases of the asset lifecycle. By considering entire asset lifecycles the City can ensure sound decision making that consider present and future service delivery needs.

The overarching goal of life cycle management is to maximize the long-term benefits and services that our assets deliver while minimizing the associated costs and risks in the long run. Every asset has a life cycle cost, which is the total cost of all the activities undertaken throughout its service life. The following sections describe activities across the life cycle of assets.

4.1 Lifecycle Activities

Any responsible owner of assets such as the City has a desire to preserve the condition of their existing assets for as long as possible, by maintaining or even extending their design lives through routine activities such as maintenance and active intervention. The City is continually acquiring infrastructure assets, but these assets require increased funding for operation and maintenance as they age. The City is also responsible for the replacement of deteriorated assets as long as the service is required. While individual assets may have a useful life that can be predicted in years or decades, the service that the asset provides could be for a substantially longer duration (perhaps in perpetuity). Part of the purpose of the AM planning process is to fully understand and predict the long-range financial requirements for the City's infrastructure to facilitate planning and resource management in the most cost-effective manner possible. **Figure 4-1** illustrates how costs typically accumulate over an asset's life. It is worth noting that the accumulation of the ongoing operations and maintenance, refurbishment and disposal / replacement costs is many multiples of the initial acquisition costs. A key and important take-away from **Figure 4-1** is therefore for the City to fully understand the entire life cycle costs before proceeding with asset acquisition.

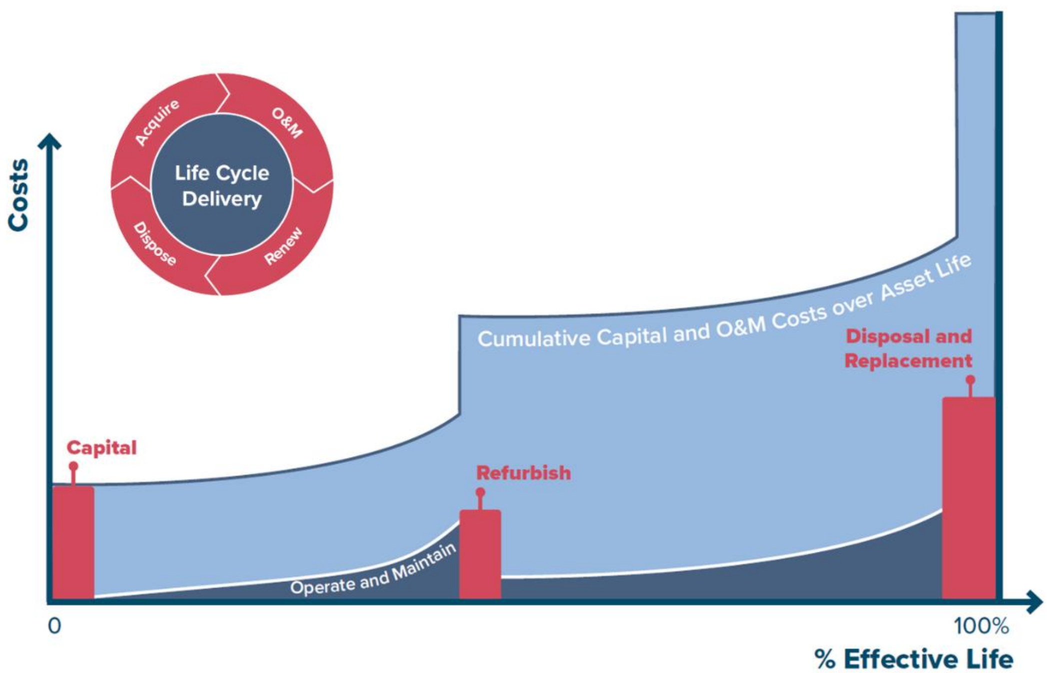


Figure 4-1: Life Cycle Cost Accumulation Over Asset Life

4.2 Asset Acquisition Strategies

City assets are acquired through public procurement processes based on replacement schedules or and departmental growth-related requests for new assets. The growth-related requests aim to meet the technical requirements for various user groups. Every department has its own capital budget in place and the City has cross-consultation processes for growth-related requests.

The City performs annual asset condition assessments; these are based on age, usage, working condition and replacement value of the asset. The number of assets acquired each year are driven by the needs of departments, replacement schedules and the available allocated budget.

To achieve carbon neutrality and the carbon resiliency goals laid out in the 2019 Community Sustainability Plan - Green Directions Vaughan, the City is moving towards the electrification of its fleet and is adopting technology to reduce pollution[1].

Looking towards the future, when acquiring new assets, the City should evaluate credible alternative design solutions that consider how the asset is to be managed at each of its life cycle stages.

Asset management and full life cycle considerations for the acquisition of new assets include, but are not limited to, the following:

- The asset's operability and maintainability.
- Availability and management of spares.
- Staff skill and availability to manage the asset.
- The manner of the asset's eventual disposal.

4.3 Operations and Maintenance Strategies

As new infrastructure is commissioned, the City accepts the responsibility of operating and maintaining the infrastructure according to operation and maintenance (O&M) standards to ensure that the infrastructure is safe and reliable. Operations staff provide the day-to-day support required to operate infrastructure. In few cases, operation costs are minor, but for most there are significant increases.

Maintenance expenses include periodic preventive maintenance to ensure that the infrastructure can provide reliable service throughout the life of the asset and corrective maintenance that is required to repair defective assets as and when needed. Inadequate funding for O&M will have an adverse impact on the lifespan of assets. The O&M resources required in any period is a function of the current inventory of infrastructure and total O&M needs required for each asset. As the inventory of infrastructure grows, total O&M requirements will also grow.

Table 4-1 presents O&M actuals for the past five years and the overall five-year average O&M expenditures was $3.4M.

Table 4-1: Historic Fleet O&M Expenditures

Year	Total O&M Actuals
2024	$3,563,575
2023	$3,620,107
2022	$3,597,247
2021	$3,591,379
2020	$2,408,312
5-Yr. Average	**$3,483,339**

All City's vehicles must be road tested before and after inspection, and after repair work is completed. All vehicle defects are recorded. The City has also separate vehicle preventive maintenance schedules for different vehicle categories including heavy single and tandem axle vehicles 6,000 up to 20,000 kg gross vehicle weight (kg GVW), medium diesel vehicles up to 5,999 kg GVW, and light and medium gas vehicles up to 5,999 kg GVW.

If the internal Fleet Shop capacity reaches its maximum, the City outsources the O&M activities to one of the four private contractors, who were awarded work through the Public Procurement process. The City's Preventative Maintenance Program is based on time and/or usage thresholds for which vehicles get inspected on a set cycle.

[1] Green Directions Vaughan

The City tracks all vehicles failures and accidents as incidents for continuous improvements in its operations. The corrective maintenance is driven by the in-house capacity based on the highest priority vehicles and the other vehicles are sent over to vendors.

4.4 Renewal and Replacement Strategies

The third portion or phase of full life cycle costing relates to the renewal and replacement of infrastructure that has deteriorated to the point where it no longer provides the required service. Renewal cost is sometimes incurred during the life of an asset where an investment is made to improve the condition and / or functionality of the asset. Disposal and replacement costs are incurred at the end of an asset's life when it is disposed of and replaced by a fully new asset. It is vital that communities fully understand the looming obligations of infrastructure renewal or replacement and develop a strategy to respond in a manner that is fair and affordable.

The City has regular preventive maintenance programs for all light, medium and heavy-duty vehicles to assist in determination of any upcoming renewals activities. The City also undertakes review of its vehicles to repurpose any add-on equipment, attachments and upfitting that have remaining lifespan.

4.5 Disposal and Decommissioning Strategies

There will inevitably come a point in time when an asset must be removed from service and, depending on the type of asset, there may be significant costs associated with its decommissioning and disposal. Factors that may influence the decision to remove an asset from service, include changes to legislation that cause the asset to be in non-compliance, the inability of the asset to cope with increased service levels, technology advances that render the asset obsolete, the cost of retaining the asset is greater than the benefit gained, or the current risk associated with the asset's failure is not tolerable. The current practices at the City look at disposal of Fleet at the end of their useful life.

Normally, major costs that may be incurred during disposal and decommissioning derive from the environmental impact of the disposal and, if required, the rehabilitation and decontamination of land. In some cases, there will be residual liabilities and risks to consider if a decision is made to partially abandon the asset as opposed to fully disposing of its components (e.g., leaving a non-functioning pipe in the ground, or an inactive building standing). For now, there is no formalized procedures in place at the City to track any environmental costs associated with Fleet disposal activities.

4.6 Capital Planning

Capital investment is to address community growth or changes, or to renew existing assets to maintain service levels. For the actual funding needs analysis, please refer to **Section 5**.

- **Life Cycle Cost Analysis Approach**. The City's analysis enables optimized decision making and mathematical deterioration modelling of infrastructure assets and the development of short, medium and long-term forecasts of renewal and replacement costs of a number of decision criteria and the ability to compare different intervention options to find the optimal solution in terms of timing and the intervention option chosen.
- **Forecast Periods.** The City aims to develop Short- to Medium-Term and Long-Term capital plans. Typically, short to medium-term capital plan identifies the activities required to meet current and future demand, the cost of those activities and a financing approach. It is developed or renewed every three to five years and should coincide with regulations on short to medium-term expenditure planning. A long-term plan can serve as part of Strategic Asset Management Plan, which indicates what will be spent, by service areas, over a set period of time. Long-term plans tend to focus only on costs.
  Consistent with the approach of other asset management plans, the analysis periods for funding need assessments are 20 years.

4.7 Asset Prioritization

4.7.1 Risk Assessment

Infrastructure-related risk exposure is assessed based on the combined consideration of probability and consequences of an asset failure, which is used to drive the selection and prioritization of appropriate action, based on risk tolerance thresholds and funding availability. Understanding the risk exposure for a given set of assets allows the City to identify where they are most exposed to risk, and to target their investments to most effectively reduce that exposure.

In addressing risk for infrastructure assets, the first step in the analysis is to identify assets that are most critical to the business. Critical assets are those that will potentially have the greatest impact on service delivery should they fail. It should be noted that the parameters, criteria and weighting factors area starting point, and should be reviewed and modified to reflect the priorities of the City on an ongoing basis.

The fundamental principle of consequence (or criticality) models is that they evaluate the relative importance of assets based on select criteria. The approach to risk analysis within this project utilizes a triple-bottom-line assessment approach utilizing the following four criticality indices:

- **Economic** – influence of the asset's failure on monetary resources
- **Operational** – influence of the asset's failure on operational ability
- **Social** – influence of the asset's failure on society
- **Environmental** – influence of the asset's failure on the environment

By applying specific indices, the risk assessment framework generates a risk (or priority) score for each asset. The risk score is a rating of the asset based on the detailed assessment of the likelihood and consequence of failure based on a number of key parameters. All parameters are then equated using equation [4].

$$\textit{Risk} = \textit{Likelihood of Failure} \times \textit{Consequence of Failure} \qquad [4]$$

Based on this principal, the risk associated with a given asset's failure can be managed by limiting the likelihood of this occurring, or the impact realized, should it occur.

Consequences of Failure (CoF) reflect the relative "impact" of a given asset's failure. While traditionally these have been looked at as purely economic terms (i.e. repair cost, loss of revenue, etc.), the truth is that investment decisions are often driven by non-economic factors. Understanding both the economic and non-economic

impacts associated with loss or limitation of service help in categorizing an asset's "criticality" and justifying infrastructure decisions in a consistent, defensible manner.

4.7.2 Analytical Logic to Sequence Interventions

The asset criticality score can be used to prioritize projects within a funding constrained environment. **Figure 4-2** illustrates this logic of carrying unfunded needs to the next year in the period where they receive a higher probability of receiving funds based on their criticality score.

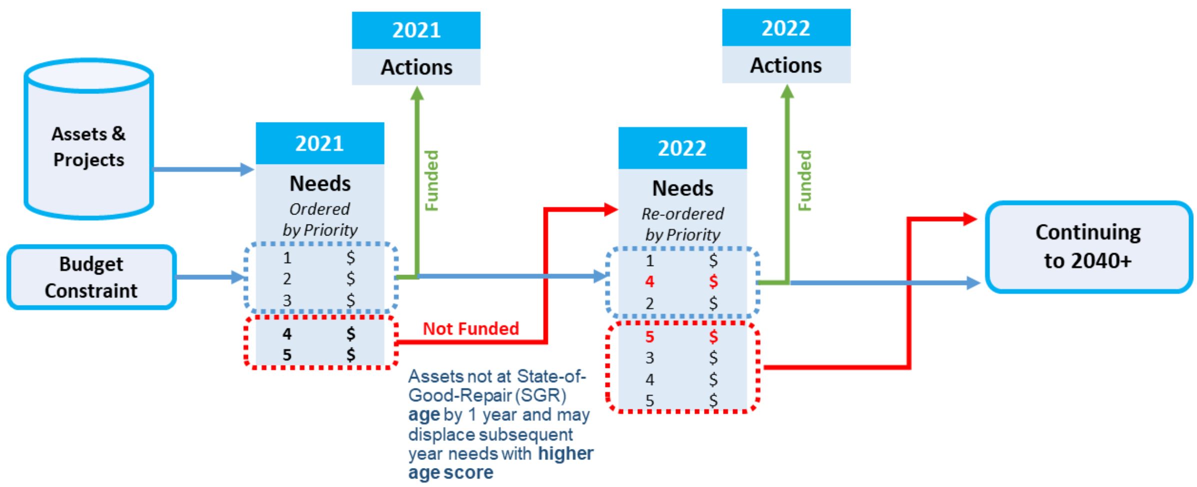


Figure 4-2: The Role of Criticality to Prioritize Projects Within A Funding Constrained Environment

4.8 Financial Planning

4.8.1 Financial Policies

The City has taken the initiative to establish financial asset management policies in 2018, which provides directions on how financial principles apply to assets to ensure that service goals are met. The policy aligns the business model of AM with the City's financial planning, financial reporting, cost management, treasury and taxation functions. The City will integrate findings from the AM Plans into its long-term financial planning and budgeting processes. Sound financial analysis will be encompassed in AM planning in order for the AM Plan to be a sought-after guide for employees in budgeting and financial planning.

4.8.2 Financial Analysis

Financial analysis activities for asset management is centered on two essential quantities: revenues and expenditures. Revenues can come from many sources. Through asset operations, the City generate its own source revenues from taxes, development charges, etc. Expenditures are all the direct and indirect costs associated with capital, operating and maintaining, and disposing of assets.

Assessing the financial implications supports in the decision-making when there are competing priorities and trade-offs between projects. Financial analysis provides a better picture of how to fund the capital plan and make critical decisions about service delivery while providing the greatest benefit for the community at the lowest cost.

4.8.3 Aligning the Financial and Non-Financial Functions of AM

ISO 55010[2] identifies the that the financial and non-financial functions of AM within organizations are generally inadequately aligned, as follows:

- **Financial Accounting Functions:** Focused on retrospective reporting of accounting / regulatory financial activities. However, there is a growing awareness in organizations of the need to focus on providing a managerial costing approach in order to support decision-making for the future.
- **Non-Financial Functions:** Have a limited understanding of financial accounting functions but are recognizing the need to improve their understanding of the financial implications of their activities.

The lack of alignment between financial and non-financial functions can be attributed to silos in an organization, including reporting structures, functional / operational business processes, and related technical data. Silos generally bring forth the necessary level of specialization. However, with a lack a communication between the silos, organizations are at risk of inefficiencies and errors in AM results, or AM failures due to a lack of alignment between AM staff and senior management. Financial and non-financial alignment needs to work both "vertically" and "horizontally", as follows:

- **Vertical Alignment:** Financial and non-financial asset-related directives by management are informed by accurate upward information flows, effectively implemented across the appropriate levels of the organization.
- **Horizontal alignment:** Financial and non-financial information that flows between departments (conducting functions such as operations, engineering, maintenance, financial accounting and management) uses the same terminology and refers to the assets identified in the same way.

Figure 4-3 presents the key elements in a framework to address the need to achieve the alignment.

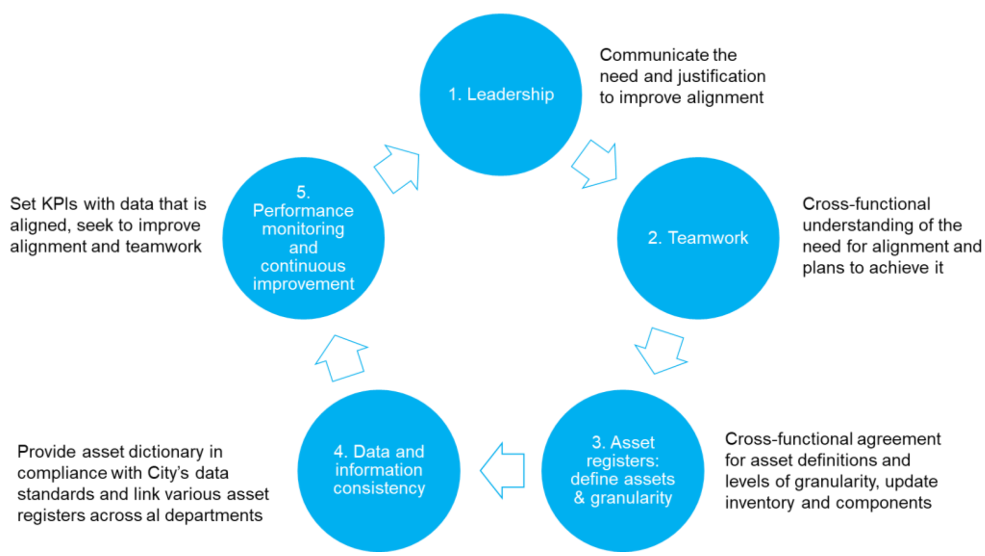


Figure 4-3: Key Elements of a Framework to Achieve Financial and Non-Financial Alignment

4.8.4 Long-Term Financial Planning

Strengthening the City's Asset Management planning according to the recommendations in Asset Management Strategy will improve the City's long-term financial planning, by accounting for whole life cycle costs as presented in **Section 4.1**. This includes all capital, annual operation and maintenance, and disposal costs over the planning timeframe, thereby aligning financial requirements with long-term level of service objectives.

The challenge is often one of agreeing on a timeframe for such planning, recognizing that the AM perspective is ideally focused on the asset life cycle, versus the political / election cycle that could be as short as a three to four-year Council term. Accordingly, financial and non-financial staff, as well as top management and politicians,

[2] International Organization for Standardization (2019): ISO 55010 - Asset management — Guidance on the alignment of financial and non-financial functions in asset management

should agree on a long enough timeframe to provide useful forward planning information that aligns the financial and non-financial perspectives, as presented in **Figure 4-4**.

Figure 4-4: AM Planning Alignment Across the Organization

The City should have an appropriate long-term financial planning process that achieves the following:

- Stimulates long-term strategic thinking and perspective for stakeholders and decision-makers.
- Can be used as a tool to prevent or predict future financial shocks and demonstrate financial sustainability.
- Demonstrates to internal and external stakeholders that the organization has a financial strategy in place to meet their demands, now and in the future.

The long-term financial planning process needs to involve financial and non-financial staff working together to combine the important elements of strategy development, asset management planning and financial forecasting (**Figure 4-3** and **Figure 4-4**).

5. Funding Need Analysis

The lifecycle analysis was implemented in an MS Excel Asset Lifecycle Model, which integrated asset inventory, age, ESL, replacement values, and condition to create a theoretical asset replacement cycle for each Fleet asset. The asset reinvestment forecasts prepared for this assessment are estimates of what it will cost over the next 20 and 40 years to sustain the City's each Fleet assets.

The annual reinvestment need for the fleet assets were based on age and ESL (i.e., replacing assets that has exceeded their ESL) in 2024 dollars. It should be noted that the nature of this type of analysis is based on a wide range of data inputs, currently available information, and a number of assumptions, and is therefore at best a high-level estimate of future funding needs.

It should be noted that the nature of this type of analysis is based on a wide range of data inputs, currently available information, and a number of assumptions, and is therefore at best a high-level estimate of future funding needs.

5.1 20-Year Reinvestment Funding Need

The average annual reinvestment rate for the City's fleet assets is $5.6M over the next 20 years in 2024 dollars. This is equivalent to a total of approximately $112M over the next 20-year period, as presented in **Figure 5-1**. It should be noted that there are significant backlogs ($29M) for reinvestment on the fleet assets that has already exceeded their ESL, as highlighted in red in the 2024 reinvestment need.

