ATTACHMENT 1

AECOM

ASSET MANAGEMENT PLANS FOR NON-CORE ASSETS,
INFRASTRUCTURE PLANNING & CORPORATE ASSET MANAGEMENT,
AECOM 2022

Asset Management Plan

Non-Core Assets
Facilities

City of Vaughan

September 2022 (version 2)

Delivering a better world

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1. Introduction

1.1 Background

The City of Vaughan (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 one with increasing concentrations of 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, with a population of over 300,000, is rapidly growing and it is projected that the number of residents will continue to increase to 430,000 by 2031. The City is also home to a well-diversified and expanding employment sector and has the largest supply of new employment lands in the Greater Toronto Area (GTA). It is projected that employment numbers within City boundaries will increase from 150,000 to 278,000 by 2031.

1.2 Objectives

In 2018, by City Council approval, the Corporate Asset Management (AM) Policy 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.

As per Ontario Regulation (O. Reg) 588/17, the City updated its AM Strategy and core infrastructure AM Plans (AMPs) in early 2021; now the City is advancing its AM Program further by capturing its non-core infrastructure assets so as to develop a comprehensive understanding of its entire asset portfolio.

The objective of this AMP is to deliver a financial and technical roadmap for the management of the City's facility 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 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 1-2**). The development of this AMP is one of the steps to guide the City towards meeting the July 1st, 2024 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 LoS 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 asset class, which are owned and maintained by the City, as shown in **Table 1-2**.

Table 1-2: In-Scope Facility Assets

Asset Category	Sub-Assets
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 Scout House).
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.

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 & 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 94 buildings with a total square footage of 2,079,000. 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, 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: Facility Asset Class Inventory & Hierarchy

Asset Category	Asset Type	Quantity	Capacity
Buildings	Administration Buildings	2	414,478 sq. ft
	Community Centers	10	994,753 sq. ft
	Fire Stations	10	98,576 sq. ft
	Heritage Buildings	19	59,177 sq. ft
	Libraries	10	174,440 sq. ft
	MNRs*	3	19,502 sq. ft
	Parks Washrooms	20	31,623 sq. ft
	Senior Clubs	7	23,893 sq. ft**
	Sport Buildings	6	212,801 sq. ft**
	Yards (including Salt Domes)	3	44,000 sq. ft**
	Other Buildings	3	11,000 sq. ft
	Buildings Total	**94**	**2,079,000 sq. ft**
Tanks	Aboveground Tanks	12	52,171 Liter
	Underground Tanks	3	54,500 Liter
Generators	Generators	11	1,973 KW

* MNR Buildings (Ministry of Natural Resources and Forestry Buildings) are not owned by the City.

** Includes leased facilities.

2.2 Current Replacement Value

The estimated replacement value is the cost of replacing an existing asset in today's dollars, considering inflation. These costs are developed based on the City's records. Where applicable, a 2% annual inflation rate was used to estimate the 2022 values; this rate is representative of the average inflation rate in Canada for the past 5 to 10 years.

The City owned facility asset class is valued at approximately $509M, as represented in **Table 2-2**. The estimated total replacement value for the eleven Community Centers is over $227M 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 $127M.

Table 2-2: Facility Assets Replacement Costs

Asset Category	Asset Type	Average Unit Cost	Total Replacement Cost (2022)
Buildings	Administration Buildings	$308 / sq. ft	$127,492,000
	Community Centers	$229 / sq. ft	$227,416,000
	Fire Stations	$467 / sq. ft	$46,020,000
	Heritage Buildings	$415 / sq. ft	$24,548,000
	Libraries	$359 / sq. ft	$62,555,000
	Parks Facilities	$218 / sq. ft	$6,894,000
	Senior Clubs	$151 / sq. ft	$3,616,000
	Sport Buildings	$235 / sq. ft	$2,788,000
	Yards	$54 / sq. ft	$1,773,000
	Other Buildings	$443 / sq. ft	$4,876,000
Tanks	Aboveground Tanks	$2,000 - $15,000 / Ea.	$66,300
	Underground Tanks	$84,000 - $30,000 / Ea.	$58,200
Generators	Generators	$75,000 - $ 255,000 / Ea.	$1,224,000
		Buildings Sub-Total	**$507,978,000**
		Facilities Total	**$509,327,000**

2.3 Age & Remaining Service Life

The average age and remaining service life (RSL) used in this assignment was based on the observations from 2016-2017 building condition assessment, industry standards, and discussions with the City's staff.

It should be noted that the observed RSL was based on the condition assessment of the building components to Uniformat II Level 3. The average age and RSL for each building type reflect the summary of their building elements. In the case where facilities field assessment conditions were not available, the construction date together with the expected service life (ESL) were used to determine the RSL.

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 components 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 components 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:** Components are 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.

Figure 2-1 shows the average asset age and average RSL as a proportion of the average ESL weighted by replacement cost by facility asset type. The administration buildings including the City Hall and Joint Operations Center are approximately one third through their ESL. Community centers are two third through their ESL, however, it should be noted that the Garnet A. Williams Community Center, Al Palladini Community Centre, and the Maple Community Centre will be under renovation starting 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, and tanks & generators are slightly past their midway ESL.

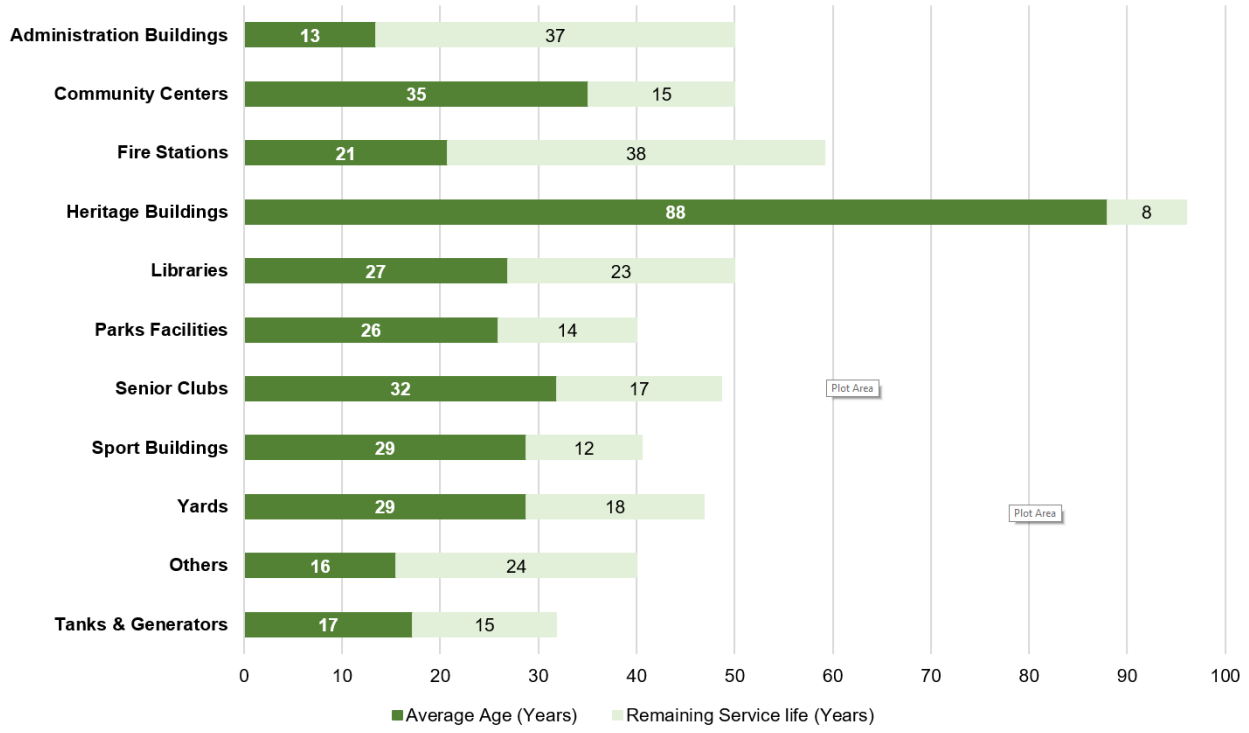

Figure 2-1: Facility Average Asset Age & RSL as a Proportion of the Average ESL

2.4 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, the physical condition of the assets is based on consultations with City staff who have experience in managing the assets, combined with existing condition data[1] (2016-2017 building condition assessment).

The condition of buildings is measured by the Facility Condition Index (FCI) and the condition of generators and tanks are measured by an age-based condition score, given the scarcity of field condition assessment data. **Section 2.4.1** and **Section 2.4.2** introduce the details on the condition assessment methods.

[1] 2016-2017 Building Condition Assessment Results

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].

$$FCI = \frac{\sum \text{Deficiencies Cost (in the tactical plan for the next 3 to 5 years)(\$)}}{Current\ Replacement\ Value\ of\ Facility\ (\$)} \quad [1]$$

Table 2-3 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 2-3: FCI Condition Rating Scale

FCI Minimum	FCI Maximum	Condition Rating
0%	14%	Very Good
15%	24%	Good
25%	49%	Fair
50%	100%	Poor

2.4.2 Age-Based Condition Assessment

Where empirical data was not available (i.e., previous condition assessments, inspections, and observations), two-parameter Weibull distribution function was used to assess the current condition and to project the future condition of the City's 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 2-4 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	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%

Condition Score (minimum)	Condition Score (maximum)	Condition Rating	Range % of ESL Consumed	Range of % Operational Life Consumed *
2.8	>=3.5	Poor	93% – >100%	61% – 100%

* NOTE: Term “operational life” is used to define the period over which an asset remains operational irrespective of performance, risk or cost considerations.

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 & Generators.

The City’s facilities are overall in very good and good condition with nearly 60% of facility assets, by replacement value, in very good condition. 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.