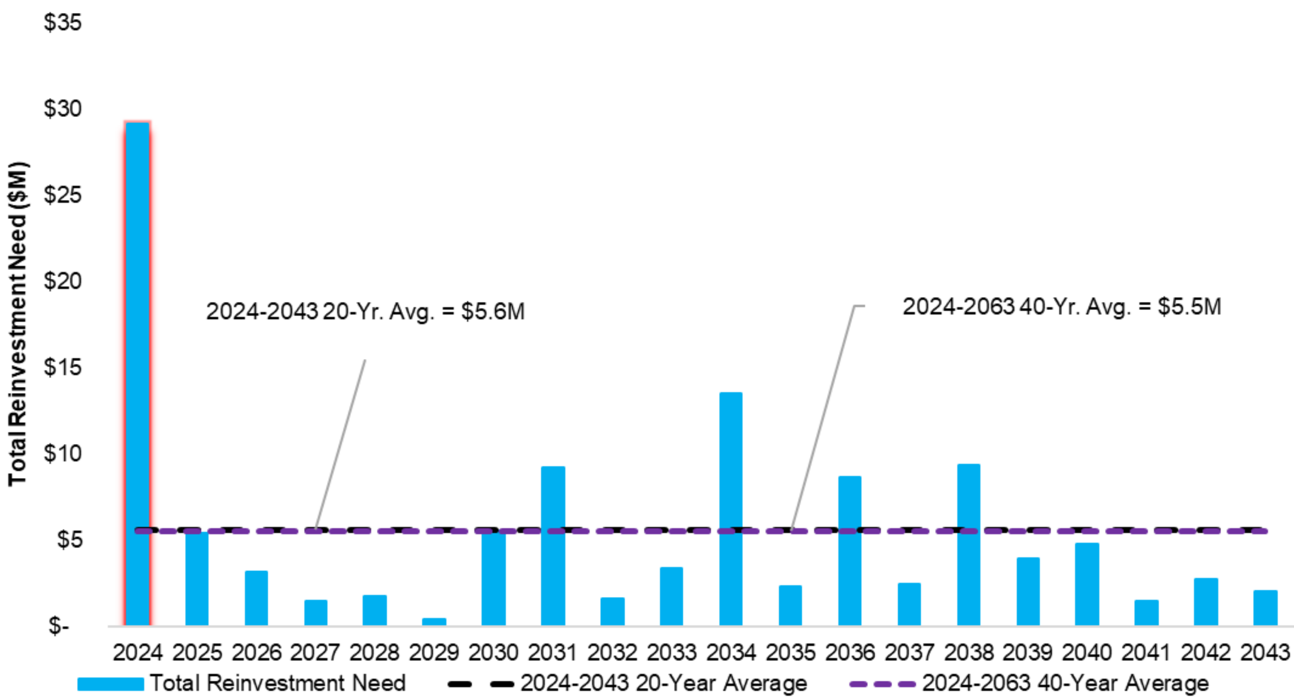


Figure 5-1: Fleet 20-Year Reinvestment Need

The detailed reinvestment needs in 2024 dollars for vehicles, equipment, trailers, and other fleet assets are presented in

Figure 5-2 and **Table 5-1**. As shown in 2024, the reinvestment needs are primarily from the aged vehicles followed by equipment assets. Looking ahead to the year starting 2030, it is recommended that the City prepares for the increased reinvestment need for vehicles and equipment as they continue to age and approach their respective ESLs.

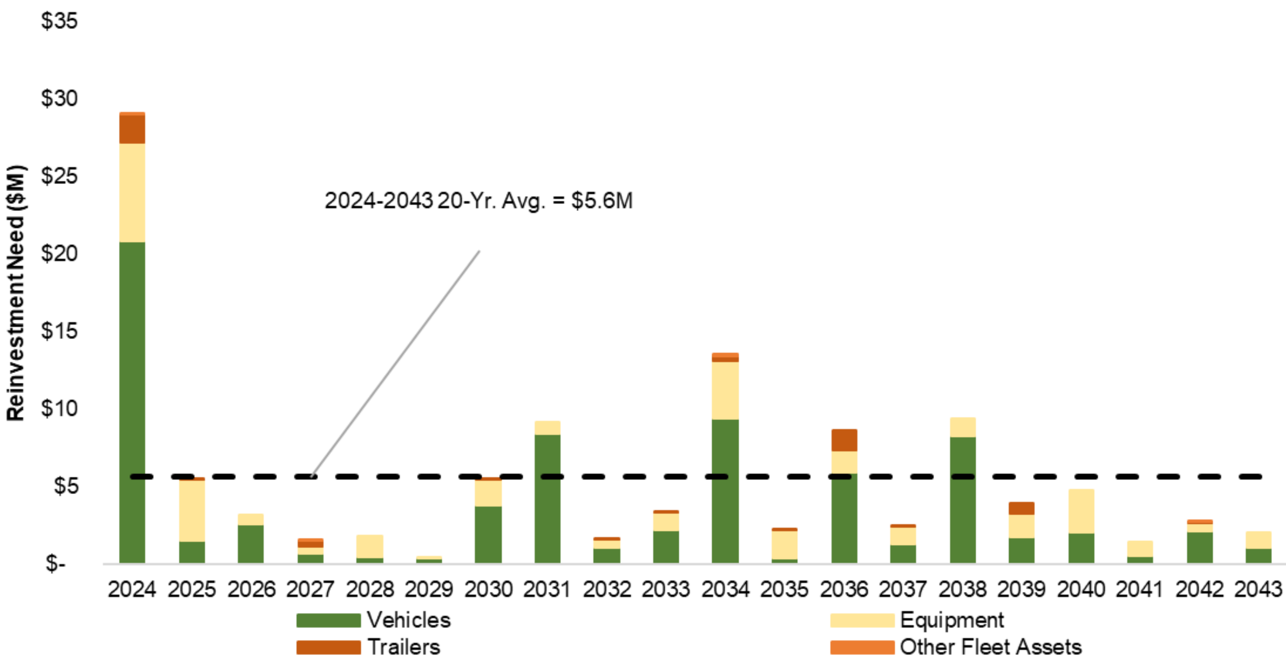


Figure 5-2: Fleet 20-Year Reinvestment Need Details

Table 5-1: Fleet 20-Year Total and Annual Average Reinvestment Need

	Vehicles	Equipment	Trailers	Other Fleet Assets	Total
Annual Average Need	$3,720,000	$1,643,000	$237,000	$11,000	**$5,611,000**
20-Year Total	$74,390,000	$32,845,000	$4,738,000	$214,000	**$112,187,000**

5.2 Full Funding Need Profile

Figure 5-3 shows a full picture of the City's Fleet funding need forecast over the next 20 years, which provides the City the full funding requirements to perform effective financial planning activities. The total annual reinvestment rate from **Figure 5-1** was overlaid with the City's Fleet O&M cost, in 2024 dollars.

Looking ahead in the long term, the average annual reinvestment rate for the City's fleet assets is $9.5M over the next 40 years in 2024 dollars, for a total of approximately $380M.

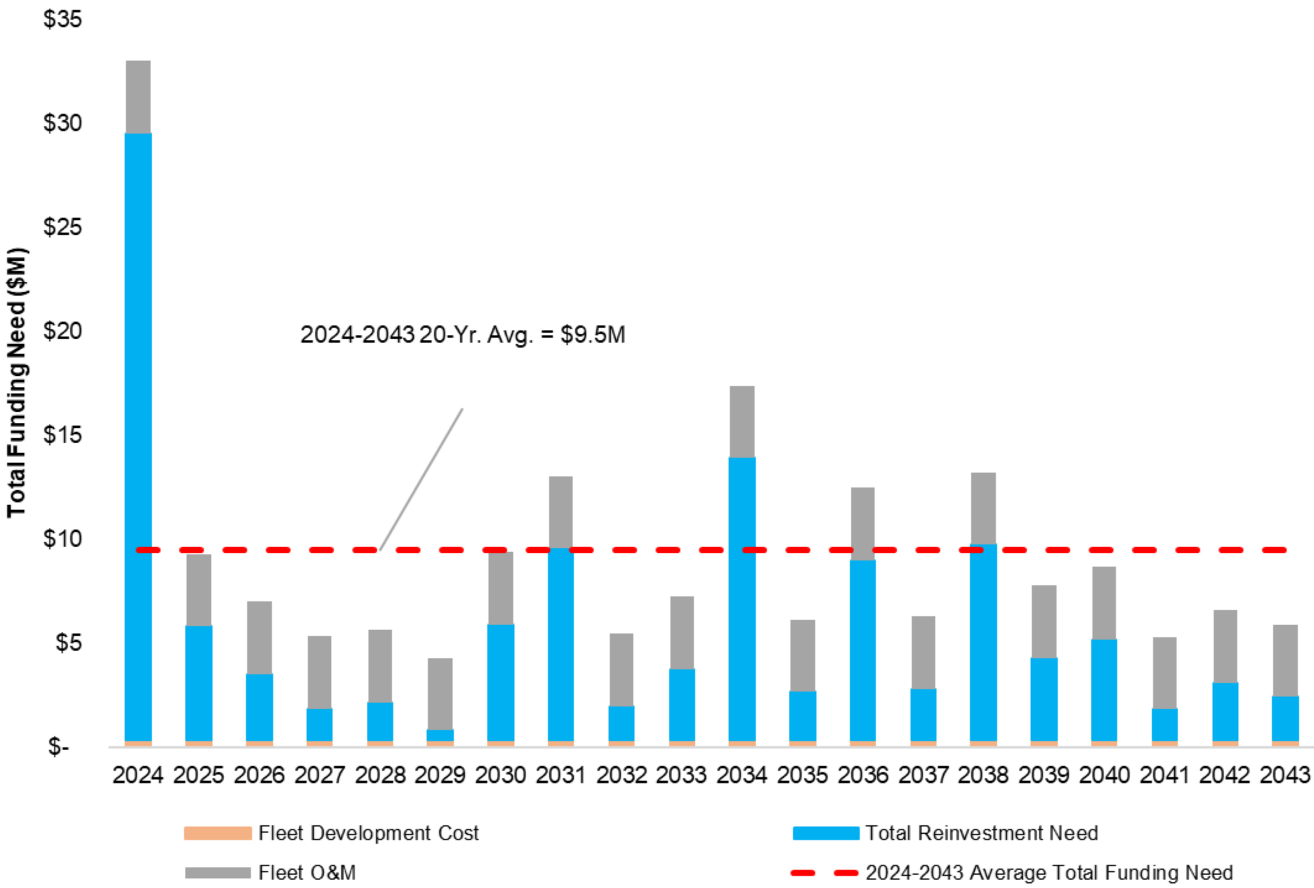


Figure 5-3: Fleet 20-Year Capital Investment and O&M Cost Forecast

5.3 Infrastructure Reserves Funding Forecast

Reserve funds are important tools in the planning and management of the City's financial resources and provide a strong indicator of the City's overall financial health and are fundamental to the City's long-term financial sustainability. The City is committed to maintaining healthy reserve fund balances which are collected through various means (i.e., development charges, contributions, dedications, taxation, etc.).

There are specific infrastructure reserves for the tax-supported service areas of Roads, Facilities, Parks, Fleet and Fire. These reserves contain funds set aside through annual contributions from taxation to help pay for the repair and replacement of infrastructure assets. Like many municipalities across Canada, Vaughan is facing increased costs associated with maintaining aging infrastructure. Corporate Asset Management Plans for both core and non-core assets suggest the City's infrastructure deficit is large and growing. The City has continued with robust strategies and plans by developing a comprehensive Long-Range Fiscal Plan and model, which was used to better inform the 2025 and future budgets by providing information about the financial requirements to sustain growth, delivery of services and the community's infrastructure needs.

Prudent financial planning requires ongoing contributions to Fleet reserves to fund the repair and replacement of infrastructure. To achieve this, continued operating and infrastructure investments are critical to ensure the City's Fleet assets remain financially sustainable now and into the future. This objective is supported by continuing to build service area infrastructure reserves. The 2024 reserve contribution for Fleet reserves totalled $14.1M with the City being committed to ensuring the financial sustainability of its Fleet assets.

The City's Asset Management Plans assess average reinvestment requirements over the next 20 years for the City's assets, including Fleet infrastructure. Annual reserve contributions should generally be in line with the asset reinvestment requirement to ensure sufficient funds are set aside for asset rehabilitation and replacement needs.

For the Fleet service area, the forecasted 20-year average funding need is $5.6M. In comparison, the average annual funding forecasted over the next 10 years is estimated to be $4.6M representing a funding coverage of 82% as illustrated in Error! Reference source not found.. The funding sources in this forecast are limited to annual reserve contributions and capital from taxation. Other available funding sources not included are grants, which would mitigate any infrastructure funding gaps.

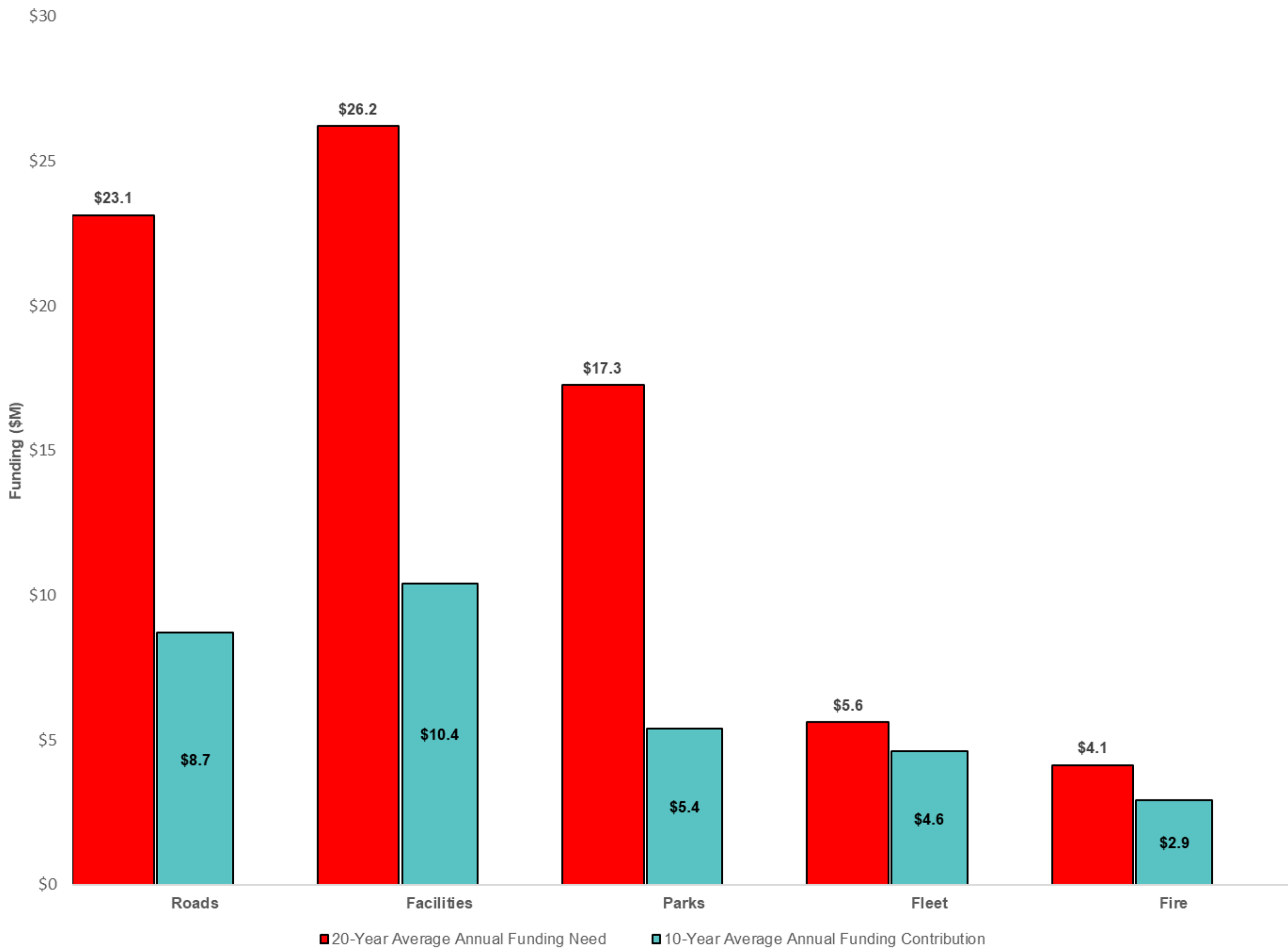


Figure 5-4: Coverage of Average Annual Funding Needs for Tax-Supported Service Areas

Revisiting the timing and scope of capital projects, optimizing the use of existing funding tools and revenue sources, such as debt and dedicated contributions to capital reserves, can help increase the City's capacity to begin to close an infrastructure funding gap.

5.4 Growth-related Assets Funding Need

The City completed a Long Range Fiscal Plan (LRFP) in 2022, which included a model to support planning to meet Fleet infrastructure needs as the City's communities continue to grow. This model analyzed the city-wide infrastructure needs to identify the required infrastructure that will meet future servicing demands. The model assessed the existing and future servicing needs and provides servicing recommendations to meet the City's growth plans. Based on the model, the forecasted funding need estimates for the construction of new Fleet assets out to 2031 is illustrated in Error! Reference source not found. with a primary funding source for these needs being Development Charges.

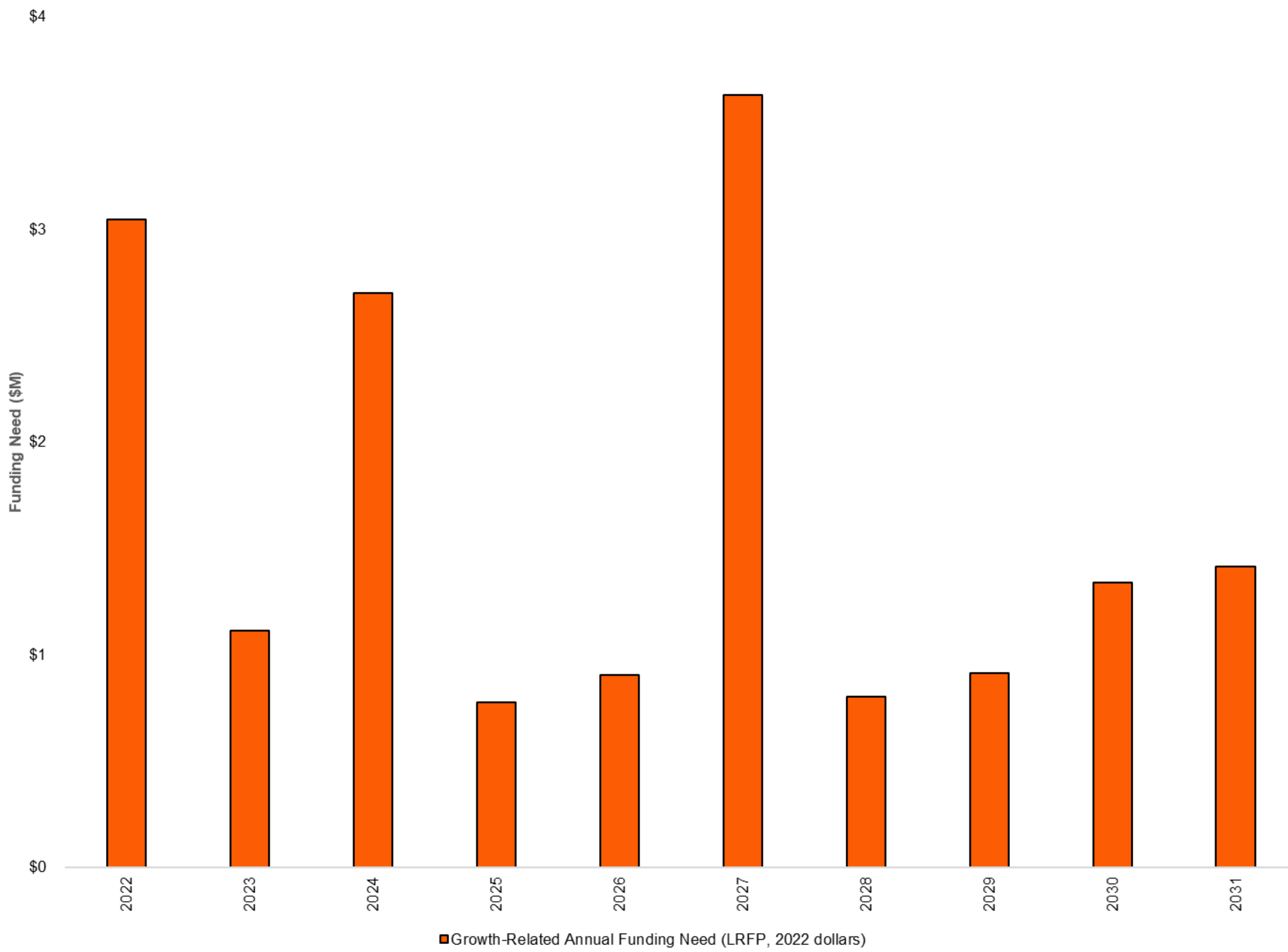


Figure 5-5: Forecasted Funding Needs for Construction of New Fleet Assets

One of the next steps in the further development of the LRFP is to apply added detail to the forecasted funding need estimates. This will provide a more refined forecast, which will serve to provide additional guidance for Asset Management planning in the future at the City of Vaughan.

Asset Management Plan

Non-Core Assets
Fire and Rescue

City of Vaughan
March 2025

Table of Contents

Figures

Tables

1. Introduction

The City of Vaughan (The City) has conducted a renewal of the City's Asset Management (AM) Plans for all its infrastructure assets, including Fire and Rescue assets.

1.1 Background

The City is one of nine area municipalities located within the Regional Municipality of York. As a lower tier municipality, the City is responsible for providing services such as buildings, fire protection, public works, water distribution, wastewater collection, and parks and recreation.

The next 25 years will see the City transition from a growing suburban municipality to a fully urban space. This type of transition will require long-term thinking about how best to accommodate and make the most of new opportunities. Planning for the future through strategic planning will position the City to deal with the many pressing issues impacting the organization such as community safety, access to health facilities, environment, traffic congestion and issues related to growth and the quality of municipal services.

The City is one of Canada's fastest growing cities, with a population of over 320,000 according to the latest census from Statistics Canada. It is projected that the number of residents will increase to 415,000 by 2031. In addition to its rapidly growing population, the City is home to a well-diversified and expanding employment sector with over 7,800 businesses and 231,000 employees. The City has the largest supply of new employment lands in the Greater Toronto Area (GTA), and it is projected that the number of employees will increase to 271,000 by 2031.

1.2 Objectives

In 2018, by City Council approval, the Corporate Asset Management (AM) Policy for the City came into effect; and, in 2013, the City's first Corporate AM Strategy was published. As identified in the Corporate AM Strategy, the City's first set of AM Plans (AMPs) were developed in 2014.

In early 2021, the City updated its AM Strategy and core infrastructure AMPs, as per Ontario Regulation (O. Reg) 588/17. The purpose of this series of AMPs is to now update the infrastructure assets so as to provide the City with a comprehensive updated AM Plan.

The objective of this AMP is to deliver a financial and technical roadmap for the management of the City's Fire and Rescue assets, and to provide the means for the City to maximize value from its assets, at the lowest overall expense while, at the same time, providing enhanced service levels for its residents and promoting green initiatives.

Organizations that implement good AM practices will benefit from improved business and financial performance, effective investment decisions, and better risk management. Stakeholders can expect lower total asset life cycle costs, higher asset performance, and confidence in sustained future performance.

1.3 AM Provincial Requirements

The Ontario Regulation 588/17 (O. Reg. 588/17) came into effect in 2018 and stipulates specific AM requirements to be in place within Ontario municipalities by certain key dates (**Table 1-1**). The development of this AMP is one of the steps to guide the City towards meeting the July 1st, 2025 deadline.

Table 1-1: O. Reg. 588/17: AM Planning for Municipal Infrastructure

Description: A regulation made under the Infrastructure for Jobs and Prosperity Act, 2015, stating that every municipality shall prepare and update a Strategic AM Policy, and that every municipality shall prepare an AM Plan for its core infrastructure assets by July 1, 2022, and an AM Plan for all other infrastructure assets by July 1, 2024. The regulation

outlines several requirements that each AM Plan must follow, such as including current and proposed level of service. Core municipal infrastructure assets include water, wastewater, stormwater, road, and bridge assets.	
Deadline Date	Regulatory Requirement
July 1st, 2019	All municipalities are required to prepare their first Strategic AM Policy.
July 1st, 2022	All municipalities are required to have an AM Plan for its entire core municipal infrastructure (i.e., water, sanitary, stormwater, and transportation).
July 1st, 2024	All municipalities are required to have an AM Plan for infrastructure assets not included under their core assets.
July 1st, 2025	All AM Plans must include information about the levels of service that the municipality proposes to provide, the activities required to meet those level of service, and a strategy to fund activities.

1.4 Scope

This AMP has been developed for the Fire and Rescue assets, which are owned and maintained by the City, as shown in **Table 1-2**.

Table 1-2: In-Scope Fire and Rescue Assets

Asset Category	Asset Types
Emergency Response Vehicles	Aerial 105ft, Aerial 55ft, Air/Light Trucks, Commands, Haz-Mat, Mechanical Service Vehicles, Platforms, Pumpers, Rescues, Rehab, and Tankers
Passenger Vehicles	Cars, SUVs, and Pick-up Trucks
Equipment	Self-Contained Breathing Apparatus, Cylinders, Hose (100,65,50,45 mm), Hose Nozzles, Mobile and Portable Radios, Fire Truck Equipment, Rescue Equipment, Fitness Equipment, Bunker Gear Washer, Bunker Gear Rak, Bunker Gear, Air Fill Stations, Cameras, Truck Hoist, Fire Station Equipment, Megablast Drying Machines, and Other.

The following elements are included within the scope of this AMP:

- A summary of the asset inventory, including the replacement cost of the assets, the average age of the assets, the condition of the assets, and the City’s approach to assessing the condition of the assets.
- Current levels of service (LoS) based on performance measures.
- Asset lifecycle management strategies to maintain identified current LoS, minimize associated asset risks, and to optimize costs over the whole lifecycle of the asset.

1.5 Approach for Asset Management Plan

The approach used in the renewal of this AM Plan is presented in **Figure 1-1**, and has been selected to ensure that the City can have the confidence to make fact-based and defensible business decisions from reliable and robust information.

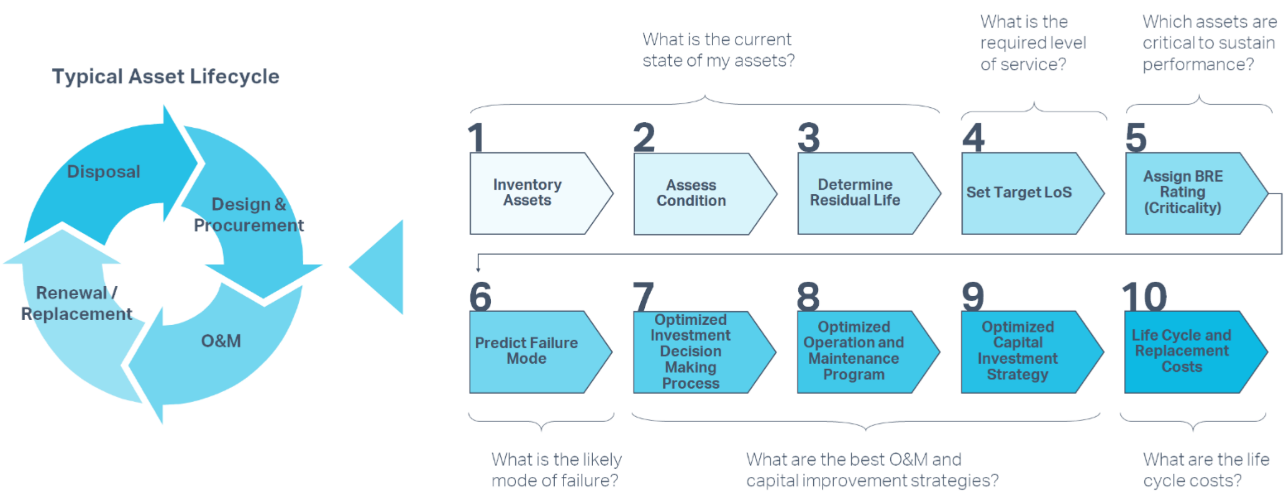


Figure 1-1: AM Plan Approach

2. State of Infrastructure

Fire and Rescue owns and maintain a collection of emergency response vehicles and equipment required to respond to emergencies. The assets used include fire suppression and support vehicles and an assortment of emergency services equipment. Fire and Rescue assets are managed by Vaughan Fire and Rescue Service (VFRS), who are dedicated to providing efficient emergency response, and fire protection, prevention, safety and education to those who live, work and visit the City.

2.1 Asset Inventory and Hierarchy

Table 2-1 presents the City's Fire and Rescue inventory and a tabulated asset hierarchy. There is a wide range of Fire and Rescue asset types. VFRS manages over 28 emergency response vehicles, 26 Passenger Vehicles, and over 3,000 equipment assets that range significantly in both complexity and value. Emergency response vehicles range from aerial 105ft and mechanical service vehicle to tanker. Equipment assets are further grouped into 24 types. They range from self-contained breathing apparatus to truck hoists.

Table 2-1: Fire and Rescue Asset Inventory and Hierarchy

Asset Category	Asset Type	Quantity	Unit of Measure
Emergency Response Vehicles	Aerial 105ft	2	Ea.
	Aerial 55ft	5	Ea.
	Air/Light Truck	1	Ea.
	Command	1	Ea.
	Haz-Mat	2	Ea.
	Mechanical Service Vehicle	1	Ea.
	Platform	2	Ea.
	Pumper	10	Ea.
	Pumper-Antique	1	Ea.
	Rescue	1	Ea.
	Tanker	2	Ea.
Passenger Vehicles	Car	6	Ea.
	SUV	12	Ea.
	Pick-up Truck	8	Ea.
Equipment	Self-Contained Breathing Apparatus	135	Ea.
	Hose-100mm	281	Ea.
	Hose-65 mm	382	Ea.
	Hose-50mm	60	Ea.
	Hose- 45mm	374	Ea.
	Hose- 38mm	48	Ea.
	Portable Radio	50	Ea.
	Cylinders	349	Ea.
Equipment	Fire Truck Equipment	35	Ea.
	Fitness Equipment	474	Ea.
	Bunker Gear Washer	10	Ea.

Asset Category	Asset Type	Quantity	Unit of Measure
	Rehab	1	Ea.
	Rescue Equipment	25	Ea.
	Bunker Gear Rak	14	Ea.
	Bunker Gear	600	Ea.
	Air Fill Stations	7	Ea.
	Camera	20	Ea.
	Truck Hoist	1	Ea.
	Fire Station Equipment	45	Ea.
	Hose Nozzles	125	Ea.
	Blitz Fire Nozzles	25	
	Megablast Drying Machine	12	Ea.
	Other	414	Ea.
Total		**3491**	**Ea.**

2.2 Current Asset Replacement Value

The estimated replacement value is the cost of replacing an existing asset in 2024-dollars. These costs are collected from the City's GIS record. Where applicable, a CPI-based inflation rate was used to estimate the 2024 values.

The City owned Fire and Rescue assets are valued at approximately $53M, as represented in **Table 2-2**. The estimated total replacement value for the emergency vehicles is approximately $37M, which accounts for the largest share of the total replacement value among the Fire and Rescue asset categories.

Table 2-2: Fire and Rescue Current Replacement Costs

Asset Category	Asset Type	Unit Cost ($ / Unit)	Total Replacement Value
Emergency Response Vehicles	Aerial 105ft	$3,000,000	$6,168,600
	Aerial 55ft	$1,500,000	$7,710,750
	Air/Light Truck	$330,000	$822,480
	Command	$385,000 - $550,000	$565,455
	Haz-Mat	$1,200,000	$1,235,804
	Mechanical Service Vehicle	$300,000	$308,430
	Platform	$2,000,000	$4,112,400
	Pumper	$1,300,000	$13,056,870
	Pumper-Antique	$-	$-
	Rescue	$1,000,000	$1,130,910
	Tanker	$900,000	$1,850,580
Passenger Vehicles	Car	$30,500 - $47,300	$321,795
	SUV	$47,300 - $84,000	$703,220
	Pick-up Truck	$84,000 - $94,500	$555,696
Equipment	Self-Contained Breathing Apparatus	$16,000	$2,238,000

Asset Category	Asset Type	Unit Cost ($ / Unit)	Total Replacement Value
	Hose-100mm	$450	$138,000
	Hose-65 mm	$140 - $1,400	$193,000
	Hose-50mm	$140 - $1,400	$27,000
	Hose- 45mm	$140 - $1,400	$175,000
	Hose- 38mm	$140 - $1,400	$23,000
	Mobile Radio	$7,000	$371,000
	Portable Radio	$8,500	$854,000
	Cylinders	$8,300	$3,128,000
	Fire Truck Equipment	$140 - $144,000	$17,000
	Fitness Equipment	22000FS, 40000(JOC)	$1,743,000
	Bunker Gear Washer	$20,000	$249,000
	Rehab	$500,000	$540,000
	Rescue Equipment	$20,000	$540,000
	Bunker Gear Rak	$10,000	$244,000
	Bunker Gear	$2,500	$1,620,000
	Air Fill Stations	$81,000	$83,000
	Camera	$15,000	$309,000
	Truck Hoist	$15,000	$16,000
	Fire Station Equipment	$17,100 - $18,000	$39,000
	Hose Nozzles	$1,500	$193,000
	Blitz Fire Nozzles	$8,000	$206,000
	Megablast Drying Machine	$6,400	$83,000
	Other	$2,600- $112,000	$1,221,000
Fire and Rescue Total			**$52,792,990**

2.3 Age and Remaining Service Life

The asset age is based on the install year of the assets and the remaining service life (RSL) is estimated by using age and expected service life (ESL) in years. The ESL for each asset is obtained from the City's inventory record.

The ESL is defined as the period over which an asset is available for use and able to provide the required LoS at an acceptable risk (i.e., without unforeseen costs of disruption for maintenance and repair). The actual service life can vary significantly from the ESL. In some instances, a variation in expected vs. actual service life is evident due to the following factors:

- **Operating conditions and demands:** Some assets are operated intermittently or even infrequently or is being operated a lower demand than its design capacity, thus the actual operating "age" of the asset is reduced.
- **Environment:** Some assets are exposed to very aggressive environmental conditions (e.g., corrosive chemicals), while other assets are in relatively benign conditions, thus the deterioration of assets is affected differently.
- **Maintenance:** Assets are maintained through replacement of components, which prolongs the service life of the asset.

- **Technological Obsolescence:** Some assets can theoretically be maintained indefinitely, although considerations such as maintenance cost, energy inefficiency and new technologies are likely to render this approach uneconomical.

Figure 2-1 shows the average asset age and RSL as a proportion of average ESL weighted by replacement value for each asset type. Haz-Mat, air/light truck, and Rescue have progressed through less than half of their weighted average ESL, while the other types of emergency vehicles have consumed more than half of their ESL. It is noticeable that cars have exceeded their expected service life indicating the need to replace them in the short term. It should be noted that the RSL can be refined further for the emergency vehicles and passenger vehicles when mileage / hour information is taken into consideration.

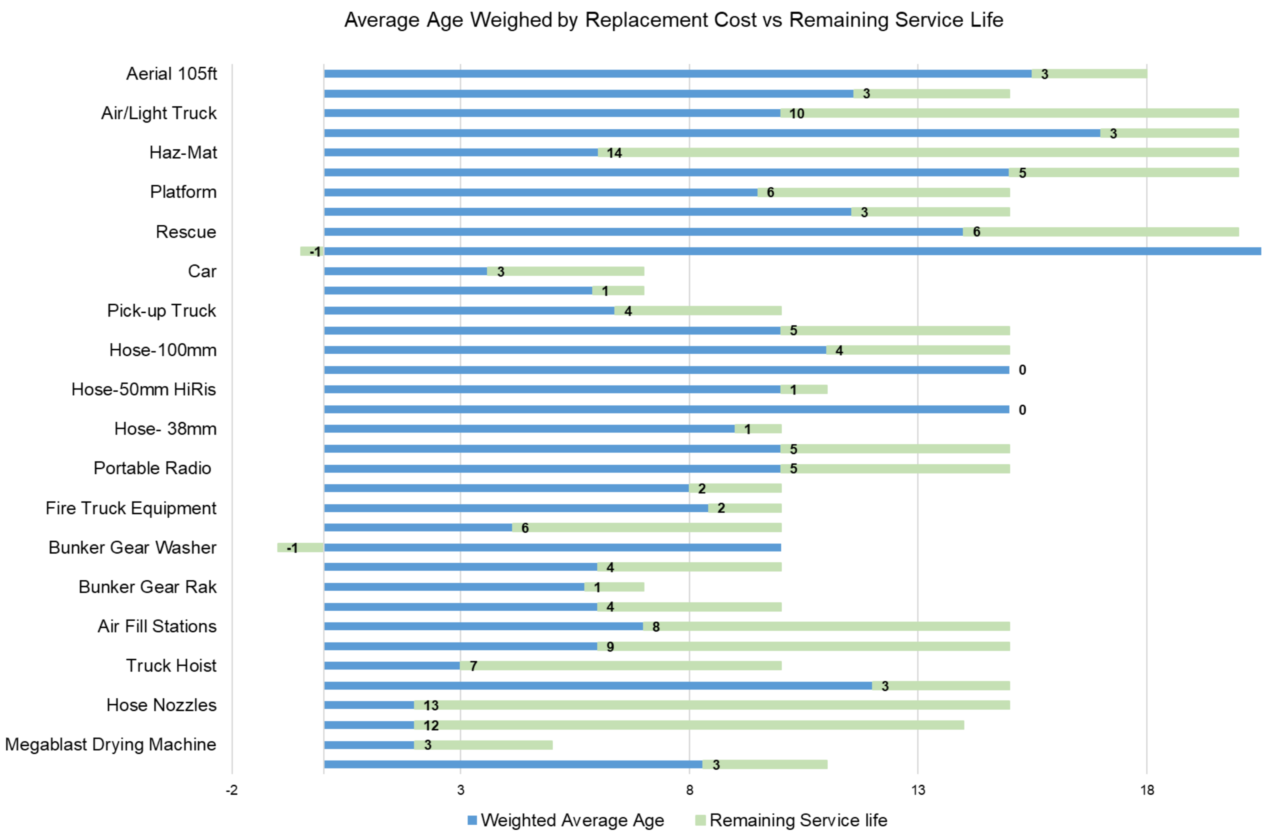


Figure 2-1: Fire and Rescue Asset Average Age and Remaining Service Life

2.4 Asset Condition

2.4.1 Age-Based Condition Assessment

Two-parameter Weibull distribution function was used to assess the current condition and to project the future condition of the City's Fire and Rescue. The Weibull distribution has been used extensively in reliability studies and lifetime prediction models in industries ranging from the automotive to the oil and gas industries; it provides a suitable distribution for this type of analysis.

The Weibull probability distribution provides a left-skewed distribution that rises slowly and diminishes quickly as the population is consumed. The underlying premise of the Weibull-shaped deterioration is that while some assets fail prematurely due to severe conditions or improper installation, other assets are very long-lived and function well beyond their theoretical expected service life. In order to perform a high order network-level analysis, it was assumed that assets would fail (and require replacement) within a deterioration envelope / curve approximated by a Weibull probability distribution. The two-parameter Weibull cumulative distribution has two parameters for scale and shape, as set out in Equation [1]:

$$f(x;\alpha,\beta) = e^{-\left(\frac{x}{\beta}\right)^{\alpha}} \quad [1]$$

Where: x = Age
α = Shape parameter
β = Scale parameter (or slope)

Table 2-3 presents the condition score ranges and the corresponding range of ESL and total life consumed.

Table 2-3: Age-Based Physical Condition Scale

Condition Score (minimum)	Condition Score (maximum)	Condition Rating	Range % of ESL Consumed	Range of % Operational Life Consumed
1.0	1.5	Very Good	0% – 71%	0% – 47%
1.5	2.2	Good	72% – 84%	48% – 56%
2.2	2.8	Fair	85% – 92%	57% – 60%
2.8	5.0	Poor	93% – 100%	61% – 100%

2.4.2 Condition Summaries

Figure 2-2 provides a summary of the condition weighted by replacement value for Fire and Rescue assets. It shows that 59% of the assets are in Good to Very Good condition. However, 23% of the assets are in Very Poor condition indicating that they have reached or exceeded their ESL and require to be renewed or replaced in the short term.