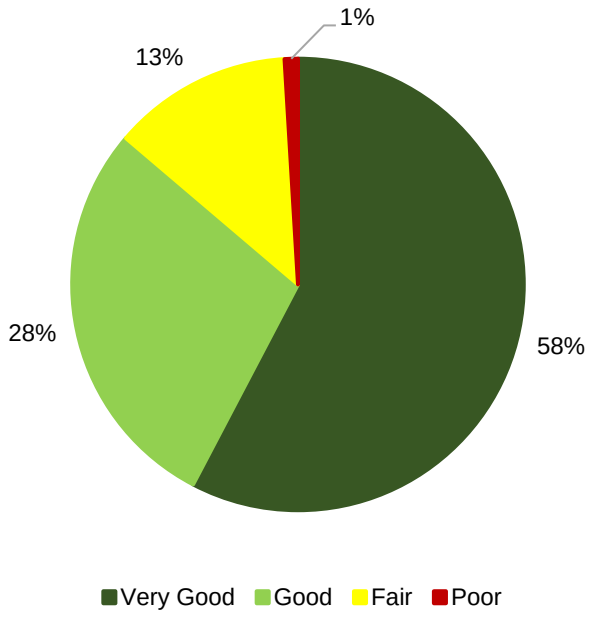

Figure 2-2: Facility Asset Condition Summary

The City has taken efforts in addressing the deficiencies for building repairs identified by the 2016 to 2017 building condition assessment results. It should be noted that the FCIs for Father Ermanno Bulfon and Woodbridge Pool & Area were based on the last condition assessment results. However, the City is currently conducting a building condition assessment for eight community centres and the condition ratings will be updated by the end of May 2022. In addition, the City is currently undertaking 64 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 of 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.

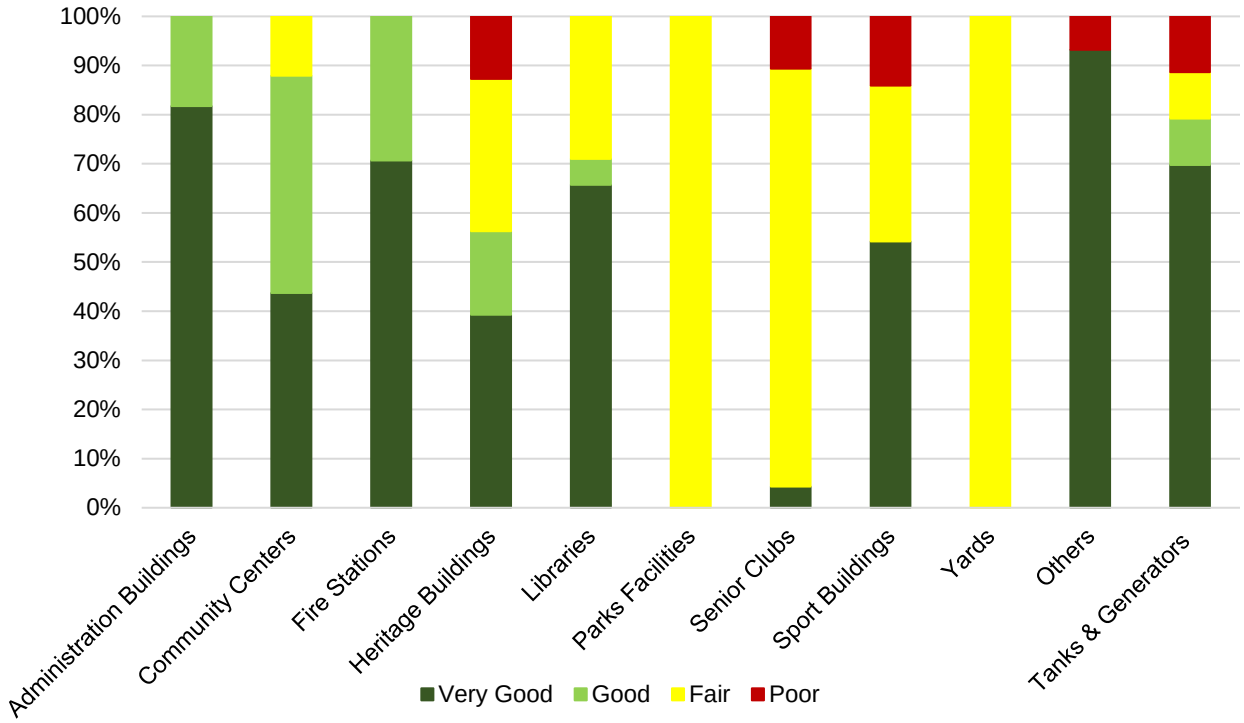

Figure 2-3: Distribution of Facility Asset Condition by Replacement Cost

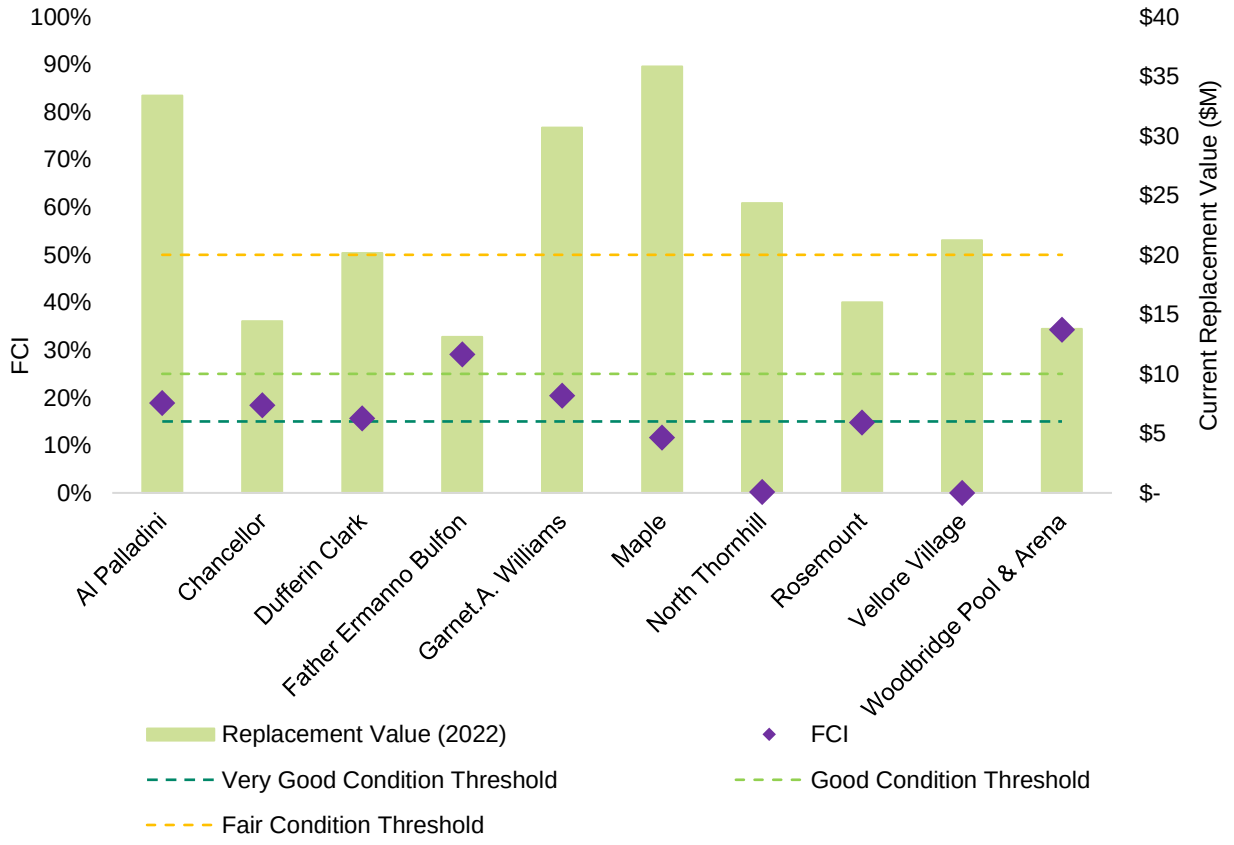

Figure 2-4: Community Centers FCI Details by Replacement Cost

3. Levels of Service (LoS)

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.

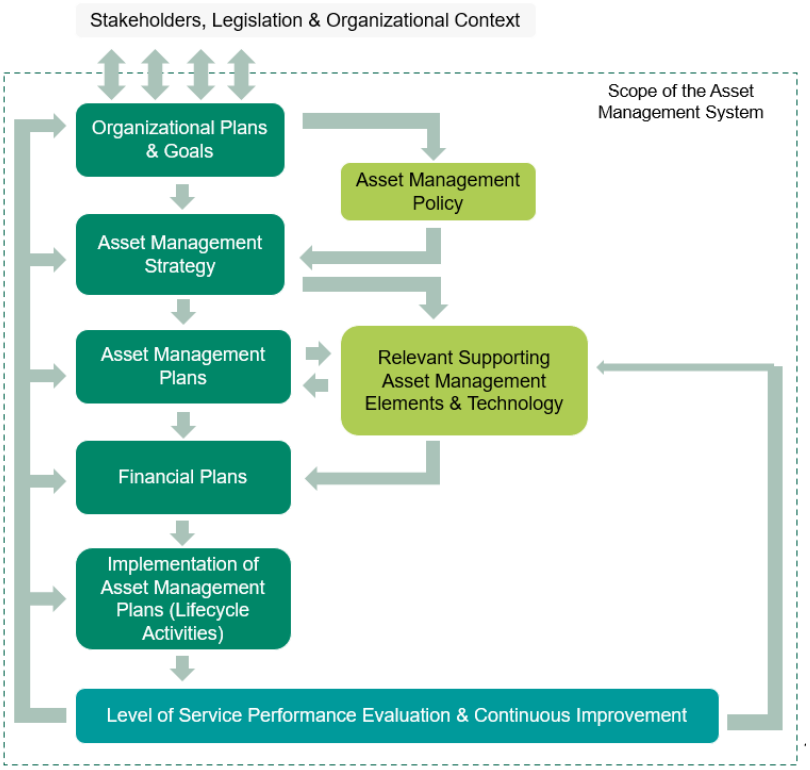

Figure 3-1: LoS within the AM System

In AECOM'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**).