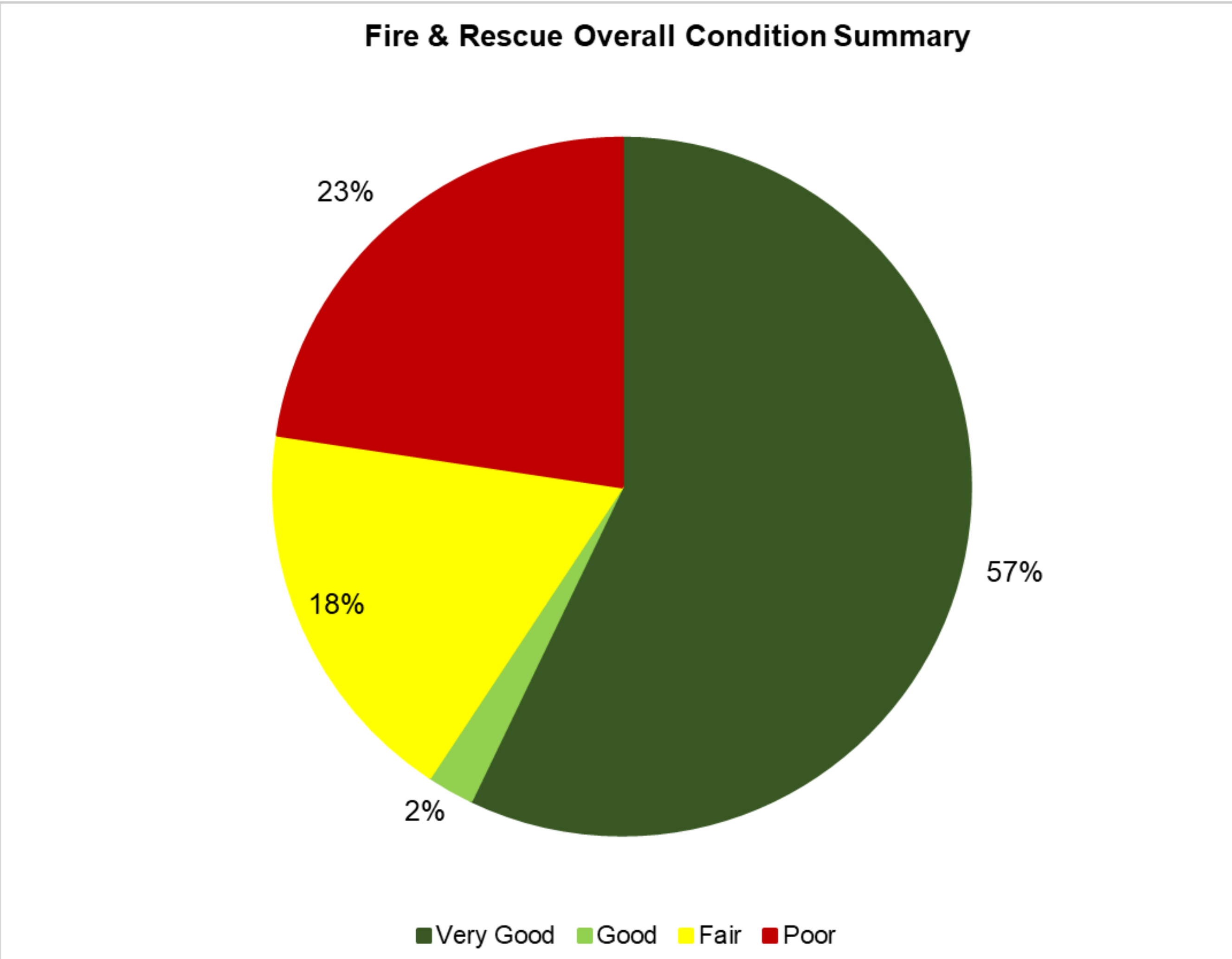


Figure 2-2: Fire and Rescue Asset Condition Summary

Figure 2-3 presents the condition distribution by Fire and Rescue asset types weighted by replacement cost. Approximately 48% of the City's emergency response vehicles and equipment are in Very Good condition, while 26% of the emergency response vehicles are in Poor condition approaching their expected replacement date. About 80% of the equipment assets are in Very Good condition. And about 58% of passenger vehicle assets are in Very Good condition.

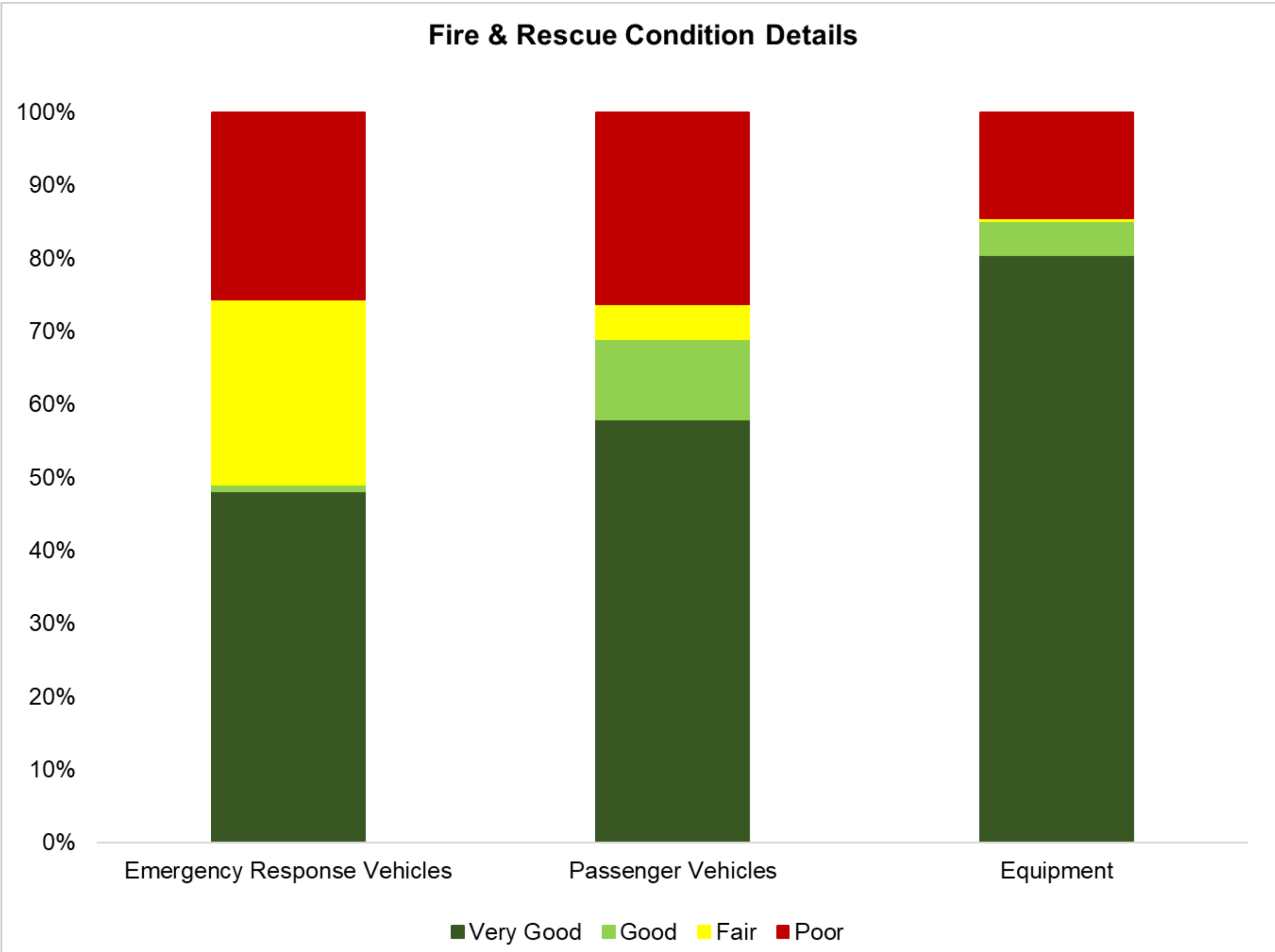


Figure 2-3: Distribution of Fire and Rescue Asset Condition

3. Levels of Service

3.1 Purpose

Levels of Service (LoS) supports every aspect of the overall AM System as shown in **Figure 3-1**. The objective of establishing clearly defined service levels is to help the City meet stakeholder values, achieve its strategic goals, make informed risk-based decisions, and implement effective asset lifecycle activities.

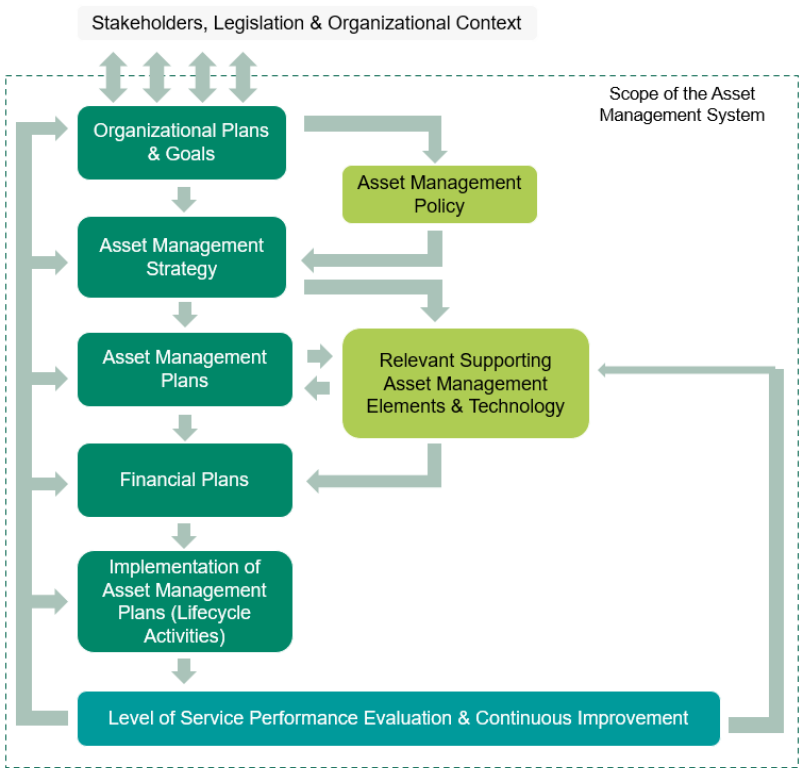


Figure 3-1: LoS within the AM System

In the City's experience, documenting LoS is a proven practice that will enable the City to:

- Link corporate strategic objectives to customer expectations and technical operations.
- Balance customer needs and expectations while evaluating the effectiveness of operations and whether the right LoS is being provided at the right cost.
- Transition from an "Asset Stewardship" approach that focuses on making decisions based on maintaining assets in an acceptable condition to a "Serviceability" approach that is geared towards making decisions based on balancing the costs, risks, and goals for the LoS being provided by the City's assets.
- Communicate the physical nature of infrastructure that the City owns and is financially responsible for while promoting the use of LoS to enable effective consultation with stakeholders regarding alternative funding options according to desired LoS outcomes.
- Make recommendations on strategies that the City can take now to minimize future renewal costs while ensuring that adequate LoS can be delivered without burdening future generations.
- Assess internal (e.g., program changes) and external (e.g., climate change) factors that have the potential to impact the City's ability to deliver services and how these factors may impact the LoS being provided.
- Implement a corporate continuous improvement program to further optimize AM across all service areas.

The O. Reg. 588/17 requires that all AMPs include information about the LoS that the City proposes to provide, the activities required to meet those service levels, and a strategy to fund those activities. The deadline for formalizing these LoS requirements is July 1, 2025 (see **Section 1.3**).

Successful AM programs aim to achieve targeted service levels through customer-based decision making. To achieve this, the City considered a customer-centric approach, where the customer is at the heart of every decision from development to implementation, consultation, and roll-out of the LoS Framework (**Figure 3-2**).

There are two types of LoS measures: Customer LoS (also called "Community" LoS) and Technical LoS. Customer LoS are recorded in a manner that attempts to describe the LoS in terms of what is actually being provided to the customer (i.e., the public) and how the customers experience the service. It is important to note that customers are not concerned with the specific operating requirements of the assets that provide the service, but rather the value they obtain from the operation of the assets. To achieve Customer LoS there needs to be line of sight between the value delivered and how that value is realized. This is the purpose of Technical LoS which attempts to describe how the City will provide and meet the expected Customer LoS.

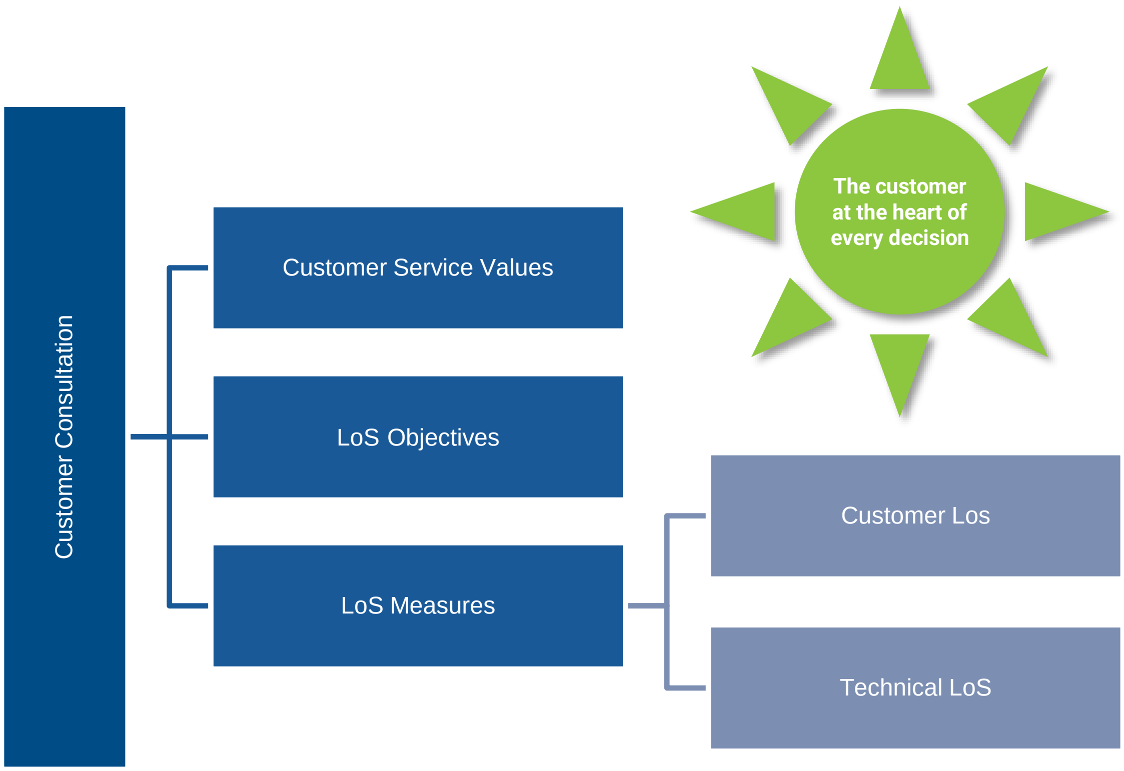


Figure 3-2: The LoS Framework Customer-Centric Approach

The LoS Framework was primarily conceived through a collaborative workshop process. In 2020, four workshops with City staff were conducted across each of the fourteen service areas.

The following outcomes were achieved during each service area workshop:

- Staff were oriented as to the purpose and importance of establishing a consistent LoS Framework;
- Stakeholders were identified, including their expectations, interests, and any regulatory requirements;
- Customer service values were established and reviewed;
- LoS objectives were established for each customer service value;
- Staff provided several performance measures that are currently being tracked as well as those that the City would like to track in the future;
- Where information was available, current performance, targets, and data sources were documented; and
- Growth and shifts in future demand were discussed across the City's service areas.

3.2 Objectives

Defining LoS objectives is important for drawing a line of sight between the City's corporate objectives and the tangible asset performance outcomes. To do so, the LoS objectives must take into consideration stakeholder

interests to develop asset performance measures that aim to meet the needs and expectations of the community. By doing this, the City will ensure that their assets are striving towards optimal performance, not only operationally, but economically, socially, and sustainably as well.

Every stakeholder has certain interests in the service being provided and in general, these interests can be categorized into six universal stakeholder values, as shown in **Table 3-1**. Each universal stakeholder value is also assigned a corporate LoS objective.

Table 3-1: The City's Values and LoS Objectives

Customer Value	LoS Objective
Quality and Reliability	The service is delivered with a high standard of excellence, and the service is available when needed.
Affordability	The cost of the service is delivered in a financially sustainable manner and does not burden customers.
Environmental Sustainability	The service is delivered in a manner that does not compromise the ability of future generations to meet their needs.
Access and Capacity	Customers can easily access the service with minimal inconvenience.
Health and Safety	The service is delivered with minimal health and safety impacts.
Responsiveness	Customer service requests are responded to efficiently and in a timely manner.

3.3 Stakeholders and Their Interests

A stakeholder is any person or organization that can affect, be affected by, or perceive themselves to be affected by a decision or an activity. Stakeholder analysis is the process of understanding stakeholder needs, expectations, and perceptions relative to the stakeholder's level-of-interest and level-of-influence over the organization. An organization typically engages with their stakeholders to:

- Establish which activities or services matter most to them.
- Understand their risk appetite and risk threshold.
- Understand their willingness to pay for services.

Stakeholders can take many forms and may be internal (i.e., staff, Council) or external (i.e., the public, regulatory agencies, suppliers, neighbouring municipalities, etc.) to the organization. Historically, only service recipients who pay for City services would be considered customers; however, today customers can take many forms and should include any entity that has a legitimate interest in the service being provided. In addition to service recipients (i.e., the public), this may include:

- **Regulatory Agencies** – Stakeholders that set standards, compliance regulations or other legislation that govern service delivery.
- **Neighbouring Municipalities** – Other communities that are adjacent to the City and are affected by or have an interest in City services.

3.4 Level of Service (LoS) Performance Measures

A documented suite of LoS performance measures enables a common understanding of the service delivery that the City's customers currently receive, and the associated cost of maintaining infrastructure assets to provide the service. Having these performance measures set at the appropriate levels within the City ensures alignment from the corporate vision, to asset investment decisions, and to day-to-day operational activities. When establishing LoS performance measures it is important to keep in mind the "SMART" acronym, as follows:

- **S**pecific, easily evaluated and understood.
- **M**easurable, quantifiable, and easily collectable to ensure ongoing data availability.
- **A**ttainable, so that they work to motivate as opposed to discourage.
- **R**elevant, in that they relate and align with a specific goal.
- **T**ime-Bound, measured over a specific period, which is typically annually for benchmarking.

There are two types of LoS performance measures: Community LoS and Technical LoS. Community LoS are recorded in a manner that attempts to describe the LoS in terms of what is being provided to the community (i.e., the public) and how the customer experiences the service. Community LoS are qualitative, non-technical, and are driven by the municipality's strategic AM objectives. Community LoS are not concerned with the specific operating requirements of the assets that provide the service, but rather the value they obtain from the operation of the assets. To achieve Community LoS, there needs to be line of sight between the value delivered and how that value is realized. This is the purpose of Technical LoS which attempts to describe, quantitively, how the City will provide and meet the expected Community LoS.

3.5 LoS Performance Results

A summary of the City's current and proposed community and technical service levels for the Fire and Rescue assets are documented in **Table 3-2.**

Table 3-2: Community and Technical Service Levels

Level of Service	Current Performance	Current Service Level Target	Proposed Service Level Target
Percentage of Assets with Condition Rating of Fair or Above	76%	50%	No Change
Percentage of Equipment Meeting Provincial Regulations	100%	100%	No Change

Measured in the most recent Citizen Satisfaction Survey conducted by Ipsos, the percentage of respondents satisfied with Fire Services was 97%. Additionally, the VFRS (Vaughan Fire and Rescue Services) Response Area Map is illustrated in **Figure 3-3**.