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 & 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 & Capacity	Customers can easily access the service with minimal inconvenience.
Health & 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 & 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:

- **Other Service Providers** – Stakeholders that require the municipal service/assets to provide their own services (e.g., organized groups that use facility space, such as recreational sports teams, etc.).
- **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.

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 Facility Stakeholders & 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 efficient
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 Levels of Service 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 oppose 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.

Measured in the most recent Citizen Satisfaction Survey conducted by Ipsos, the percentage of respondents satisfied with Recreation and Fitness Facilities was 93% and regarding Local Public Libraries, the percentage was 96%. Additionally, as illustrated in **Figure 3-2**, the percentage of properties within 3 km of a Library facility is 91%.

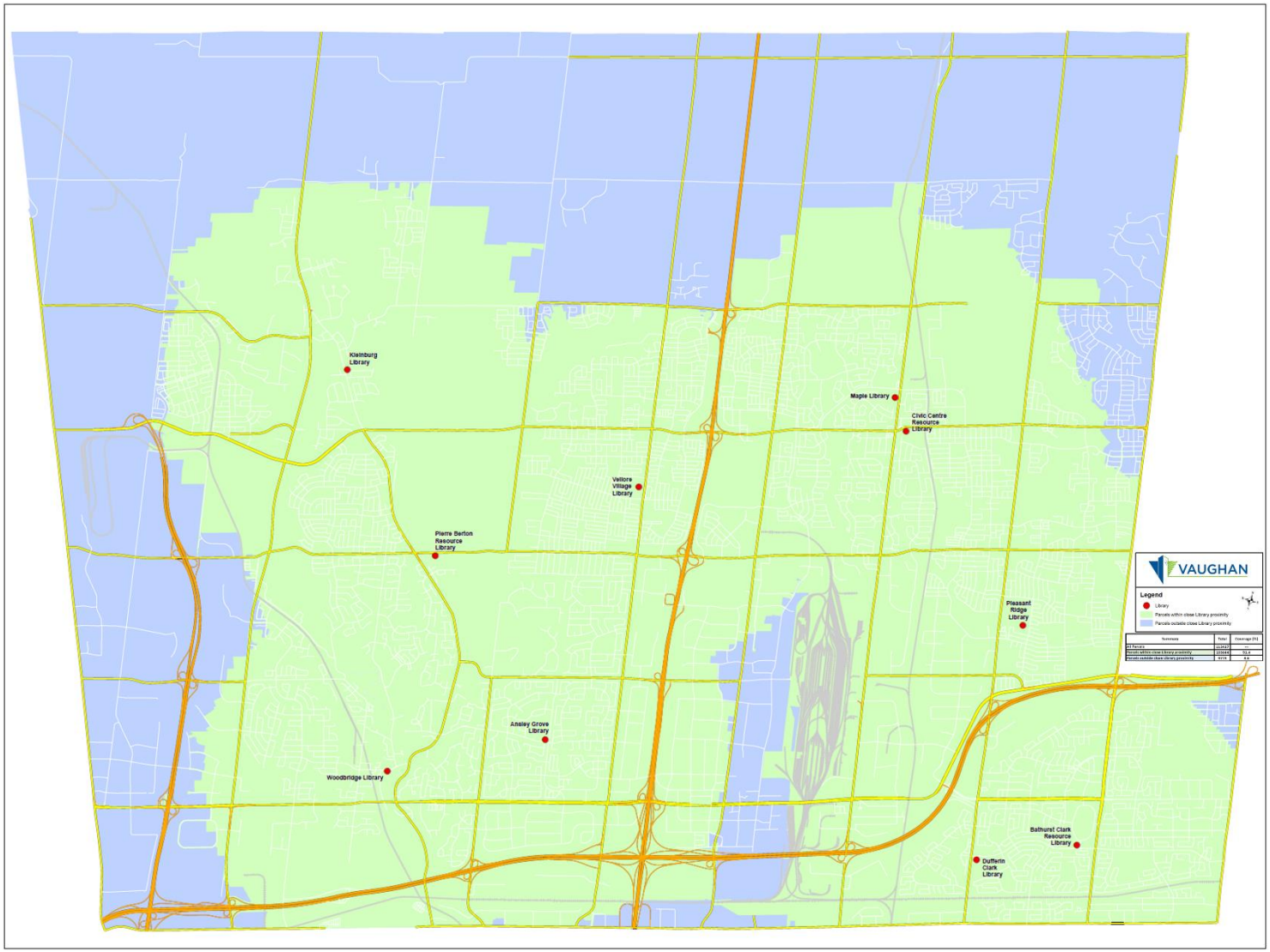

Figure 3-2: Properties within 3 km of a Library Facility

3.5 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

Demand Driver	Potential Impact on the City's 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. Considering entire asset lifecycles can ensure we make sound decisions that consider present and future service delivery needs.

The overarching goal of life cycle management is to maximize the long-term benefits and services 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.

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.

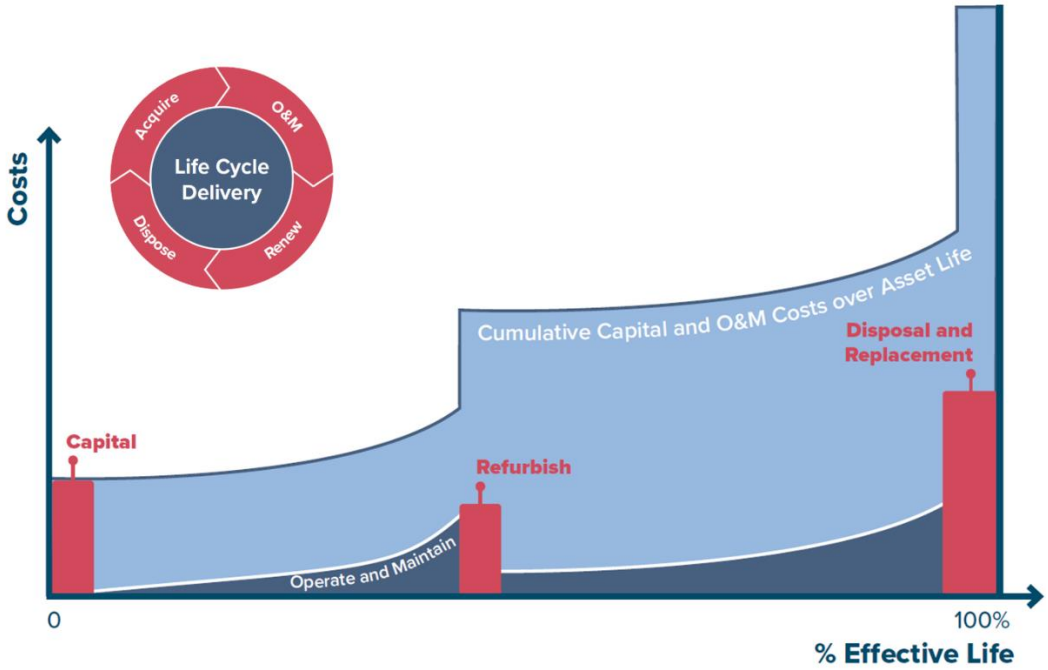

Figure 4-1: Life Cycle Cost Accumulation Over Asset Life

4.1 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[2] 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.

4.2 Operations and Maintenance Strategies

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. Maintenance expenses include periodic preventive and reactive 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 number 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.

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 $17,760,99. **Table 4-2** presents the estimated five-year average unit O&M cost per building type.

Table 4-1: Historical Facilities O&M Actuals

Year	Total O&M Actuals
2020	$ 16,160,000
2019	$ 14,696,000
2018	$ 14,237,000
2017	$ 22,035,000
2016	$ 21,678,000
5-Yr. Average	**$ 17,761,000**

Table 4-2: Unit O&M Cost of Building Types

Building Type	2016-2020 5-year Average Unit O&M Cost ($/Sq.ft.)
Administration Building	$ 7.50
Community Centers	$ 6.35
Fire Stations	$ 4.89
Heritage Buildings	$ 7.61
Libraries	$ 11.49
MNRs	$ 20.75
Parks Washrooms	$ 12.74

[2] Active Together Master Plan 2018 Update (vaughan.ca).

Building Type	2016-2020 5-year Average Unit O&M Cost ($/Sq.ft.)
Senior Clubs	$ 14.33
Sport Buildings	$ 15.80
Yards	$ 16.11
Other buildings	$ 8.72

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	$ 2,322,000
Preventative maintenance (Cleaning services only)	$ 638,000

4.3 Renewal and Replacement Strategies

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. 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.

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 Library and Community Centre also provided recommendations to improve the space functionality, energy utilization and upgrades to ensure sustainability and accessibility enhancements. The City then developed a renovation plan for the library 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.

4.4 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.

In the past, the City undertook disposal initiatives and has demolitions scheduled for the current year. For the purposes of decision- making, the City relies on real estate market and once a facility is declared as surplus, the facility department gets involved with condition assessments and carries out high and best use analysis of the facility. This process also involves stakeholders from other departments such as parks, development, legal, heritage and policy planning. In the recent demolishment of the Humber River Trail building, the land due to proximity to river was naturalized to reduce the environmental impact. Another example includes the MNRs, as they fall under Toronto and Region Conservation Authority's (TRCA) jurisdiction.

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 facility 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 facility assets.

The annual renewal needs for buildings were based on an annual renewal rate of 3.5% of current replacement value with an inflation of 2% annually, while the annual reinvestment need for tanks & generators were based on age & ESL (i.e., replacing assets that has exceeded their ESL) in inflated dollar values. 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 inflated dollar values. This is equivalent to a total of approximately $520M over the next 20-year period, as presented in **Figure 5-1**.

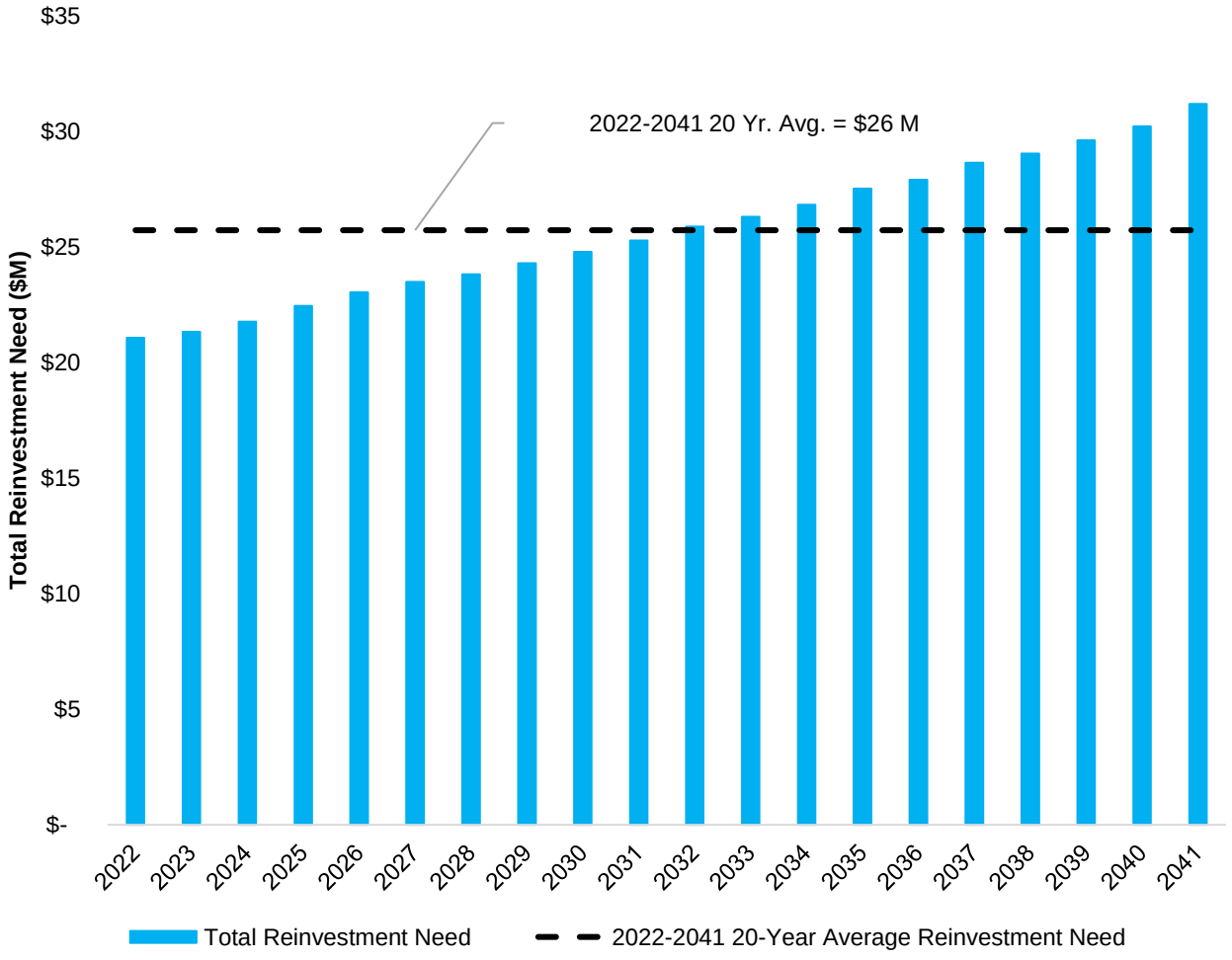

Figure 5-1: Facilities 20-Year Reinvestment Need

The detailed reinvestment needs in inflated dollar values 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.

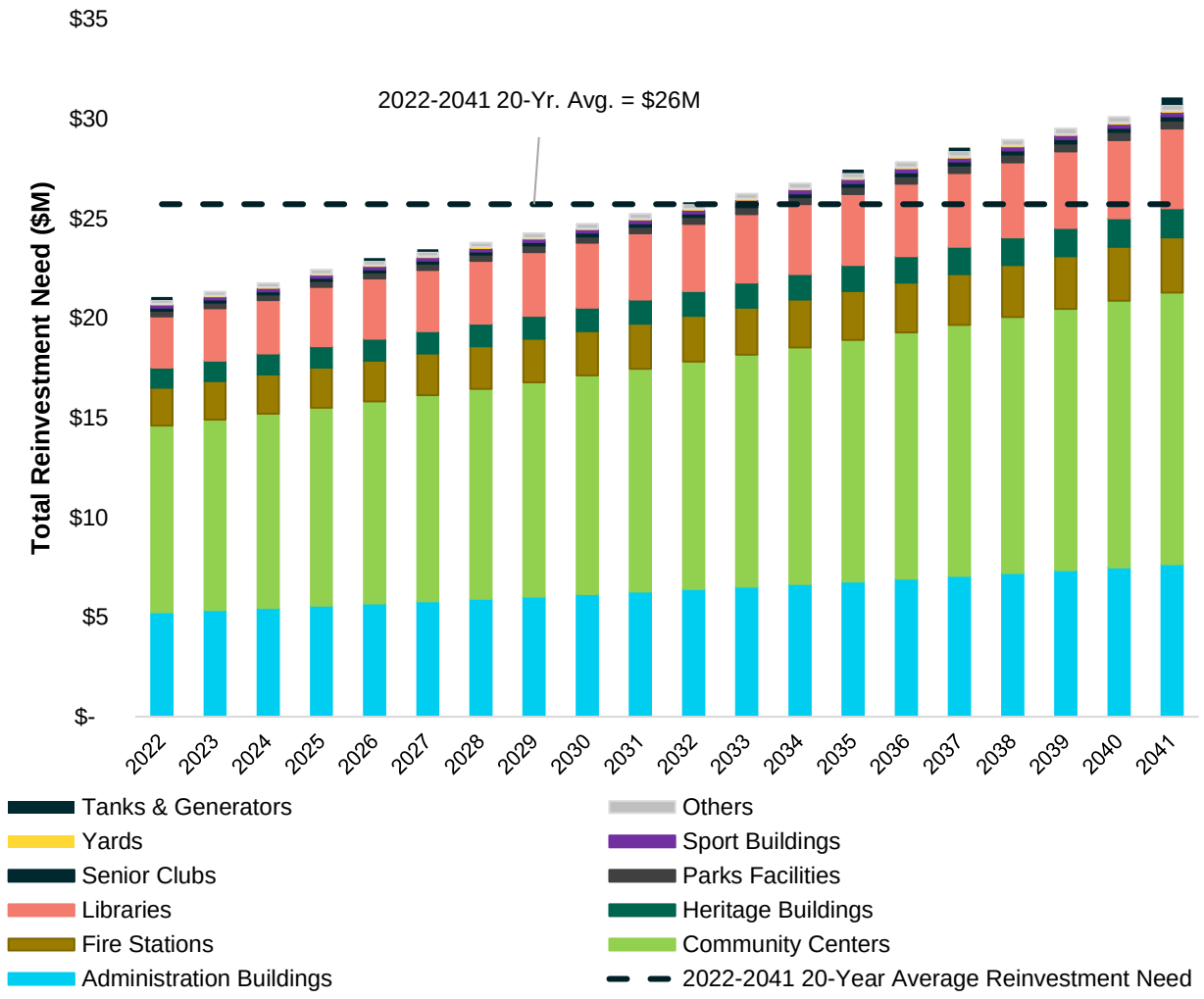

Figure 5-2: Facilities 20-Year Reinvestment Need Details

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

Asset Type	Annual Average Need	20-Year Total
Administration Buildings	$6,378,000	$127,560,000
Community Centers	$11,377,000	$227,540,000
Fire Stations	$2,303,000	$46,060,000
Heritage Buildings	$1,228,000	$24,560,000
Libraries	$3,332,000	$66,640,000
Parks Facilities	$339,400	$6,788,000
Senior Clubs	$180,900	$3,618,000
Sport Buildings	$139,500	$2,790,000
Yards	$88,700	$1,774,000
Other building facilities	$243,900	$4,878,000
Tanks & Generators	$60,900	$1,218,000
Total	**$25,671,300**	**$513,426,000**

5.2 60-Year Reinvestment Need

Looking ahead in the long term, the average annual reinvestment rate for the City's facilities assets is $40M over the next 60 years in inflated dollar value, for a total of approximately $2.4B, as presented in **Figure 5-3**.