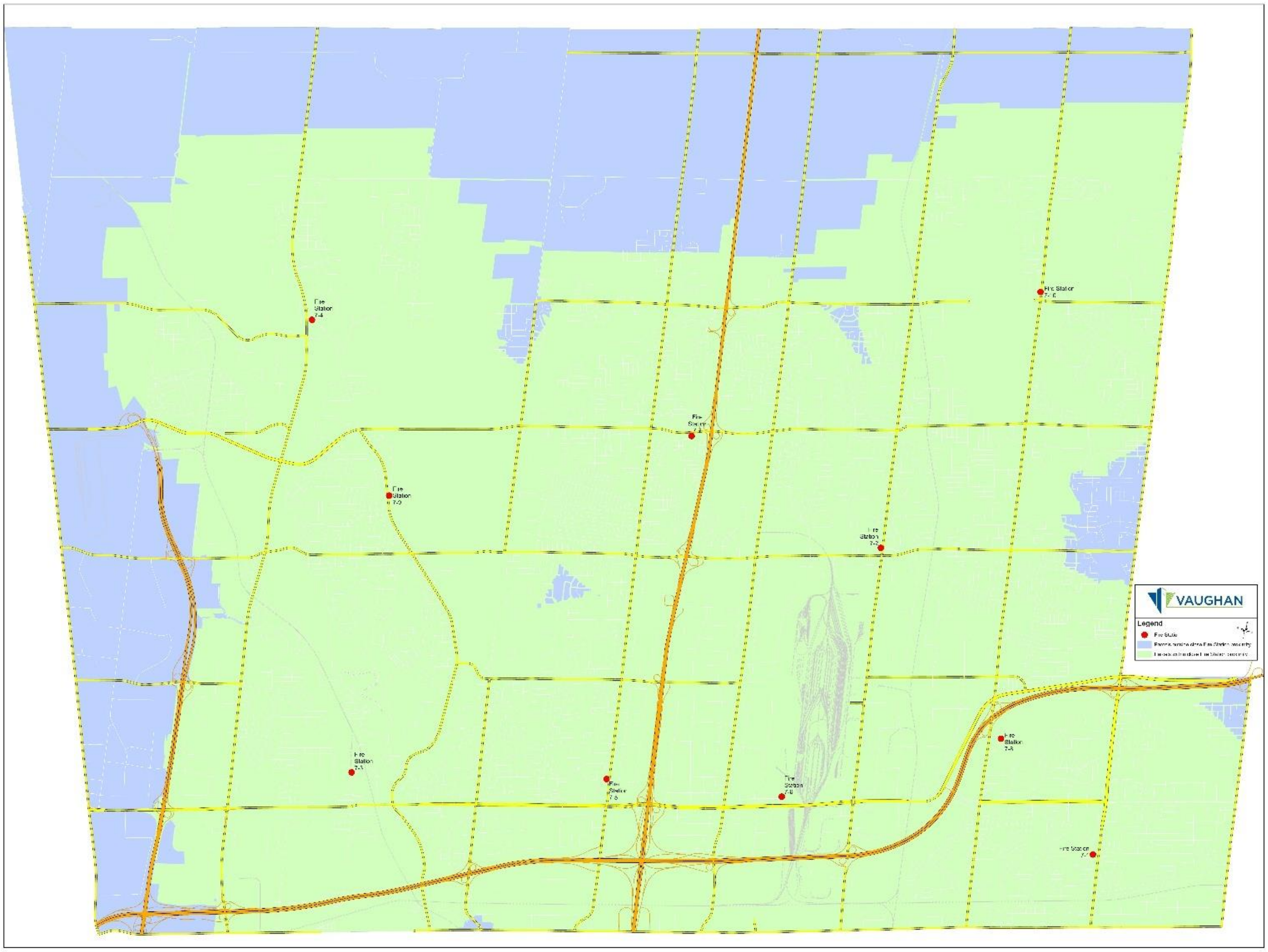


Figure 3-3: VFRS Response Area Map

3.6 LoS Performance Targets

Establishing LoS targets is an important part of continual improvement and performance management. Without targets, it is difficult to ascertain whether goals are being met, or the extent of the gap if they are not. Incorporating targets into the City's LoS Framework helps to ensure that targets are reasonable, aligned with customer expectations, and evaluated on an objective basis by considering cost-benefit trade-offs.

One of the key challenges in setting targets in a municipal environment is that they can often become biased and/or politically motivated. Therefore, it is important to review LoS targets with stakeholders. An important aspect of evaluating LoS targets is determining how willing the user is to pay for the service. Regulatory requirements are an exception; however, they only provide the minimum service standard. Cost is still an important parameter to consider when assessing the merits of service improvements.

To deal with the financial realities, it is necessary to:

- Calculate how much the service costs based on current LoS.
- Determine the cost associated with varying the LoS.
- Assess the customers' willingness to pay.

3.7 Future Demand Drivers

Understanding internal and external factors that may impact service delivery (positively or negatively), such as staff resources, climate change, and shifts in population is a critical component for managing desired service levels in a sustainable manner. It is important to proactively develop effective, long-term strategies that are suitable for the City's unique economic, environmental, and social landscape.

In most cases, the factors presented in **Table 3-3** may result in a negative impact on the City's existing service levels, unless additional funding or resources can be allocated to meet future needs; however, in some instances, such as technological advancements and higher regulation standards, the impact on service delivery may actually improve as a result.

Table 3-3: Potential Future Demand Drivers

Anticipated Issue	Potential Impact on Service Delivery
Availability of skilled labour	While the availability of skilled labour is a challenge, the City does not have the physical capacity to complete all of the preventative maintenance and repairs internally. As a result, a select group of assets is sent to third party vendors for preventative maintenance when capacity maximums are reached. The City is currently relying on vendors since they have the resources and required expertise. Furthermore, there are only a handful of vendors with the desired qualifications that the City requires. The City has a large municipal fleet and is finding that only a few vendors are bidding due the commitment required for maintaining a large fleet.
Technological advancements	As equipment becomes more sophisticated, with proprietary technology, the cost and complexity of keeping up with the technology presents an ongoing challenge. Additional space and ongoing technological training is required for servicing these assets in-house.
Fleet Electrification	To achieve carbon neutrality and the carbon resiliency goals laid out in the 2019 Community Sustainability Plan - Green Directions Vaughan, the City is moving towards the electrification of its fleet, where/when feasible. In addition, there is a need for charging infrastructure, dedicated for fleet use, to support this transition.
Funding	Fleet is tasked with replacing vehicles and equipment even when funding is limited. As a result, the department has increased costs to repair vehicles across the City. In addition, the fleet reserve fund is not topped up annually to a level that is on par with the expected service life and replacement needs of the assets. As such, asset replacements are being deferred each year, putting additional stress on day-to-day operations.

By considering potential drivers, as well as any issues that may pose a threat to meeting future demand, the City has the advantage to proactively plan and prepare mitigation strategies.

Approaches for the City to consider include:

- Asset-based solutions (e.g., upgrading existing assets, providing new assets, etc.).
- Non-asset-based solutions (e.g., restricting usage, changing habits through education, providing service alternatives, etc.).

A hybrid solution often works well since every municipality has its own challenges and there is not a "one solution fits all" approach. It is important that the City remains aware of its internal and external situational context and modifies its approach and mitigation strategies in a consistent, periodic, and well documented manner.

4. Asset Lifecycle Strategies

Asset lifecycle management focuses on the specific activities we must undertake during all phases of the asset lifecycle. By considering entire asset lifecycles the City can ensure sound decision making that consider present and future service delivery needs.

The overarching goal of life cycle management is to maximize the long-term benefits and services that our assets deliver while minimizing the associated costs and risks in the long run. Every asset has a life cycle cost, which is the total cost of all the activities undertaken throughout its service life. The following sections describe activities across the life cycle of assets.

4.1 Lifecycle Activities

Any responsible owner of assets such as the City has a desire to preserve the condition of their existing assets for as long as possible, by maintaining or even extending their design lives through routine activities such as maintenance and active intervention. The City is continually acquiring infrastructure assets, but these assets require increased funding for operation and maintenance as they age. The City is also responsible for the replacement of deteriorated assets as long as the service is required. While individual assets may have a useful life that can be predicted in years or decades, the service that the asset provides could be for a substantially longer duration (perhaps in perpetuity). Part of the purpose of the AM planning process is to fully understand and predict the long-range financial requirements for the City's infrastructure to facilitate planning and resource management in the most cost-effective manner possible. **Figure 4-1** illustrates how costs typically accumulate over an asset's life. It is worth noting that the accumulation of the ongoing operations and maintenance, refurbishment and disposal / replacement costs is many multiples of the initial acquisition costs. A key and important take-away from **Figure 4-1** is therefore for the City to fully understand the entire life cycle costs before proceeding with asset acquisition.

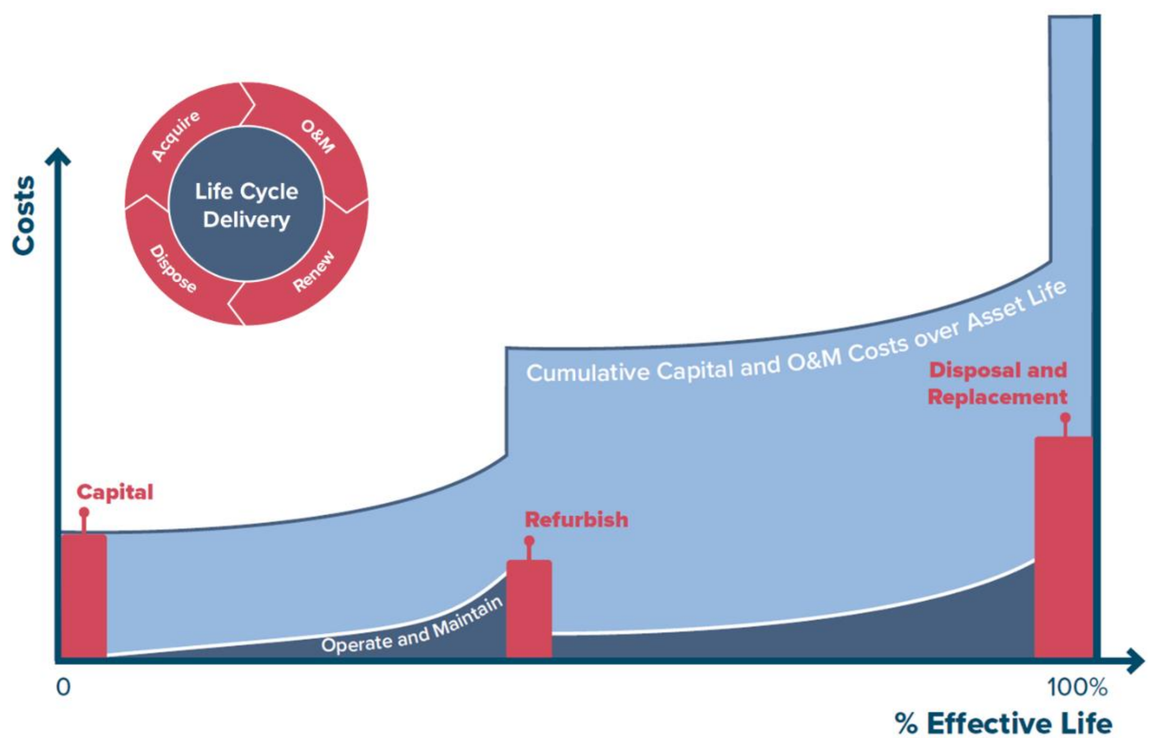


Figure 4-1: Life Cycle Cost Accumulation Over Asset Life

4.2 Asset Acquisition Strategies

City assets are acquired through public procurement processes based on replacement schedules or and departmental growth-related requests for new assets. The growth-related requests aim to meet the technical requirements for various user groups. Every department has its own capital budget in place and the City has cross-consultation processes for growth-related requests.

The City performs annual asset condition assessments; these are based on age, usage, working condition and replacement value of the asset. The number of assets acquired each year are driven by the needs of departments, replacement schedules and the available allocated budget.

To achieve carbon neutrality and the carbon resiliency goals laid out in the 2019 Community Sustainability Plan - Green Directions Vaughan, the City is moving towards the electrification of its fleet and is adopting technology to reduce pollution[1].

Looking towards the future, when acquiring new assets, the City should evaluate credible alternative design solutions that consider how the asset is to be managed at each of its life cycle stages.

Asset management and full life cycle considerations for the acquisition of new assets include, but are not limited to, the following:

- The asset's operability and maintainability.
- Availability and management of spares.
- Staff skill and availability to manage the asset.
- The manner of the asset's eventual disposal.

4.3 Operations and Maintenance Strategies

As new infrastructure is commissioned, the City accepts the responsibility of operating and maintaining the infrastructure according to operation and maintenance (O&M) standards to ensure that the infrastructure is safe and reliable. Operations staff provide the day-to-day support required to operate infrastructure. In few cases, operation costs are minor, but for most there are significant increases.

Maintenance expenses include periodic preventive maintenance to ensure that the infrastructure can provide reliable service throughout the life of the asset and corrective maintenance that is required to repair defective assets as and when needed. Inadequate funding for O&M will have an adverse impact on the lifespan of assets. The O&M resources required in any period is a function of the current inventory of infrastructure and total O&M needs required for each asset. As the inventory of infrastructure grows, total O&M requirements will also grow.

Table 4-1 presents O&M actuals for the past five years and the overall five-year average O&M expenditures was $58.6M.

Table 4-1: Historic Fire and Rescue O&M Expenditures

Year	Total O&M Actuals
2024	$62,203,065
2023	$58,011,031
2022	$56,113,485
2021	$53,236,168
2020	$54,012,876
5-Yr. Average	**$58,942,900**

[1] Green Directions Vaughan

4.4 Renewal and Replacement Strategies

The third portion or phase of full life cycle costing relates to the renewal and replacement of infrastructure that has deteriorated to the point where it no longer provides the required service. Renewal cost is sometimes incurred during the life of an asset where an investment is made to improve the condition and / or functionality of the asset. Disposal and replacement costs are incurred at the end of an asset's life when it is disposed of and replaced by a fully new asset. It is vital that communities fully understand the looming obligations of infrastructure renewal or replacement and develop a strategy to respond in a manner that is fair and affordable.

For growing communities like the City, there has not been a historical need to forecast expenses that are not anticipated for decades. However, based on the experiences of more established Canadian cities (where vast inventories of old assets are now in dire need of renewal or replacement), it is vital that communities fully understand the looming obligations of infrastructure renewal or replacement and develop a strategy to respond in a manner that is fair and affordable.

4.5 Disposal and Decommissioning Strategies

There will inevitably come a point in time when an asset must be removed from service and, depending on the type of asset, there may be significant costs associated with its decommissioning and disposal. Factors that may influence the decision to remove an asset from service, include changes to legislation that cause the asset to be in non-compliance, the inability of the asset to cope with increased service levels, technology advances that render the asset obsolete, the cost of retaining the asset is greater than the benefit gained, or the current risk associated with the asset's failure is not tolerable. The current practices at the City look at disposal of Fire and Rescue at the end of their useful life.

Normally, major costs that may be incurred during disposal and decommissioning derive from the environmental impact of the disposal and, if required, the rehabilitation and decontamination of land. In some cases, there will be residual liabilities and risks to consider if a decision is made to partially abandon the asset as opposed to fully disposing of its components (e.g., leaving a non-functioning pipe in the ground, or an inactive building standing). For now, there is no formalized procedures in place at the City to track any environmental costs associated with Fire and Rescue disposal activities.

4.6 Capital Planning

Capital investment is to address community growth or changes, or to renew existing assets to maintain service levels. For the actual funding needs analysis, please refer to **Section 5**.

- **Life Cycle Cost Analysis Approach**. The City's analysis enables optimized decision making and mathematical deterioration modelling of infrastructure assets and the development of short, medium and long-term forecasts of renewal and replacement costs of a number of decision criteria and the ability to compare different intervention options to find the optimal solution in terms of timing and the intervention option chosen.
- **Forecast Periods.** The City aims to develop Short- to Medium-Term and Long-Term capital plans. Typically, short to medium-term capital plan identifies the activities required to meet current and future demand, the cost of those activities and a financing approach. It is developed or renewed every three to five years and should coincide with regulations on short to medium-term expenditure planning. A long-term plan can serve as part of Strategic Asset Management Plan, which indicates what will be spent, by service areas, over a set period of time. Long-term plans tend to focus only on costs.
  Consistent with the approach of other asset management plans, the analysis periods for funding need assessments are 20 years.

4.7 Asset Prioritization

4.7.1 Risk Assessment

Infrastructure-related risk exposure is assessed based on the combined consideration of probability and consequences of an asset failure, which is used to drive the selection and prioritization of appropriate action, based on risk tolerance thresholds and funding availability. Understanding the risk exposure for a given set of assets allows the City to identify where they are most exposed to risk, and to target their investments to most effectively reduce that exposure.

In addressing risk for infrastructure assets, the first step in the analysis is to identify assets that are most critical to the business. Critical assets are those that will potentially have the greatest impact on service delivery should they fail. It should be noted that the parameters, criteria and weighting factors area starting point, and should be reviewed and modified to reflect the priorities of the City on an ongoing basis.

The fundamental principle of consequence (or criticality) models is that they evaluate the relative importance of assets based on select criteria. The approach to risk analysis within this project utilizes a triple-bottom-line assessment approach utilizing the following four criticality indices:

- **Economic** – influence of the asset's failure on monetary resources
- **Operational** – influence of the asset's failure on operational ability
- **Social** – influence of the asset's failure on society
- **Environmental** – influence of the asset's failure on the environment

By applying specific indices, the risk assessment framework generates a risk (or priority) score for each asset. The risk score is a rating of the asset based on the detailed assessment of the likelihood and consequence of failure based on a number of key parameters. All parameters are then equated using equation [4].

$$Risk = Likelihood\ of\ Failure \times Consequence\ of\ Failure \qquad [4]$$

Based on this principal, the risk associated with a given asset's failure can be managed by limiting the likelihood of this occurring, or the impact realized, should it occur.

Consequences of Failure (CoF) reflect the relative "impact" of a given asset's failure. While traditionally these have been looked at as purely economic terms (i.e. repair cost, loss of revenue, etc.), the truth is that investment decisions are often driven by non-economic factors. Understanding both the economic and non-economic

impacts associated with loss or limitation of service help in categorizing an asset's "criticality" and justifying infrastructure decisions in a consistent, defensible manner.

4.7.2 Analytical Logic to Sequence Interventions

The asset criticality score can be used to prioritize projects within a funding constrained environment. **Figure 4-2** illustrates this logic of carrying unfunded needs to the next year in the period where they receive a higher probability of receiving funds based on their criticality score.

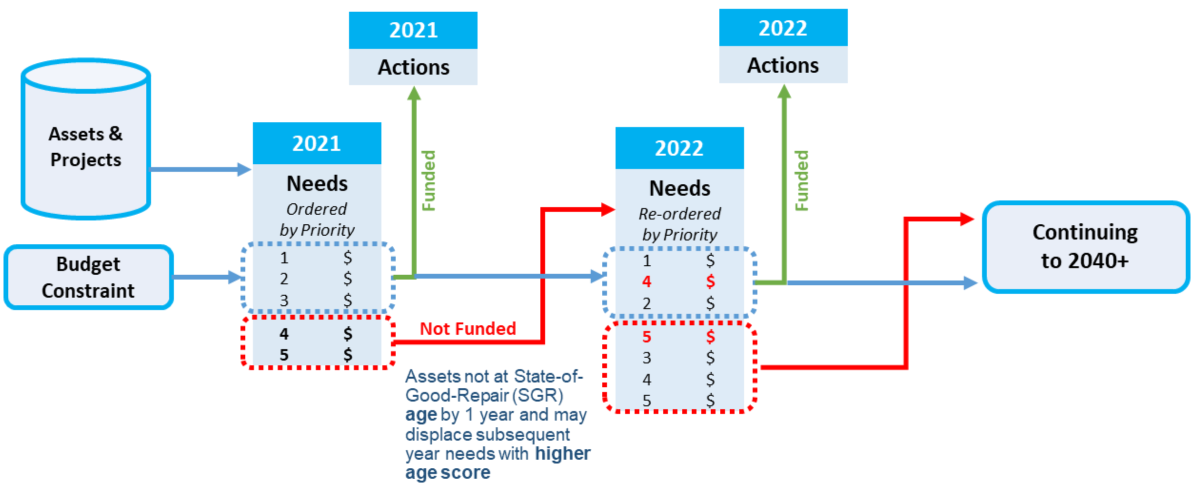


Figure 4-2: The Role of Criticality to Prioritize Projects Within A Funding Constrained Environment

4.8 Financial Planning

4.8.1 Financial Policies

The City has taken the initiative to establish financial asset management policies in 2018, which provides directions on how financial principles apply to assets to ensure that service goals are met. The policy aligns the business model of AM with the City's financial planning, financial reporting, cost management, treasury and taxation functions. The City will integrate findings from the AM Plans into its long-term financial planning and budgeting processes. Sound financial analysis will be encompassed in AM planning in order for the AM Plan to be a sought-after guide for employees in budgeting and financial planning.

4.8.2 Financial Analysis

Financial analysis activities for asset management is centered on two essential quantities: revenues and expenditures. Revenues can come from many sources. Through asset operations, the City generate its own source revenues from taxes, development charges, etc. Expenditures are all the direct and indirect costs associated with capital, operating and maintaining, and disposing of assets.

Assessing the financial implications supports in the decision-making when there are competing priorities and trade-offs between projects. Financial analysis provides a better picture of how to fund the capital plan and make critical decisions about service delivery while providing the greatest benefit for the community at the lowest cost.