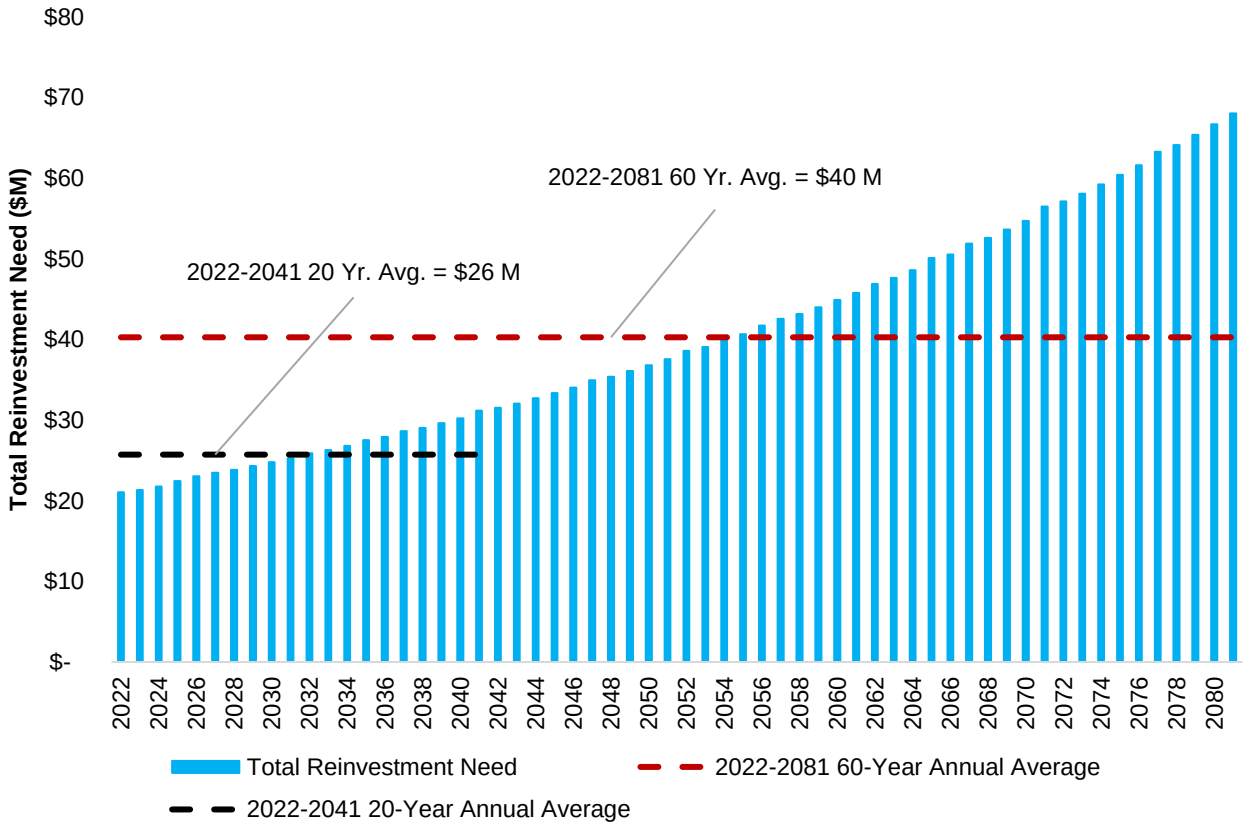

Figure 5-3: Facilities 60-Year Total Reinvestment Need (Inflated Dollar Value)

5.3 20-Year Full Funding Need Profile

Figure 5-4 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 in order to perform effective financial planning activities. The total annual reinvestment rate from **Figure 5-1** was overlaid with the City's facilities 5-year annual average O&M cost (see **Table 4-1**), and annual average facilities growth-related development cost inflated dollar values.

Facilities assets requires approximately $22.4M annually over the next 20 years for O&M, equivalent to totally $449M in inflated dollar value. The facilities growth-related cost or development cost requires approximately $406M over the next 20 years, equivalent to roughly $20.3M annually. As such, with the addition of O&M and facilities DC, the total average annual funding need for the City's facilities assets increases to approximately $68M annually, for a total of $1.36B 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.

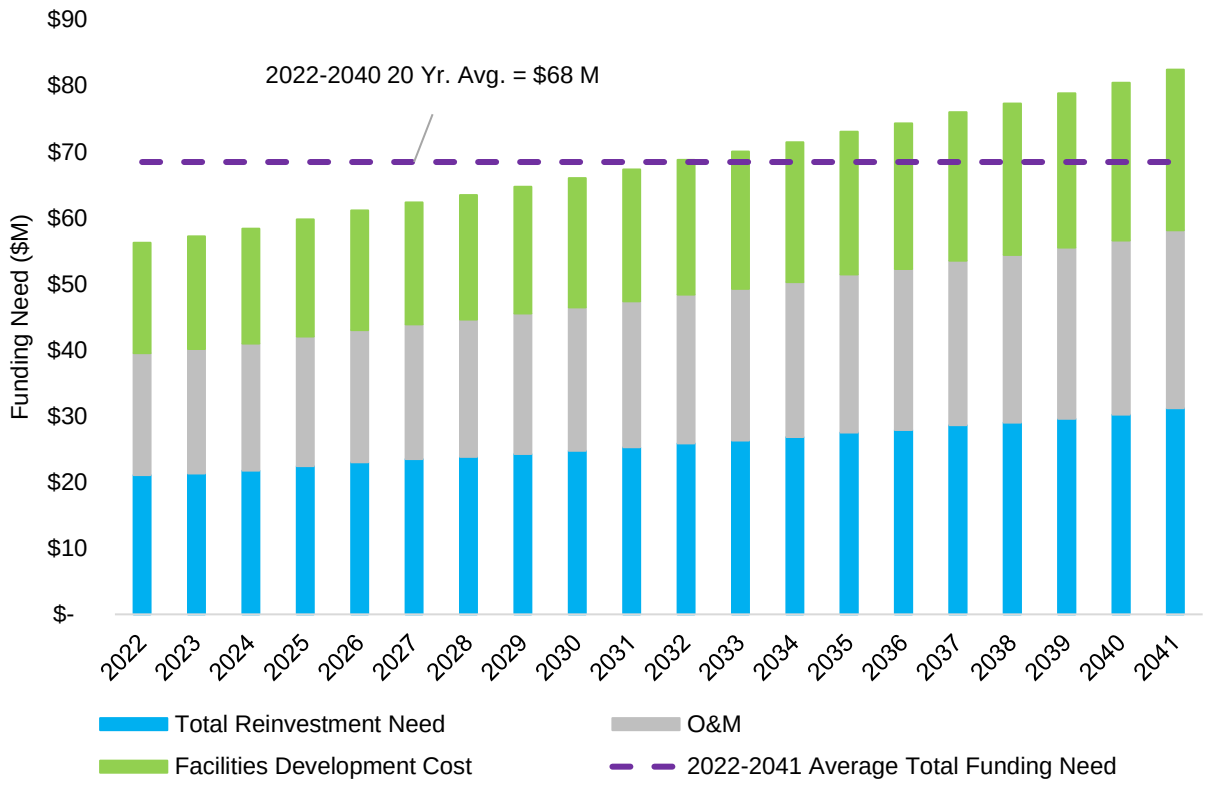

Figure 5-4: Facilities 20-Year Capital Investment and O&M Cost Forecast

6. Recommendations for Facilities AMP Continuous Improvement

Continuous improvement is an important component of any AM program and is achieved through the implementation of recommended improvement initiatives which support sustainable service delivery. AECOM has identified a set of activities that represents the next stage of AM planning and implementation within the City.

- **Continue to refine the asset inventory and close existing data gaps, so as to have a more accurate representation of the current state of the facility assets; and, ultimately, to make more informed and defensible decisions**.
  - AECOM recommends the City to continue maintaining the facilities inventory, keep tracking building renewal records, and update the inventory as soon as a new building is constructed.
  - It is recommended that the City assign unique identifiers for each facility asset, and link the ID across data sources, so that the assets can be tracked throughout their whole lifecycle.
  - It is also recommended that the new acquired buildings to have Building Information Modeling (BIM) records to visualize buildings assets and support the asset life cycle management activities moving forward.
- **Continue with the facility condition assessment process and use a consistent condition grading scheme across all facility assets.**
  - The grading system should contain a description of the condition, which is tied directly to the FCI range, and a description of the asset performance and level of corrective and preventive maintenance required for assets falling within a certain condition rating category. This process will allow the City to keep track of and better forecast facility assets renewal needs.
- **Refine the LoS Framework.**
  - Collect current asset performance data for key performance indicators (KPIs) that are not currently being tracked, including associated costs.
  - Analyze asset performance data to determine trends and to establish annual performance benchmarks.
  - Engage in a discussion with key stakeholders to establish service level targets and identify associated costs to meet those targets.
  - Once LoS targets have been decided upon, the City should develop strategies on how to meet service level targets considering its existing operating environment (i.e., staff availability, current funding, resources, etc.).
  - Develop a Customer Consultation Plan to engage the public and other stakeholders on the LoS framework and to better understand customers' willingness to pay for enhanced service levels.
- **Incorporate risk assessment for future iterations of the AM plan, and use the risk assessment results to drive future condition assessments and financial needs forecasting.**
  - Conduct a comprehensive criticality and risk assessment of facility assets to inform work prioritization.
  - Review risk attribute values periodically to ensure alignment with business objectives and appetite.
  - Overlay the risk model with the current state of the assets (i.e., condition), and the financial forecast. Using this approach, the City could focus its monitoring, maintenance, and renewal and replacement budget and activities on high-risk assets. Medium risk infrastructure could be addressed through the mitigation of failure through regular monitoring, and the low-risk assets could be accepted with caution.
- **Establish a sustainable facilities funding model that fits the needs of the community.**
  - In light of the annual capital investment and O&M need outlined in **Figure 5-4**, the City should budget for totally $68M per year, on average, for facility capital reinvestment, capital development, and O&M expenditures of over the next 20 years.

  - Review financial modeling assumptions on reinvestment rate and replacement values and update the financial model with new information as it becomes available. The financial model is based on a number of key assumptions that could have a significant impact on the outcomes of the model.

- **Continue to find ways to improve AM initiatives across the City by maintaining a high level of AM awareness through training, communication, and knowledge sharing.**
  - Conduct an AM Software Assessment to identify future system requirements that may include enhancing existing software, adding-on, or replacing.
  - Develop a Knowledge Retention Strategy & Internal Communications Plan to document staff AM knowledge and experience for reporting and succession planning purposes. Communicate AM improvement initiatives and enhance AM awareness internally through internal communication.

aecom.com

Asset Management Plan

Non-Core Assets
Parks

City of Vaughan

September 2022 (version 2)

Delivering a better world

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1. Introduction

1.1 Background

The City of Vaughan (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 one with increasing concentrations of 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, with a population of over 300,000, is rapidly growing and it is projected that the number of residents will continue to increase to 430,000 by 2031. The City is also home to a well-diversified and expanding employment sector and has the largest supply of new employment lands in the Greater Toronto Area (GTA). It is projected that employment numbers within City boundaries will increase from 150,000 to 278,000 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 capture the non-core infrastructure assets so as to provide the City with a comprehensive AM Program.

The objective of this AMP is to deliver a financial and technical roadmap for the management of the City's parks 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, 2024 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 LoS 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, Ice Rinks, Skate Parks, Soccer Fields, and Tennis Courts.
Park Amenities	Benches, Fitness Equipment, Picnic Tables, Playgrounds, Soccer Benches, Soccer Bleachers, and Spray Pads.
Transportation Infrastructure	Park Pathways, Park Parking Lots, and Park Signs.
Electrical	Parking Lot Lights, Pathway Lighting, and Pathway Light Underground Cables.
Structures	Shade and Shelters
Park Facilities	Storage Bunkers

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.

2. State of Infrastructure

The City's network of parks includes over 230 sites distributed across the City accounting for more than 650 hectares 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	393
Public Square	4	1
District	15	112
Regional	4	133
Greenway	11	5
Total	**237**	**643**

2.1 Parks Asset Inventory & Hierarchy

Table 2-2 presents the City's Parks assets inventory and hierarchy. Parks assets are categorized into six categories: Sports Fields, Park Amenities, Transportation Infrastructure, Electrical, Structures, and Park Facilities.

The City's sport fields include a total of 377 fields of baseball diamonds, basketball courts, bocce courts, ice rinks, skate parks, soccer fields, and tennis courts. Park amenities include over 1,600 assets such as playgrounds, picnic tables, etc. Transportation Infrastructure include 100 km park pathways, 22 park parking lots, and 986 park signs. Electrical assets include parking lot lights, pathway lighting, and underground cables. There are a total of 151 shade and shelters. Park facilities include four storage bunkers.

Table 2-2: Parks Asset Inventory & Hierarchy

Asset Category	Asset Type	Quantity	Unit of Measurement
Sports Fields	Baseball Diamonds	58	Ea.
	Basketball Courts	73	Ea.
	Bocce Courts	23	Ea.
	Ice Rinks	5	Ea.
	Skate Parks	10	Ea.
	Soccer Fields	149	Ea.
	Tennis Facilities (Courts)	59 (134)	Ea.
Park Amenities	Benches	955	Ea.
	Fitness Equipment	23	Ea.
	Picnic Tables	168	Ea.
	Playgrounds	271	Ea.
	Soccer Benches	101	Ea.

[1] City of Vaughan. 2018. Vaughan Parks Redevelopment Strategy

Asset Category	Asset Type	Quantity	Unit of Measurement
	Soccer Bleachers	63	Ea.
	Spray Pads	20	Ea.
Transportation Infrastructure	Park Pathways	100	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 Shelters	151	Ea.
Park Facilities	Storage Bunkers	4	Ea.

2.2 Current Replacement Value

The estimated replacement value is the cost of replacing an existing asset in today's dollars, considering inflation. These costs are developed based on the City's records within the Parks Redevelopment Strategy, Citywide records and the City's historical contract information. Where applicable, a 2% annual inflation rate was used to estimate the 2022 values; this rate is representative of the average inflation rate in Canada for the past 5 to 10 years. The total replacement values in this section are rounded to the nearest thousand.

Table 2-3 shows that the City owned parks assets is valued at approximately $243M, with sports fields and parks amenities comprising approximately 36% and 35% of the total replacement value, respectively.

Table 2-3: Parks Assets Replacement Value

Asset Category	Asset Type	Unit Cost	Total Replacement Cost (2022)
Sports Fields	Baseball Diamonds	$61,000 - $597,000 / Ea.	$20,406,000
	Basketball Courts	$54,000 - $113,000 / Ea.	$6,838,000
	Bocce Courts	$96,000 - $603,000 / Ea.	$6,397,000
	Ice Rinks	$1,270,000 / Ea.	$6,347,000
	Skate Parks	$225,000 - $1,110,000 / Ea.	$3,137,000
	Soccer Fields	$17,000 - $2,211,000 / Ea.	$31,574,000
	Tennis Courts	$81,400 - $383,000 / Ea.	$13,288,000
Park Amenities	Benches	$2,260 / Ea.	$2,151,000
	Fitness Equipment	$33,800 / Ea.	$778,000
	Picnic Tables	$2,600 / Ea.	$436,000
	Playgrounds	$56,400 - $508,000 / Ea.	$75,586,000
	Soccer Benches	$3,100 / Ea.	$313,000
	Soccer Bleachers	$6,000 / Ea.	$378,000
	Spray Pads	$233,000 - $326,000 / Ea.	$5,106,000
Transportation Infrastructure	Park Pathways	$150 / m	$14,970,000
	Park Parking Lots	$115 / m2	$12,204,000
	Park Signs	$415 - $5,500	$1,721,000
Electrical	Parking Lot Lights	$8,000 / Ea.	$1,560,000
	Pathway Lighting	$8,000 / Ea.	$16,896,000

Asset Category	Asset Type	Unit Cost	Total Replacement Cost (2022)
	Pathway Light Underground Cables	$75 / m	$3,955,000
Structures	Shade and Shelter	$45,100 - $226,000 / Ea.	$18,036,000
Park Buildings	Storage Bunkers	$118,250 / Ea.	$473,000
Parks Total			**$242,550,000**

2.3 Age & Remaining Service Life

The average age and remaining service life (RSL) were assessed based on the 2016-2017 condition assessment results[2], industry standards, and discussions with the City's staff. In the case where parks conditions were not available, the install date together with the expected service life (ESL) were used to determine the RSL.

To apply the actual condition data obtained in 2016-2017 for estimating the RSL, the remaining life of each asset was adjusted based on an "apparent age" to reflect the current condition. Apparent age is estimated based on the observed condition as apposed to the expected condition **Eq. [2]** at the time of condition assessment. Expected condition is estimated by age at the time of condition assessment **Eq. [1]**. Below is the methodology for estimating apparent age:

- If the observed condition was worse than the expected condition at the time of assessment, the apparent age was linearly scaled upwards according to the observed condition **Eq. [3] - Formula 1**.
- If the observed condition was better than the expected condition at the time of assessment, the apparent age was non-linearly scaled downward according to the difference between the observed and expected conditions **Eq. [3] - Formula 2.**
- If the observed condition was the same as the expected condition at the time of the assessment, the apparent age was set equal to the actual age of the asset.
- If there is condition data for assets installed after 2017, install date together with the ESL were used to determine the RSL.

Then, the "apparent age" was updated to the current year 2022 to reflect the current apparent age. Below are the key equations used to implement the methodology.

Age at Time of Condition Assessment = Age – (Start Year [2022] – Condition Assessment Year) **Equation [1]**

Expected Condition (1-5 scale) = 1 + Age at Time of Condition Assessment / ESL x 4 **Equation [2]**

Apparent Age at the time of Condition Assessment **Equation [3]**

- Formula 1*: Apparent Age = [(Condition Rating – 1) / 4] x ESL*
- Formula 2*: Apparent Age = [1 – (Expected Condition – Condition Rating) / 10] x Age at Time of Condition Assessment*

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.

[2] City of Vaughan. 2016-2017. Parks Assets Condition Assessment Results.

- **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 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.

Figure 2-1 shows the average asset age and average RSL weighted by replacement value by parks asset type. It should be noted that the age presented is the actual average age calculated based on install date and the RSL is based on apparent age.