4.8.3 Aligning the Financial and Non-Financial Functions of AM

ISO 55010[2] identifies the that the financial and non-financial functions of AM within organizations are generally inadequately aligned, as follows:

- **Financial Accounting Functions:** Focused on retrospective reporting of accounting / regulatory financial activities. However, there is a growing awareness in organizations of the need to focus on providing a managerial costing approach in order to support decision-making for the future.
- **Non-Financial Functions:** Have a limited understanding of financial accounting functions but are recognizing the need to improve their understanding of the financial implications of their activities.

The lack of alignment between financial and non-financial functions can be attributed to silos in an organization, including reporting structures, functional / operational business processes, and related technical data. Silos generally bring forth the necessary level of specialization. However, with a lack a communication between the silos, organizations are at risk of inefficiencies and errors in AM results, or AM failures due to a lack of alignment between AM staff and senior management. Financial and non-financial alignment needs to work both "vertically" and "horizontally", as follows:

- **Vertical Alignment:** Financial and non-financial asset-related directives by management are informed by accurate upward information flows, effectively implemented across the appropriate levels of the organization.
- **Horizontal alignment:** Financial and non-financial information that flows between departments (conducting functions such as operations, engineering, maintenance, financial accounting and management) uses the same terminology and refers to the assets identified in the same way.

Figure 4-3 presents the key elements in a framework to address the need to achieve the alignment.

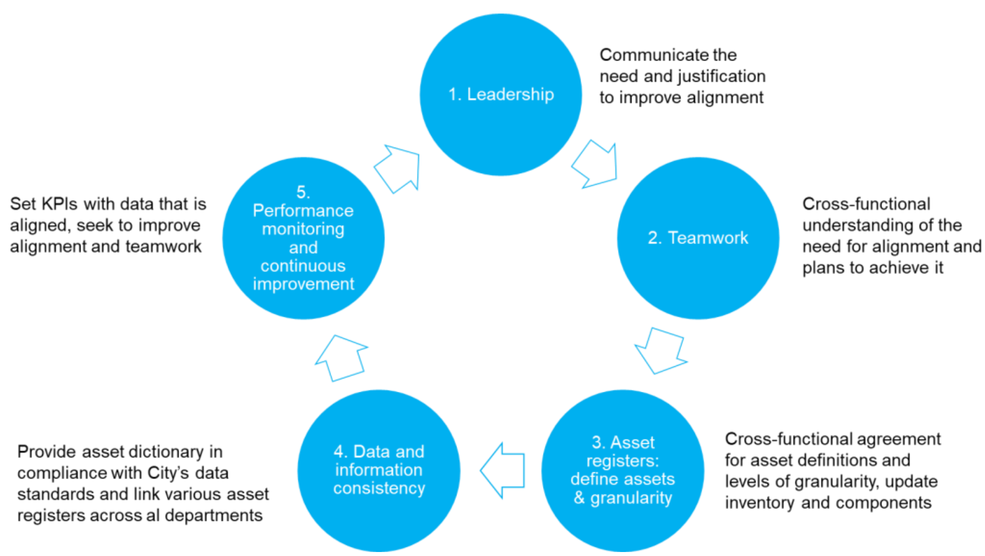


Figure 4-3: Key Elements of a Framework to Achieve Financial and Non-Financial Alignment

4.8.4 Long-Term Financial Planning

Strengthening the City's Asset Management planning according to the recommendations in Asset Management Strategy will improve the City's long-term financial planning, by accounting for whole life cycle costs as presented in **Section 4.1**. This includes all capital, annual operation and maintenance, and disposal costs over the planning timeframe, thereby aligning financial requirements with long-term level of service objectives.

The challenge is often one of agreeing on a timeframe for such planning, recognizing that the AM perspective is ideally focused on the asset life cycle, versus the political / election cycle that could be as short as a three to four-year Council term. Accordingly, financial and non-financial staff, as well as top management and politicians,

[2] International Organization for Standardization (2019): ISO 55010 - Asset management — Guidance on the alignment of financial and non-financial functions in asset management

should agree on a long enough timeframe to provide useful forward planning information that aligns the financial and non-financial perspectives, as presented in **Figure 4-4**.

Figure 4-4: AM Planning Alignment Across the Organization

The City should have an appropriate long-term financial planning process that achieves the following:

- Stimulates long-term strategic thinking and perspective for stakeholders and decision-makers.
- Can be used as a tool to prevent or predict future financial shocks and demonstrate financial sustainability.
- Demonstrates to internal and external stakeholders that the organization has a financial strategy in place to meet their demands, now and in the future.

The long-term financial planning process needs to involve financial and non-financial staff working together to combine the important elements of strategy development, asset management planning and financial forecasting (**Figure 4-3** and **Figure 4-4**).

5. Funding Need Analysis

The lifecycle analysis was implemented in an MS Excel Asset Lifecycle Model, which integrated asset inventory, age, ESL, replacement values, and condition to create a theoretical asset replacement cycle for each Fire and Rescue asset. The asset reinvestment forecasts prepared for this assessment are estimates of what it will cost over the next 20 and 50 years to sustain the City's Fire and Rescue assets.

The annual reinvestment need for the Fire and Rescue assets were based on age and ESL (i.e., replacing assets that has exceeded their ESL) in 2024 dollars.

It should be noted that the nature of this type of analysis is based on a wide range of data inputs, currently available information, and a number of assumptions, and is therefore at best a high-level estimate of future funding needs.

5.1 20-Year Reinvestment Funding Need

The average annual reinvestment rate for the City's Fire and Rescue assets are approximately $4.14M over the next 20 years in 2024 dollars. This is equivalent to a total of approximately $82.8M over the next 20-year period, as presented in **Figure 5-1**.

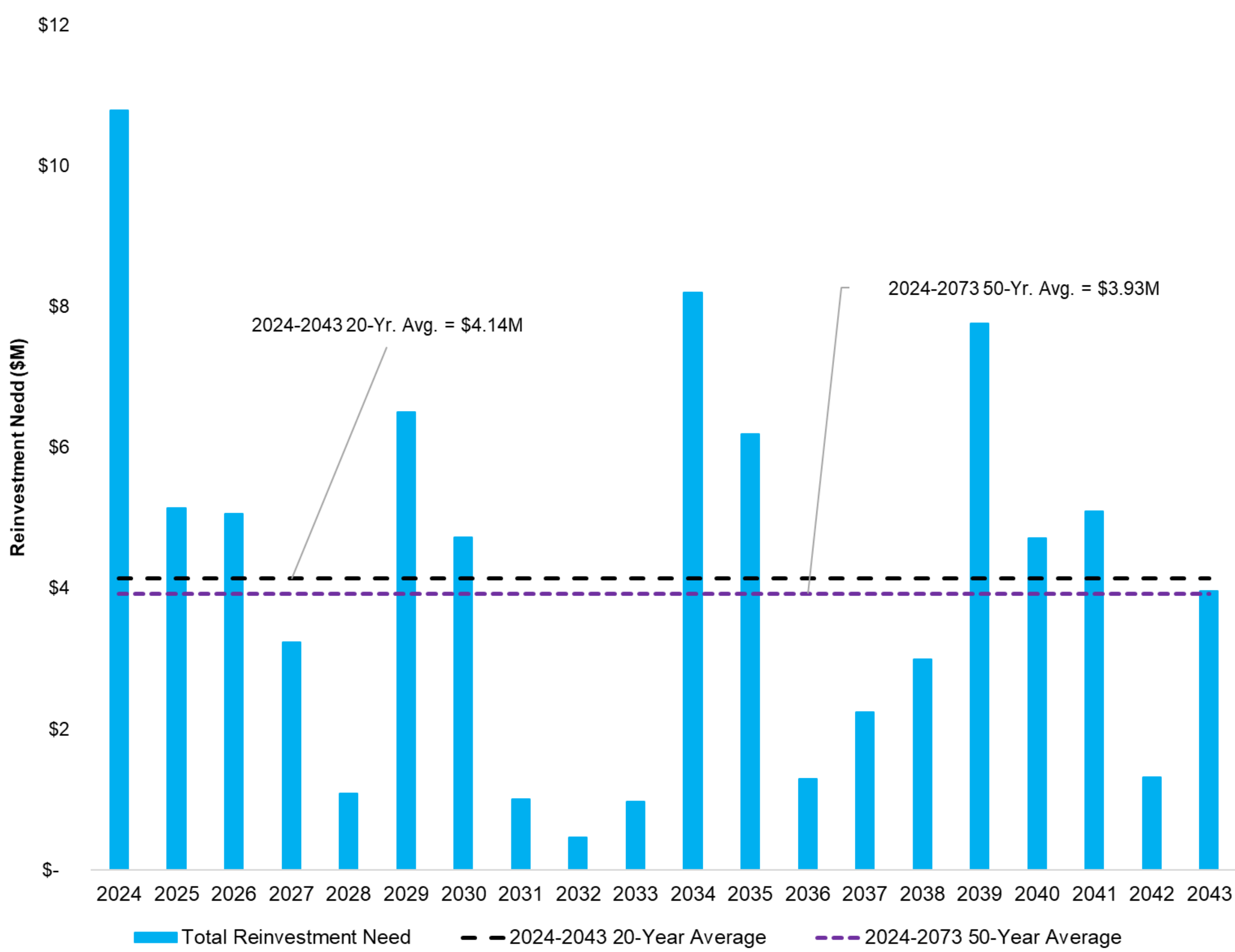


Figure 5-1: Fire and Rescue 20-Year Reinvestment Need

As shown in **Figure 5-2** in 2025, there is a significant increase in the reinvestment needs which is primarily due to the aged emergency response vehicles that are due for replacement. Looking ahead to the year starting 2034, the City is recommended to prepare for the increased reinvestment need for emergency response vehicles and equipment as they continue to age and start to approach and exceed their respective ESL's.

The detailed reinvestment needs for Emergency Response Vehicles, Passenger Vehicles, and Equipment assets are presented in **Table 5-1** in 2024 dollars.

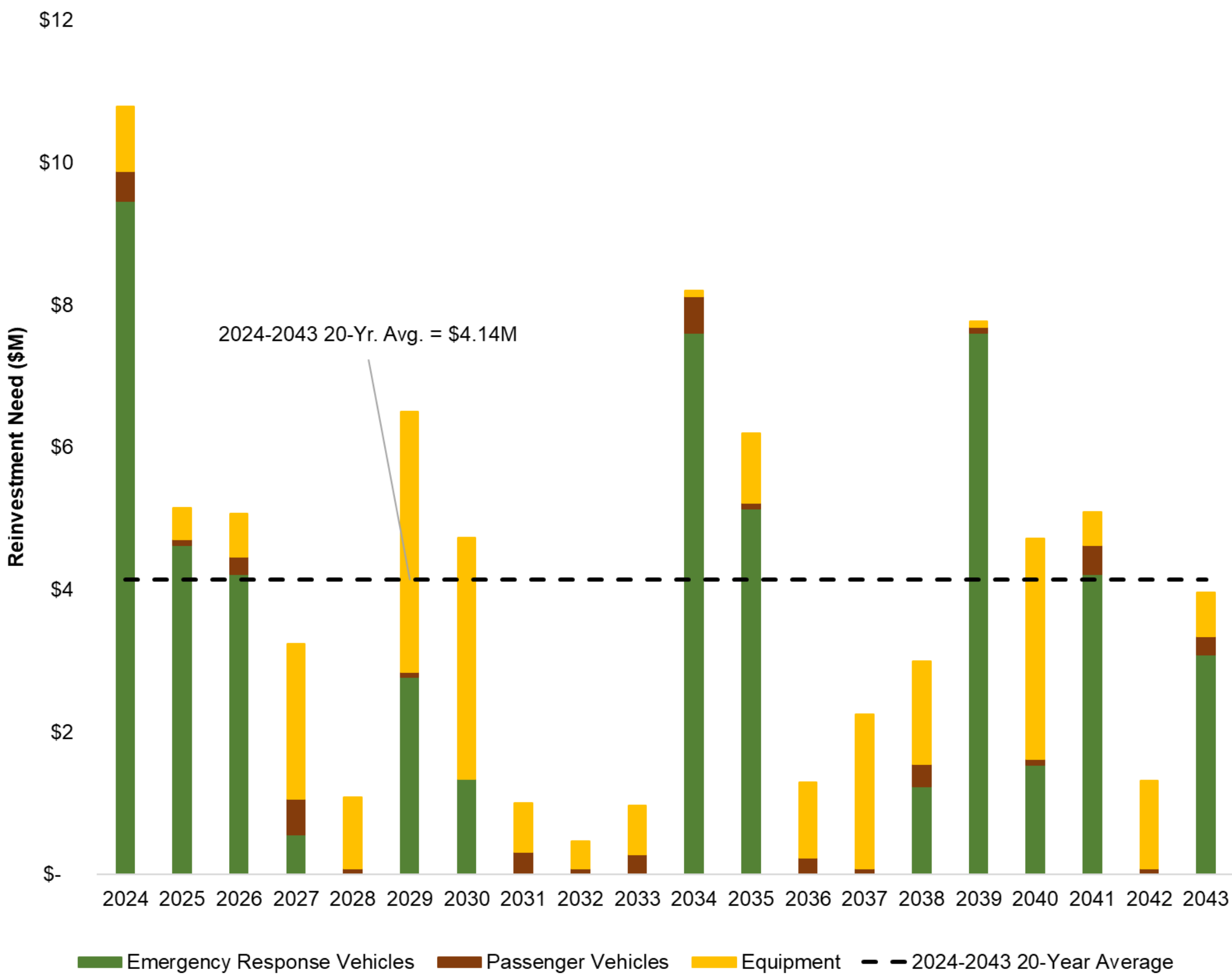


Figure 5-2: Fire and Rescue 20-Year Reinvestment Need Details

Table 5-1: Fire and Rescue 20-Year Total and Annual Average Reinvestment Need

	Emergency Response Vehicles	Passenger Vehicles	Equipment	Total
Annual Average Need	$2,671,000	$209,000	$1,259,000	**$4,140,000**
20-Year Total	$53,412,000	$4,186,000	$25,189,000	**$82,787,000**

5.2 Full Funding Need Profile

Figure 5-3 shows a full picture of the City's Fire and Rescue funding need forecast over the next 20 years, which provides the City the full funding requirements to perform effective financial planning activities. The total annual reinvestment rate from **Figure 5-1** was overlaid with the City's Fire and Rescue O&M cost, in 2024 dollars.

Fire and Rescue assets require approximately $59M annually over the next 20 years for O&M, the equivalent of a total of $1.18B in 2024 dollars. As such, with the addition of O&M, the total average annual funding need for the City's Fire and Rescue assets increases to approximately $64M annually, for a total of $1.28B over the next 20-year period.

It should be noted that the O&M cost covers the labour cost for the firefighters at the City, which on average accounts for more than 86% of the total O&M expenditure.

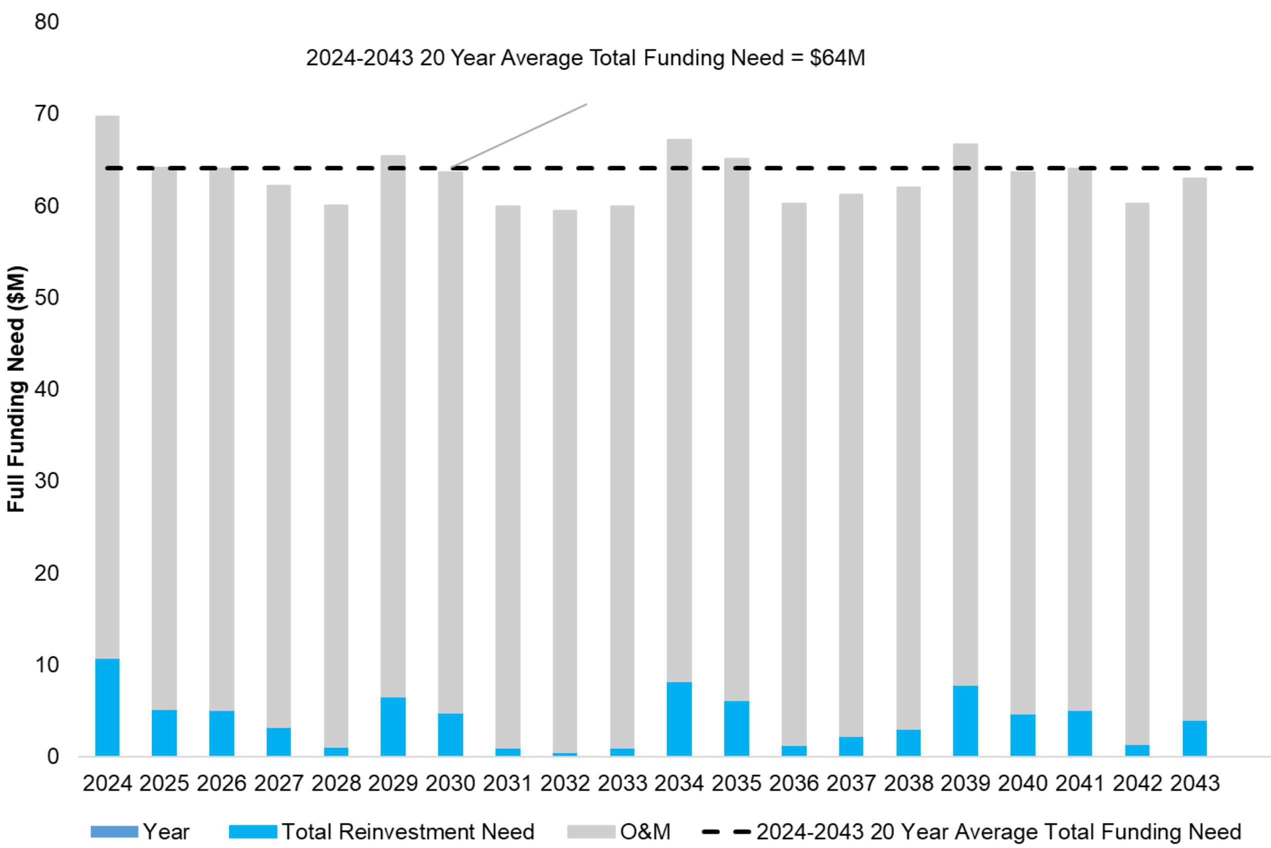


Figure 5-3: Fire and Rescue 20-Year Capital Investment and O&M Cost Forecast

5.3 Infrastructure Reserves Funding Forecast

Reserve funds are important tools in the planning and management of the City's financial resources and provide a strong indicator of the City's overall financial health and are fundamental to the City's long-term financial sustainability. The City is committed to maintaining healthy reserve fund balances which are collected through various means (i.e., development charges, contributions, dedications, taxation, etc.).

There are specific infrastructure reserves for the tax-supported service areas of Roads, Facilities, Parks, Fleet and Fire. These reserves contain funds set aside through annual contributions from taxation to help pay for the repair and replacement of infrastructure assets. Like many municipalities across Canada, Vaughan is facing increased costs associated with maintaining aging infrastructure. Corporate Asset Management Plans for both core and non-core assets suggest the City's infrastructure deficit is large and growing. The City has continued with robust strategies and plans by developing a comprehensive Long-Range Fiscal Plan and model, which was used to better inform the 2025 and future budgets by providing information about the financial requirements to sustain growth, delivery of services and the community's infrastructure needs.

Prudent financial planning requires ongoing contributions to Fire reserves to fund the repair and replacement of infrastructure. To achieve this, continued operating and infrastructure investments are critical to ensure the City's Fire assets remain financially sustainable now and into the future. This objective is supported by continuing to build service area infrastructure reserves. The 2024 reserve contribution for Fire reserves totalled $3.5M with the City being committed to ensuring the financial sustainability of its Fire assets.

The City's Asset Management Plans assess average reinvestment requirements over the next 20 years for the City's assets, including Fire infrastructure. Annual reserve contributions should generally be in line with the asset reinvestment requirement to ensure sufficient funds are set aside for asset rehabilitation and replacement needs.

For the Fire service area, the forecasted 20-year average funding need is $4.1M. In comparison, the average annual funding forecasted over the next 10 years is estimated to be $2.9M representing a funding coverage of 71% as illustrated in Error! Reference source not found.. The funding sources in this forecast are limited to annual reserve contributions and capital from taxation. Other available funding sources not included are grants, which would mitigate any infrastructure funding gaps.

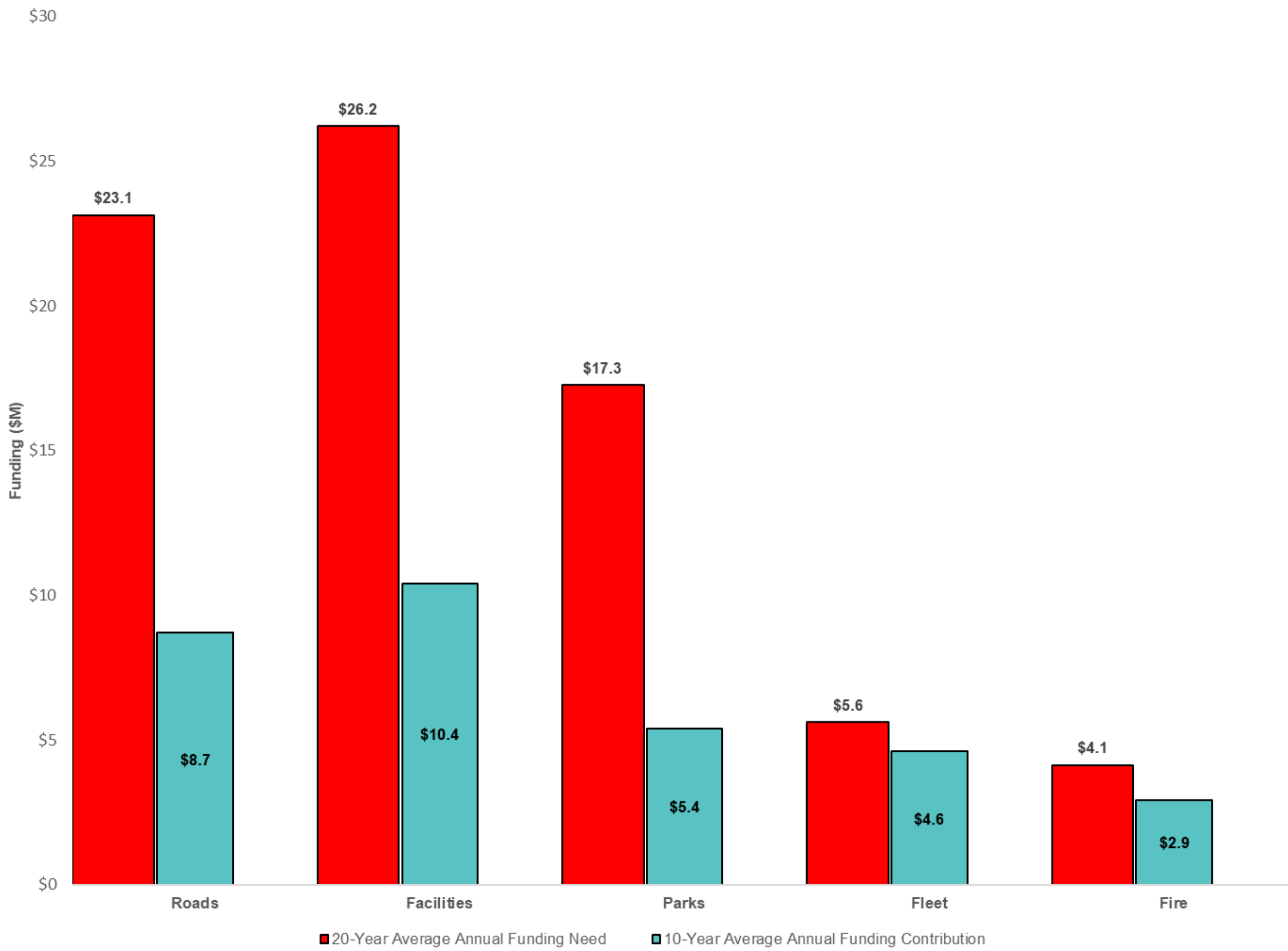


Figure 5-4: Coverage of Average Annual Funding Needs for Tax-Supported Service Areas

Revisiting the timing and scope of capital projects, optimizing the use of existing funding tools and revenue sources, such as debt and dedicated contributions to capital reserves, can help increase the City's capacity to begin to close an infrastructure funding gap.

5.4 Growth-related Assets Funding Need

The City completed a Long Range Fiscal Plan (LRFP) in 2022, which included a model to support planning to meet Fire infrastructure needs as the City's communities continue to grow. This model analyzed the city-wide infrastructure needs to identify the required infrastructure that will meet future servicing demands. The model assessed the existing and future servicing needs and provides servicing recommendations to meet the City's growth plans. Based on the model, the forecasted funding need estimates for the construction of new Fire assets out to 2031 is illustrated in Error! Reference source not found. with a primary funding source for these needs being Development Charges.

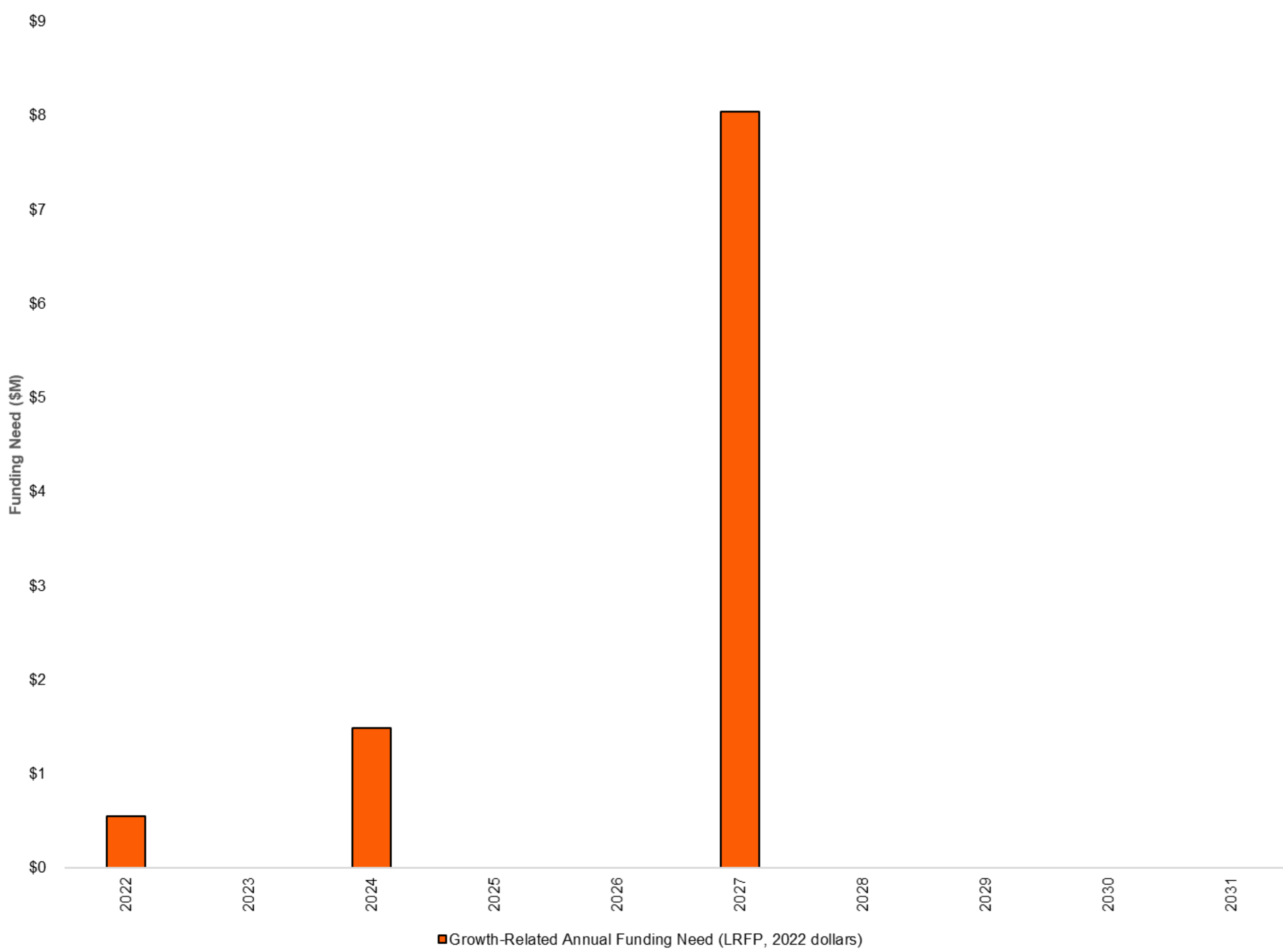


Figure 5-5: Forecasted Funding Needs for Construction of New Fire Assets

One of the next steps in the further development of the LRFP is to apply added detail to the forecasted funding need estimates. This will provide a more refined forecast, which will serve to provide additional guidance for Asset Management planning in the future at the City of Vaughan.

Water

REPLACEMENT COST

$1,539,608,000

OVERALL CONDITION GRADE

A

CONDITION (FAIR OR BETTER)

92%

ASSET PORTFOLIO

- **1,178** kilometres of watermains
- **88,900** service connections with meters
- **54,100** valves
- **10,600** hydrants
- **10,600** chambers
- **2** water pumping stations

CHANGES IN ASSET PORTFOLIO

In 2024, the City added 3,950 metres of watermains.

FUTURE OUTLOOK

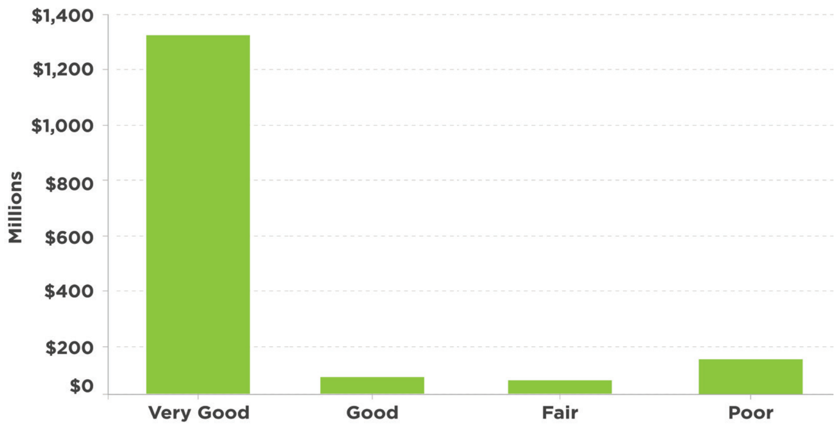
Continue multi-year watermain condition assessment program to provide up-to-date condition information on the City's watermains.

The City's water service provides drinking water and fire protection services to approximately 335,000 residents and 19,500 businesses. The City manages a reliable water system, that provides sufficient quality flow and safe and drinkable water to all residential, industrial, commercial and institutional customers.

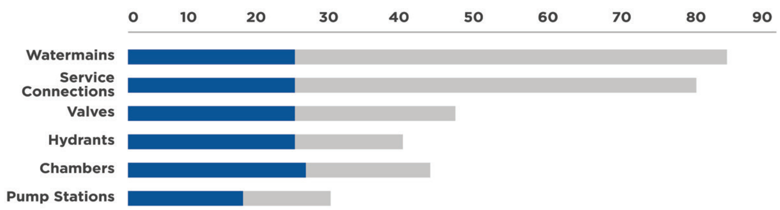
Replacement cost summary

2023 replacement cost		$1,501,106,000
Changes		$38,502,000
New and upgraded assets	$23,000	
Asset evaluation improvements and inflation	$38,479,000	
Decommissioned assets	$0	
2024 replacement cost		**$1,539,608,000**

Condition



Average age and useful life expectancy in years



Wastewater

REPLACEMENT COST

$1,143,998,000

OVERALL CONDITION GRADE

A

CONDITION (FAIR OR BETTER)

99%

ASSET PORTFOLIO

- **1,026** kilometres of wastewater mains
- **88,900** laterals
- **16,721** maintenance holes
- **12** water pumping stations
- **1** generator station

CHANGES IN ASSET PORTFOLIO

In 2024, the City added 2,840 metres of wastewater mains.

FUTURE OUTLOOK

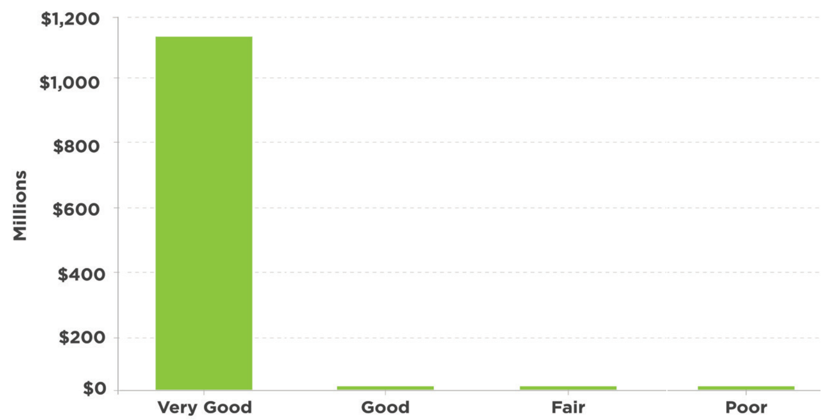
Initiate a condition assessment study for wastewater pressurized infrastructure including pump stations, forcemains, valves and outfalls and continue CCTV inspections on the entire wastewater pipe network to update pipe condition data.

The City's wastewater infrastructure is a combination of linear sewers (pipes) and pumping stations that collect residential, commercial and industrial wastewater through gravity and force mains. This infrastructure discharges the collected wastewater into regional wastewater treatment plants, where it is cleaned and returned to the environment.

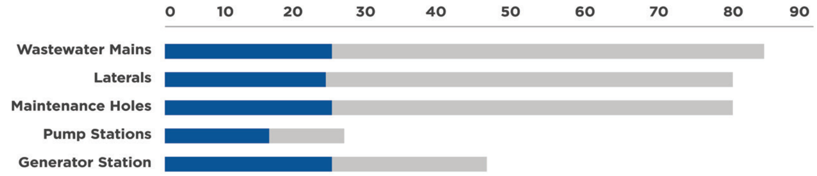
Replacement cost summary

2023 replacement cost		$1,120,943,000
Changes		$23,055,000
New and upgraded assets	$19,000	
Asset evaluation improvements and inflation	$23,036,000	
Decommissioned assets	$0	
2024 replacement cost		**$1,143,998,000**

Condition



Average age and useful life expectancy in years



Stormwater

REPLACEMENT COST

$2,443,418,000

OVERALL CONDITION GRADE

A

CONDITION (FAIR OR BETTER)

99%

ASSET PORTFOLIO

- **1,196** kilometres of stormwater mains
- **88,900** laterals
- **16,454** maintenance holes
- **22,790** catch basins
- **365** minor culverts
- **136** major culverts
- **856** inlet-outlet structures
- **489** devices
- **88** kilometres of ditches
- **182** stormwater management ponds

CHANGES IN ASSET PORTFOLIO

In 2024, the City added 20 kilometres of stormwater mains, and 200 kilometres of ditches were reclassified under York Region ownership.

FUTURE OUTLOOK

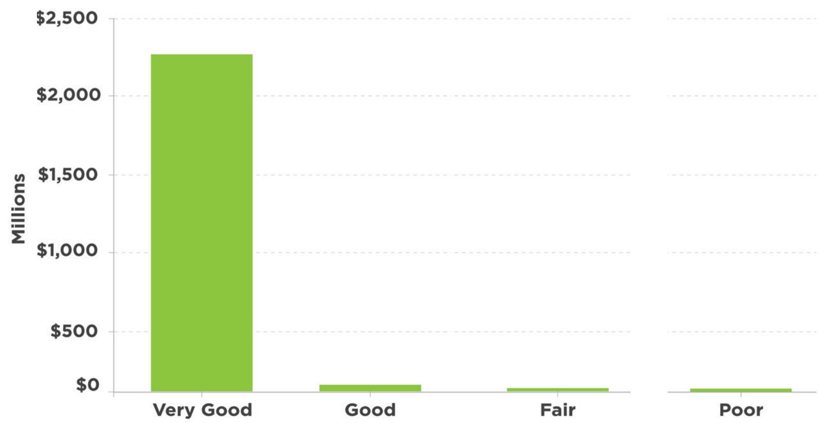
Continue CCTV inspections on the entire stormwater pipe network to update pipe condition data.

The City's stormwater management system is designed to mitigate flooding and minimize hazards during major storm events. The system protects the environment by cleaning stormwater and returning it to the environment. By doing this, the City is helping to preserve this natural resource and protect aquatic life in the natural environment.

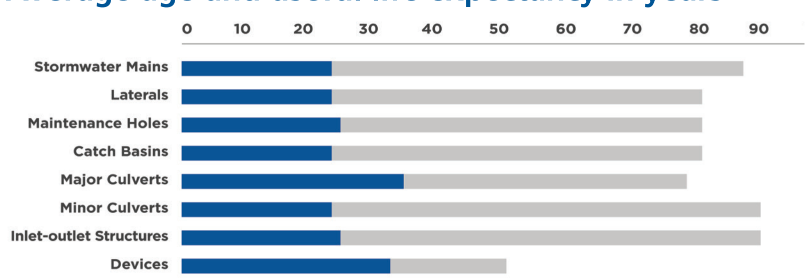
Replacement cost summary

2023 replacement cost		**$2,464,749,000**
Changes		-$21,331,000
New and upgraded assets	$12,777,000	
Asset evaluation improvements and inflation	-$34,108,000	
Decommissioned assets	$0	
2024 replacement cost		**$2,443,418,000**

Condition



Average age and useful life expectancy in years



VAUGHAN

Roads

REPLACEMENT COST

$1,560,476,000

OVERALL CONDITION GRADE

A

CONDITION (FAIR OR BETTER)

100%

ASSET PORTFOLIO

- **1,335** lane-kilometres of local roads
- **642** lane-kilometres of collector roads
- **103** lane-kilometres of rural roads
- **16** lane-kilometres of laneways

CHANGES IN ASSET PORTFOLIO

In 2024, the City rehabilitated 60 lane-kilometres of roads.

FUTURE OUTLOOK

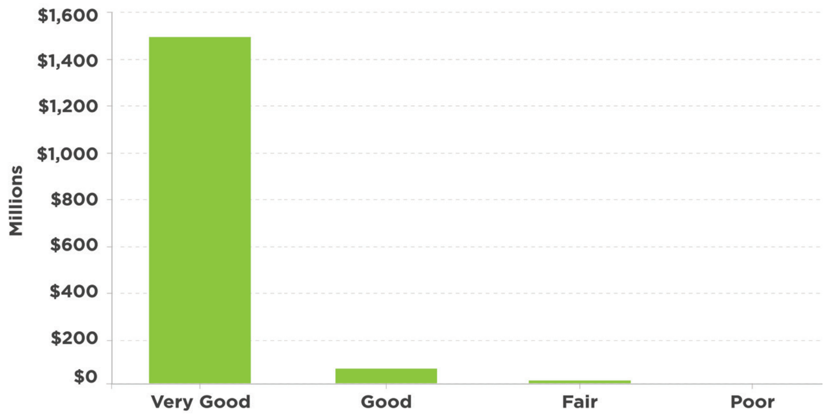
The City has several capital projects planned for 2025 to meet current and future transportation demands including preservation, rehabilitation and replacement of road pavement.

City-owned roads are efficiently maintained to enable safe and effective travel. The City is dedicated to achieving high-quality standards in the maintenance of its road assets through road inspections, crack sealing, pothole repairs and more.

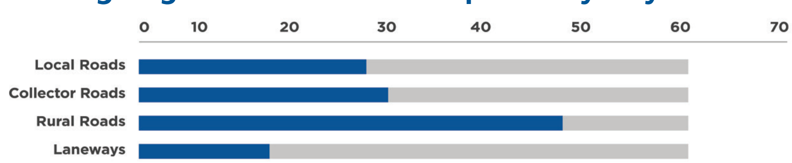
Replacement cost summary

2023 replacement cost		$1,499,753,000
Changes		$60,723,000
New and upgraded assets	$14,733,000	
Asset evaluation improvements and inflation	$46,718,000	
Decommissioned assets	$728,000	
2024 replacement cost		**$1,560,476,000**

Condition



Average age and useful life expectancy in years



Bridges

REPLACEMENT COST

$183,948,000

OVERALL CONDITION GRADE

B

CONDITION (FAIR OR BETTER)

100%

ASSET PORTFOLIO

- **26** vehicular bridges
- **53** pedestrian bridges

CHANGES IN ASSET PORTFOLIO

In 2024, the City renewed one vehicular bridge and two pedestrian bridges.