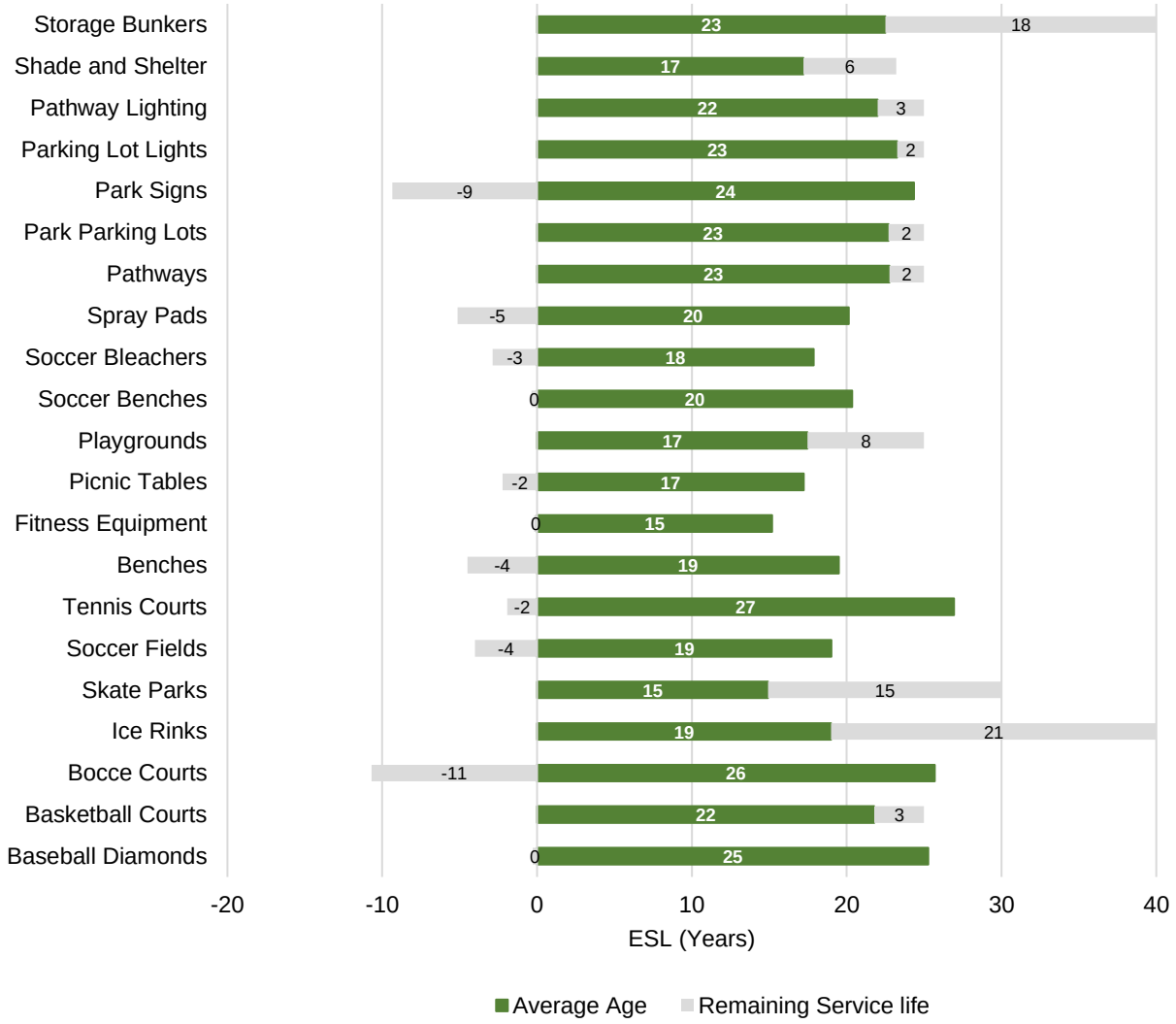

Figure 2-1: Average Parks Asset Age vs Remaining Service Life

2.4 Asset Condition

All assets are expected to deteriorate over their lifetime, and their assigned condition reflects the physical state of the asset. The physical condition of the assets is based on consultations with City staff who have experience in managing the assets, combined with existing condition data[3] (2016-2017 Condition Assessment).

Where previous condition assessment data is not available, two-parameter Weibull distribution function was used to assess the current condition and to project the future condition of the City's 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 **Eq. [4]**:

$$f(x;\alpha,\beta) = e^{-\left(\frac{x}{\beta}\right)^{\alpha}}$$ **Equation [4]**

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

Table 2-4 Table 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	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	>=3.5	Poor	93% - >100%	61% - 100%

The updated 2022 "apparent age" as described in **Section 2.3** was used as the age input in the Weibull distribution function to estimate the current condition. Where previous condition assessment data was not available, the age input was based on the install date.

Figure 2-2 provides a summary of the condition for the City owned parks assets, weighted by replacement value. The City has a total of 58% of parks assets in Very Good and Good condition. Approximately 33% of assets are in Poor condition meaning that they are approaching or exceeded their ESL, indicating a need for investment in the short term. The remaining 9% of assets are in Fair condition indicating that they are meeting current needs but may require attention as they age.

[3] City of Vaughan. 2016-2017. Parks Assets Condition Assessment Results.

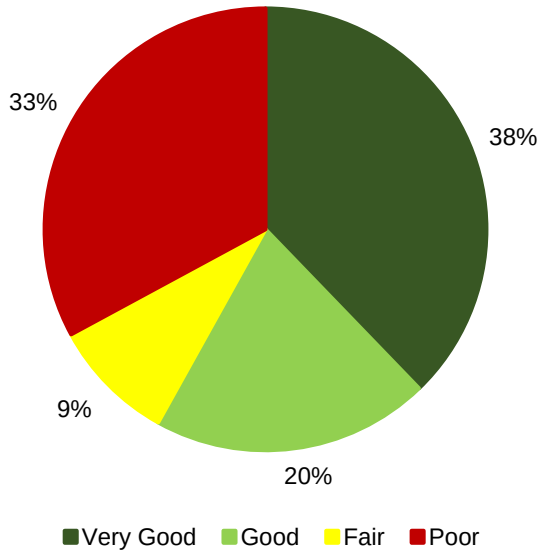

Figure 2-2: Parks Asset Condition Summary

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 74% of playgrounds (the highest replacement value among parks assets) in Very Good to Good condition. More than 50% of soccer field and baseball diamonds are in Very good to Fair condition. Overall, the ice rinks, skate parks and storage bunkers are in Very Good to Good condition. As per the same figure, Bocce courts has over 80% in Poor condition.

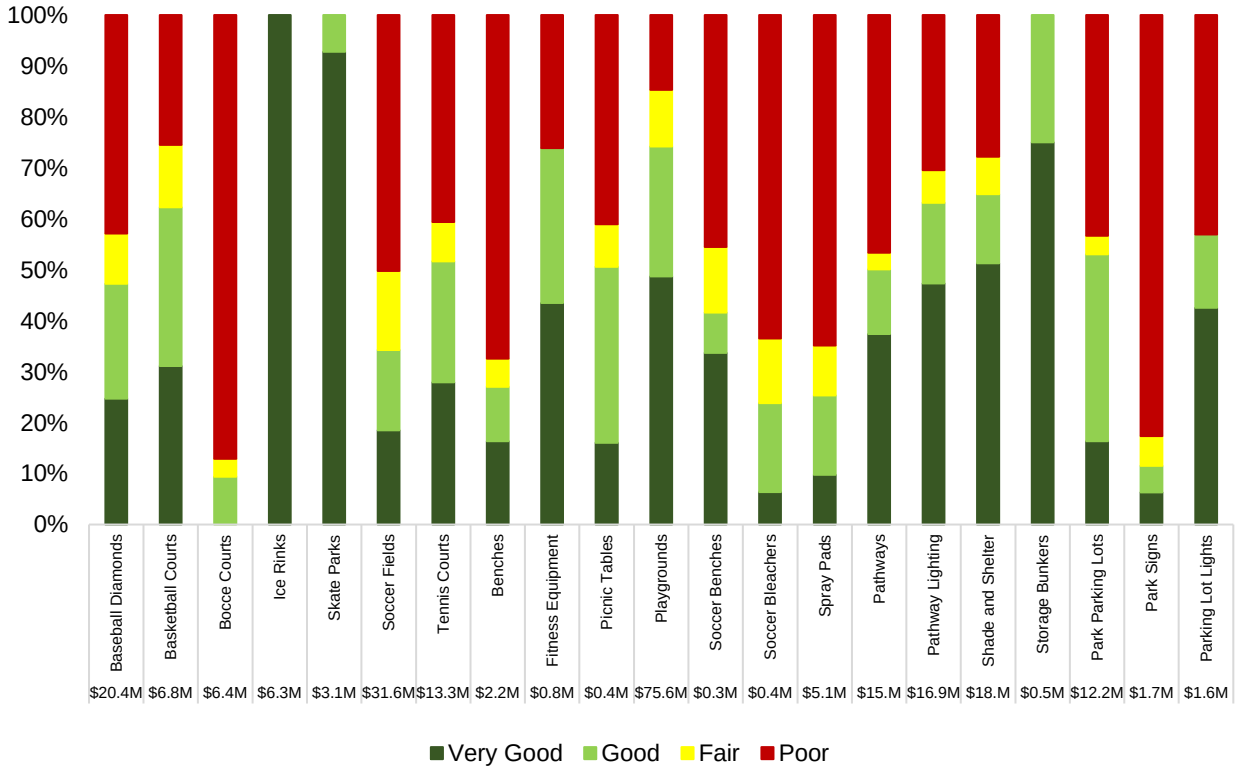

Figure 2-3: Distribution of Parks Asset Condition

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.

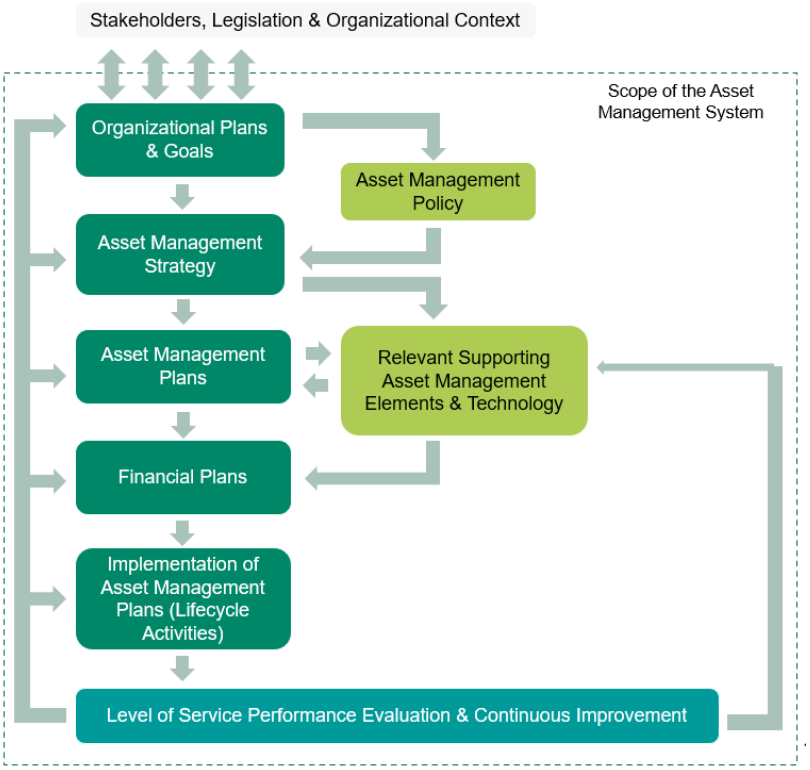

Figure 3-1: LoS within the AM System

In AECOM'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**).