FUTURE OUTLOOK

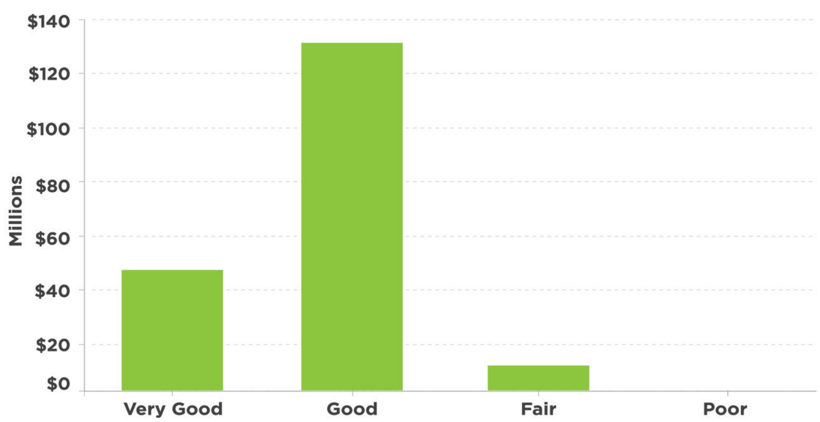
The City has several capital projects planned for 2025 to meet current and future transportation demands, including preservation, rehabilitation and replacement of bridges.

City-owned bridges are managed in accordance with Provincial Bridge Legislation and Guidelines. These assets are controlled based on biennial field inspections by qualified experts to identify structural issues and concerns following the Ontario Structure Inspection Manual.

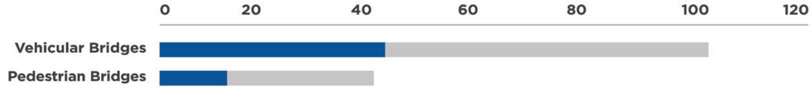
Replacement cost summary

2023 replacement cost		$169,611,000
Changes		$14,337,000
New and upgraded assets	$1,247,000	
Asset evaluation improvements and inflation	$13,090,000	
Decommissioned assets	$0	
2024 replacement cost		**$183,948,000**

Condition



Average age and useful life expectancy in years



Facilities

REPLACEMENT COST

$702,658,000

OVERALL CONDITION GRADE

B

CONDITION (FAIR OR BETTER)

99%

ASSET PORTFOLIO

- **2** administration buildings
- **13** community centres and other City facilities
- **11** fire stations
- **19** heritage buildings
- **10** libraries
- **21** parks facilities
- **14** water pumping stations
- **7** seniors clubs
- **6** sport buildings
- **3** operation yards
- **26** tanks and generators

CHANGES IN ASSET PORTFOLIO

In 2024, the City completed a number of building upgrades to meet *Accessibility for Ontarians with Disabilities Act* requirements.

There were also stormwater upgrades completed at North Thornhill Community Centre and masonry repairs at Rosemount Community Centre.

FUTURE OUTLOOK

In 2025, Carrville Community Centre, Fire Station-12 and two new community spaces will be added to the portfolio.

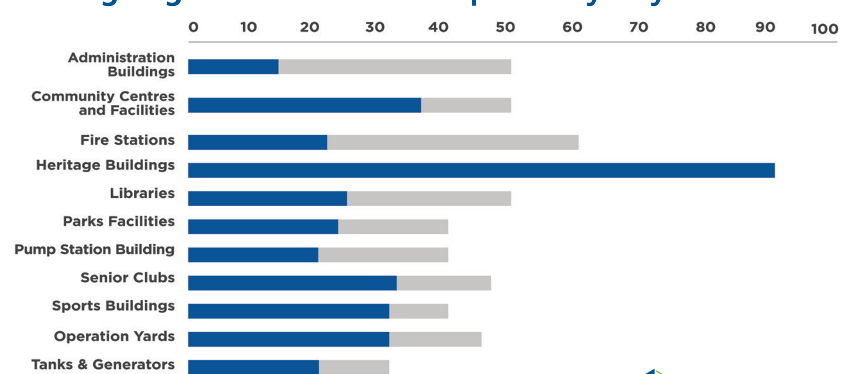
The City operates more than 100 properties, facilities and buildings. These facilities provide a wide range of services and programs offered by the City. Vaughan's Facility Management team focuses on property management services of these assets, to ensure each facility meets functional requirements, such as building and safety codes.

Replacement cost summary

2023 replacement cost		$680,475,000
Changes		$22,183,000
New and upgraded assets	$1,542,000	
Asset evaluation improvements and inflation	$20,641,000	
Decommissioned assets	$0	
2024 replacement cost		**$702,658,000**

Condition

Average age and useful life expectancy in years



Parks

REPLACEMENT COST

$296,476,000

OVERALL CONDITION GRADE

B

CONDITION (FAIR OR BETTER)

76%

ASSET PORTFOLIO

- **233** parks
- **10** skate parks
- **61** baseball diamonds
- **148** soccer fields
- **75** basketball courts
- **135** tennis courts
- **23** bocce courts
- **296** playgrounds
- **8** ice rinks and ice trails
- **23** splashpads

CHANGES IN ASSET PORTFOLIO

Parks asset inventory and condition data updated with 2024 assessment information and improved accuracy.

FUTURE OUTLOOK

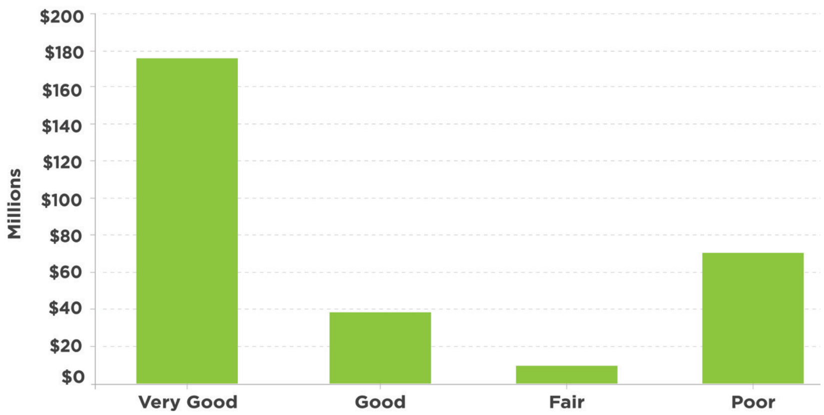
In 2025, the City will update asset replacement costs based on recent capital project expenditures and further refine major asset condition scores based on updated rating criteria with annual assessments.

The City's park network features more than 230 locations across 640 hectares of land in Vaughan. The City's Parks Operations team manages these assets to ensure they meet the needs of current and future generations.

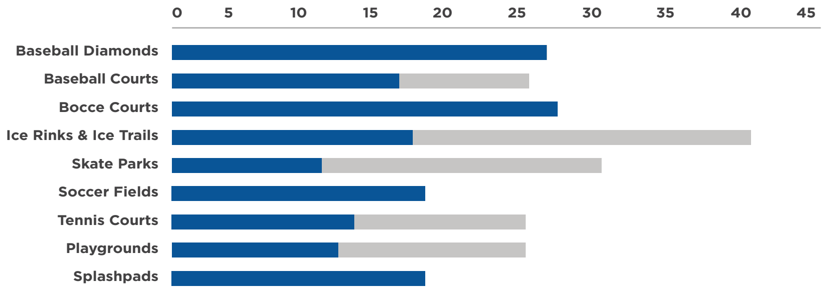
Replacement cost summary

2023 replacement cost		$273,304,000
Changes		$23,172,000
New and upgraded assets	$15,236,000	
Asset evaluation improvements and inflation	$7,936,000	
Decommissioned assets	$0	
2024 replacement cost		**$296,476,000**

Condition



Average age and useful life expectancy in years



Urban Forestry

REPLACEMENT COST

$120,412,000

OVERALL CONDITION GRADE

B

CONDITION (FAIR OR BETTER)

77%

ASSET PORTFOLIO

- **133,759** street trees

CHANGES IN ASSET PORTFOLIO

Key updates to the street tree inventory include new plantings as recent as 2023 in addition to improvements in accuracy of asset inventory data.

FUTURE OUTLOOK

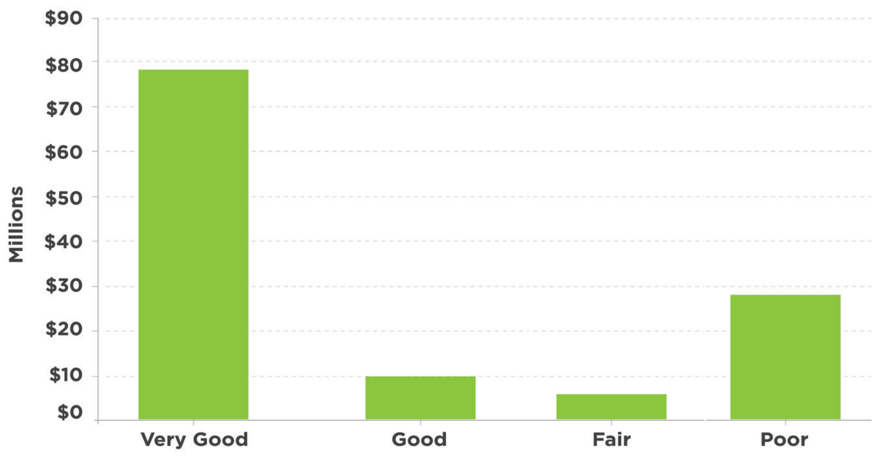
In 2025, the City will update the street tree database to include all new plantings from the prior year as well as updates to species type, trunk diameter and pruning activities information.

The Forestry Operations team manages 130,000 street trees in Vaughan. Unlike other assets, trees are living, natural assets and increase in value with age for most of their lifecycle. The City recognizes the significant role that the urban tree canopy plays in providing an improved quality of life. Preserving and protecting the health of trees will help the City achieve its commitment to maintaining and enhancing the urban forest and the environment.

Replacement cost summary

2023 replacement cost		$117,121,000
Changes		$3,291,000
New and upgraded assets	$0	
Asset evaluation improvements and inflation	$3,291,000	
Decommissioned assets	$0	
2024 replacement cost		**$120,412,000**

Condition



Average age and useful life expectancy in years

VAUGHAN

Active Transportation

REPLACEMENT COST

$235,089,000

OVERALL CONDITION GRADE

B

CONDITION (FAIR OR BETTER)

94%

ASSET PORTFOLIO

- **1,111** kilometres of sidewalks and walkways
- **21** kilometres of cycle tracks
- **41** kilometres of in-boulevard multi-use pathways
- **54** kilometres of open space multi-use recreational trails

CHANGES IN ASSET PORTFOLIO

In 2024, the City added 2.3 kilometres of new sidewalks and walkways, and 5.3 kilometres of new cycle tracks.

FUTURE OUTLOOK

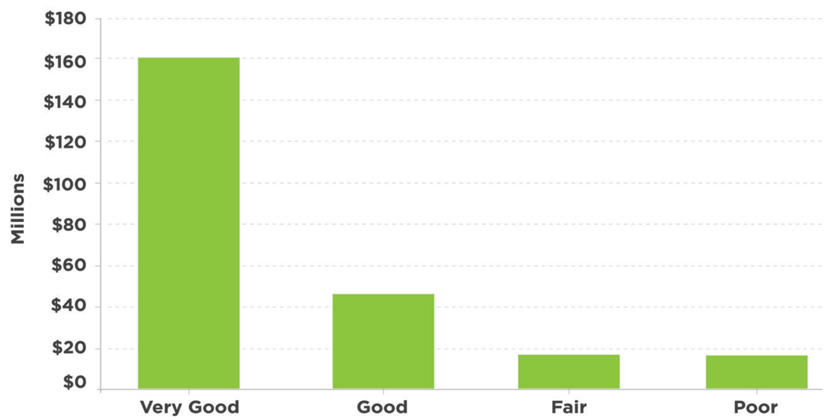
Active transportation infrastructure on local and regional roads will continue to be advanced in 2025 as part of larger capital and development projects.

The City has an expansive active transportation network – and it continues to grow. This network includes more than 1,000 kilometres of pedestrian, cycling and shared-use facilities to get people through the city, in whichever mode of transportation they choose, seamlessly.

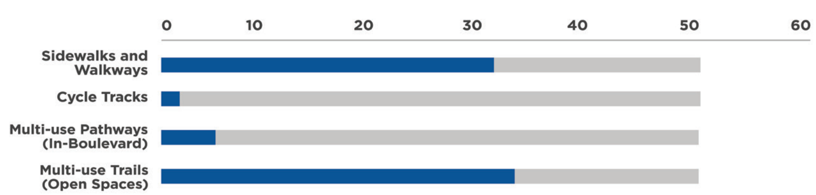
Replacement cost summary

2023 replacement cost		**$227,776,000**
Changes		$7,313,000
New and upgraded assets	$1,746,000	
Asset evaluation improvements and inflation	$5,567,000	
Decommissioned assets	$0	
2024 replacement cost		**$235,089,000**

Condition



Average age and useful life expectancy in years



VAUGHAN

Traffic Control and Streetlights

REPLACEMENT COST

$231,912,000

OVERALL CONDITION GRADE

B

CONDITION (FAIR OR BETTER)

76%

ASSET PORTFOLIO

- **97** traffic signal controls
- **435** traffic calming measures
- **23,717** street signs
- **27,084** streetlights

CHANGES IN ASSET PORTFOLIO

In 2024, the City added one new traffic intersection control.

FUTURE OUTLOOK

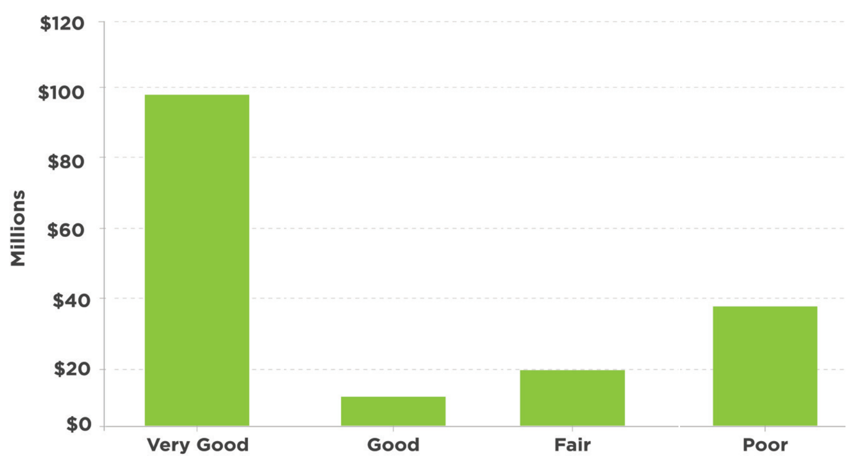
Update asset replacement costs based on recent capital project expenditures and continue with program to convert all remaining high-pressure sodium streetlights to LED.

The City's traffic control and streetlight assets are managed by the Traffic Engineering team. These assets include traffic signal controls, traffic signs, traffic calming measures and streetlights.

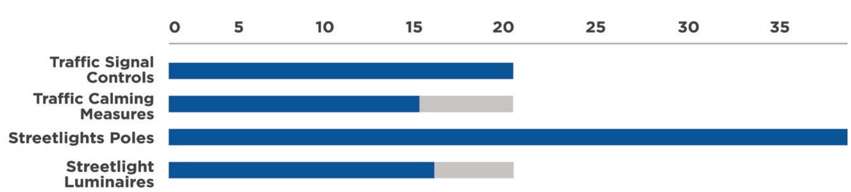
Replacement cost summary

2023 replacement cost		$226,730,000
Changes		$5,182,000
New and upgraded assets	$288,000	
Asset evaluation improvements and inflation	$4,894,000	
Decommissioned assets	$0	
2024 replacement cost		**$231,912,000**

Condition



Average age and useful life expectancy in years



Fleet

REPLACEMENT COST

$57,894,000

OVERALL CONDITION GRADE

C

CONDITION (FAIR OR BETTER)

41%

ASSET PORTFOLIO

- **323** vehicles
- **782** pieces of equipment
- **79** trailers
- **22** others

CHANGES IN ASSET PORTFOLIO

In 2024, the City added or replaced 30 vehicles, 11 pieces of equipment and one trailer. Improvements in accuracy of asset inventory data were also made.

FUTURE OUTLOOK

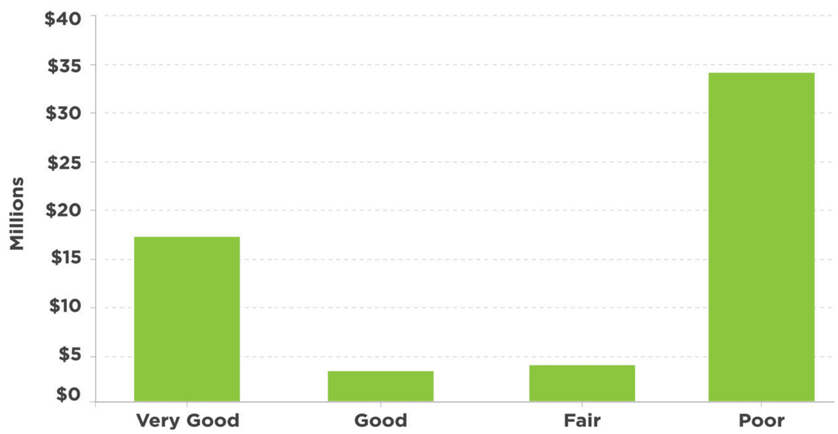
The City is considering making new additions to its fleet, which could include fully electric and hybrid vehicles.

The City's fleet assets are managed and maintained by the Fleet Management Services team. These assets include City vehicles and equipment, which are utilized by various departments for their day-to-day operations.

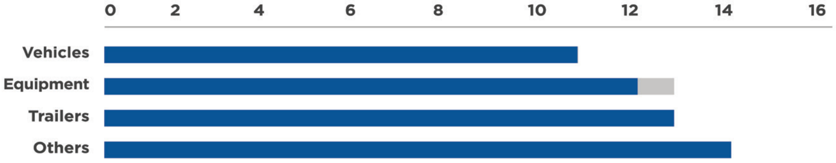
Replacement cost summary

2023 replacement cost		**$58,785,000**
Changes		-$891,000
New and upgraded assets	$2,057,000	
Asset evaluation improvements and inflation	-$2,864,000	
Decommissioned assets	$84,000	
2024 replacement cost		**$57,894,000**

Condition



Average age and useful life expectancy in years



Fire

REPLACEMENT COST

$52,793,000

OVERALL CONDITION GRADE

B

CONDITION (FAIR OR BETTER)

77%

ASSET PORTFOLIO

- **28** emergency response vehicles
- **22** passenger vehicles
- **3,736** pieces of equipment

CHANGES IN ASSET PORTFOLIO

In 2024, the City updated unit costs for vehicles and equipment.

FUTURE OUTLOOK

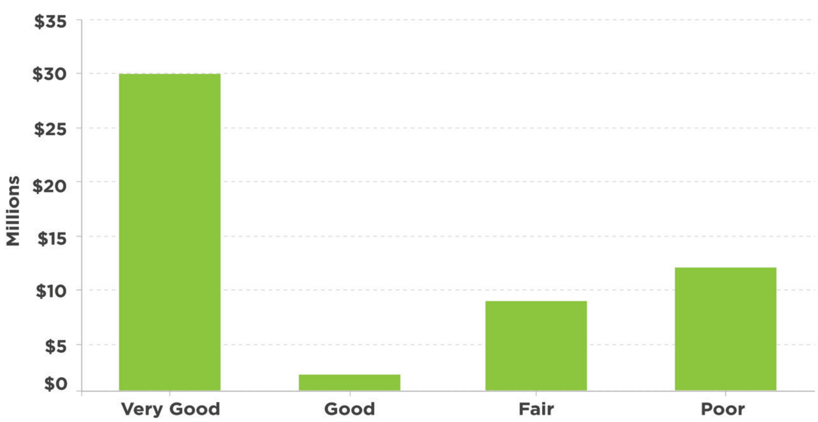
The City has plans to add new emergency response vehicles to its fleet in 2025.

The City of Vaughan's Vaughan Fire and Rescue Service (VFRS) manages an array of emergency response vehicles and equipment such as fire suppression and support vehicles. VFRS is dedicated to providing efficient emergency response as well as fire protection, prevention, safety and education to those who live, work and visit the city.

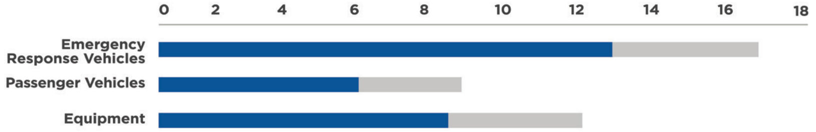
Replacement cost summary

2023 replacement cost		**$50,731,000**
Changes		$2,062,000
New and upgraded assets	$0	
Asset evaluation improvements and inflation	$2,062,000	
Decommissioned assets	$0	
2024 replacement cost		**$52,793,000**

Condition



Average age and useful life expectancy in years



VAUGHAN