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 & 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 & Capacity	Customers can easily access the service with minimal inconvenience.
Health & 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 & 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:

- **Other Service Providers** – Stakeholders that require the municipal service/assets to provide their own services (e.g., organized groups that use park space, such as recreational sports teams, etc.).
- **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.

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 Facility Stakeholders & 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 Levels of Service 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 oppose 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.

Measured in the most recent Citizen Satisfaction Survey conducted by Ipsos, the percentage of respondents satisfied with Maintenance of Parks and Greenspace was 90%. Additionally, as illustrated in **Figure 3-2**, the percentage of properties within 500 m of a public Park is 93%.

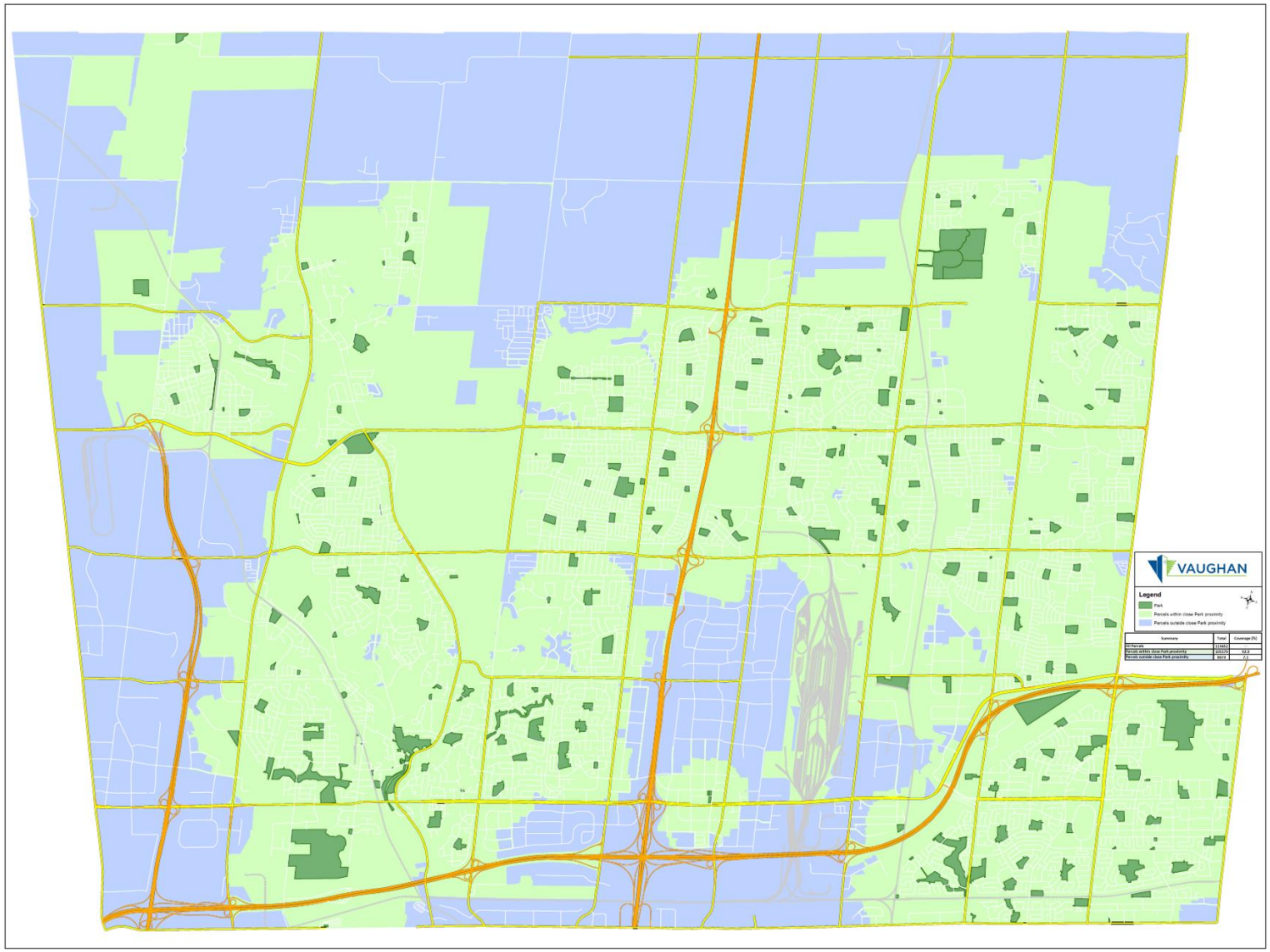

Figure 3-2: Properties within 500 m of a Public Park

3.5 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
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 for the City to provide park amenities. • There is an interest by developers to build private parks exclusive to strata owners only. • The City has some privately owned parks by commercial entities. These parks are a mix of businesses, retail, and park space. The City noted that these developments tend to become more retail oriented than park oriented over time.
Climate Change	• Change in climatic temperature is leading to warmer winters 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 limited, as the result of a shorter growing season.
Demographics and Shifting Behaviours	• The City is noticing an increased need for dog parks. • There seems to be low or declining interest in the City's bocce courts and basketball courts, but an increase in pickleball courts 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.

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. Considering entire asset lifecycles can ensure we make sound decisions that consider present and future service delivery needs.

The overarching goal of life cycle management is to maximize the long-term benefits and services 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.

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.

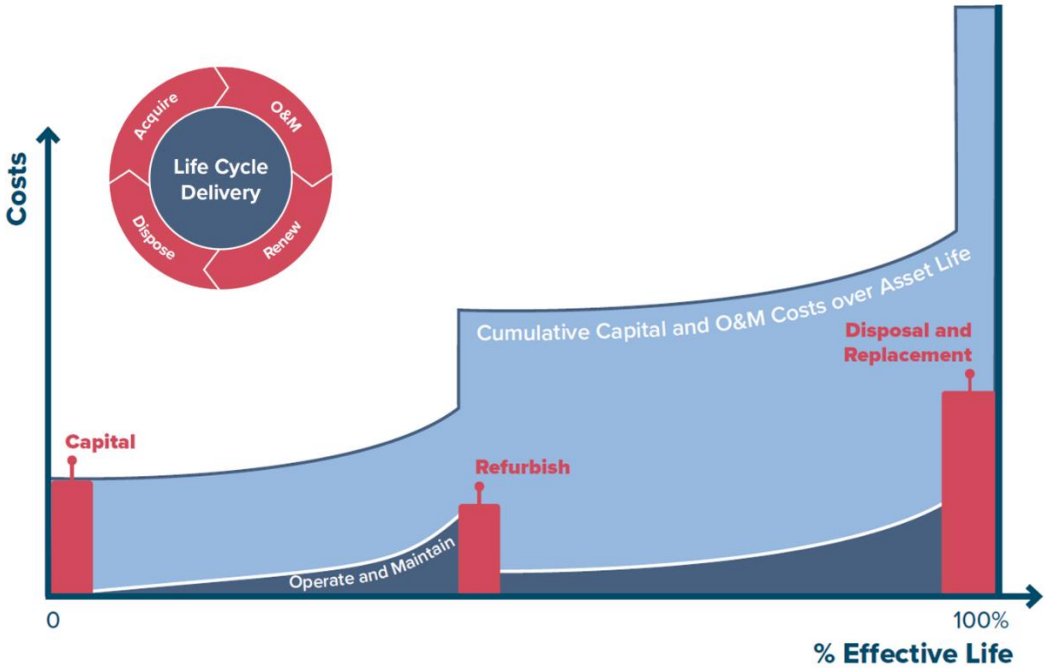

Figure 4-1: Life Cycle Cost Accumulation Over Asset Life

4.1 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-built avenues, for the latter they get reimbursed based on development charges and approved budget for the specific parks. The decision-making is based at meeting the target service levels and other master planning policies, such as the provision of five percent green field for the developed land.

For the City developed parks, the procurement process looks at the design of playgrounds, asphalt pathways, and other sub-divisional requirements. 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 the parks design. The City envisions to move towards the developer-built approach for all of its future projects wherein the collection of development charges is identified as a funding source.

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.

4.2 Operation 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 (approximately $8.0M).

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

O&M Activities	Description	Five-Year Average Cost (2016-2020)
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.	$6,124,000
Overhead	All overhead costs (e.g., assistant supervision, admin costs, staff training, yard operations, equipment/ vehicle maintenance, services-in-kind)	$1,826,000
Total		**$7,950,000**

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 field the City has sharing agreements with school boards, where recreation is identified as a revenue source.

4.3 Renewal and Replacement Strategies

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. 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.

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[4]. Currently, the reconstruction programs for the tennis courts and playgrounds are underway.

4.4 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-off whereas others such as rubber crumble is recycled.

[4] City of Vaughan. 2018. Vaughan Parks Redevelopment Study.

5. Funding Need Analysis

The lifecycle analysis was implemented in an MS Excel Asset Lifecycle Model, which integrated asset inventory, age, apparent age, ESL, replacement values, and condition to develop a theoretical asset replacement cycle for each park 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 in years (i.e., replacing assets that has exceeded their ESL) in inflated dollar values. Where there is condition data available, apparent age was used to estimate the asset replacement need. The inflation rate is 2% base on the consultation with the City staff. 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 $15.6M over the next 20 years in inflated dollar values. This is equivalent to a total of approximately $312M over the next 20-year period, as presented in **Figure 5-1**. It should be noted that there are significant backlogs for reinvestment on the parks assets that has already exceeded their ESL as highlighted in red in the 2022 reinvestment need including the need for sport field ($33M), park amenities ($12M), transportation infrastructure ($10M), electric ($4.3M), and structure ($4M).

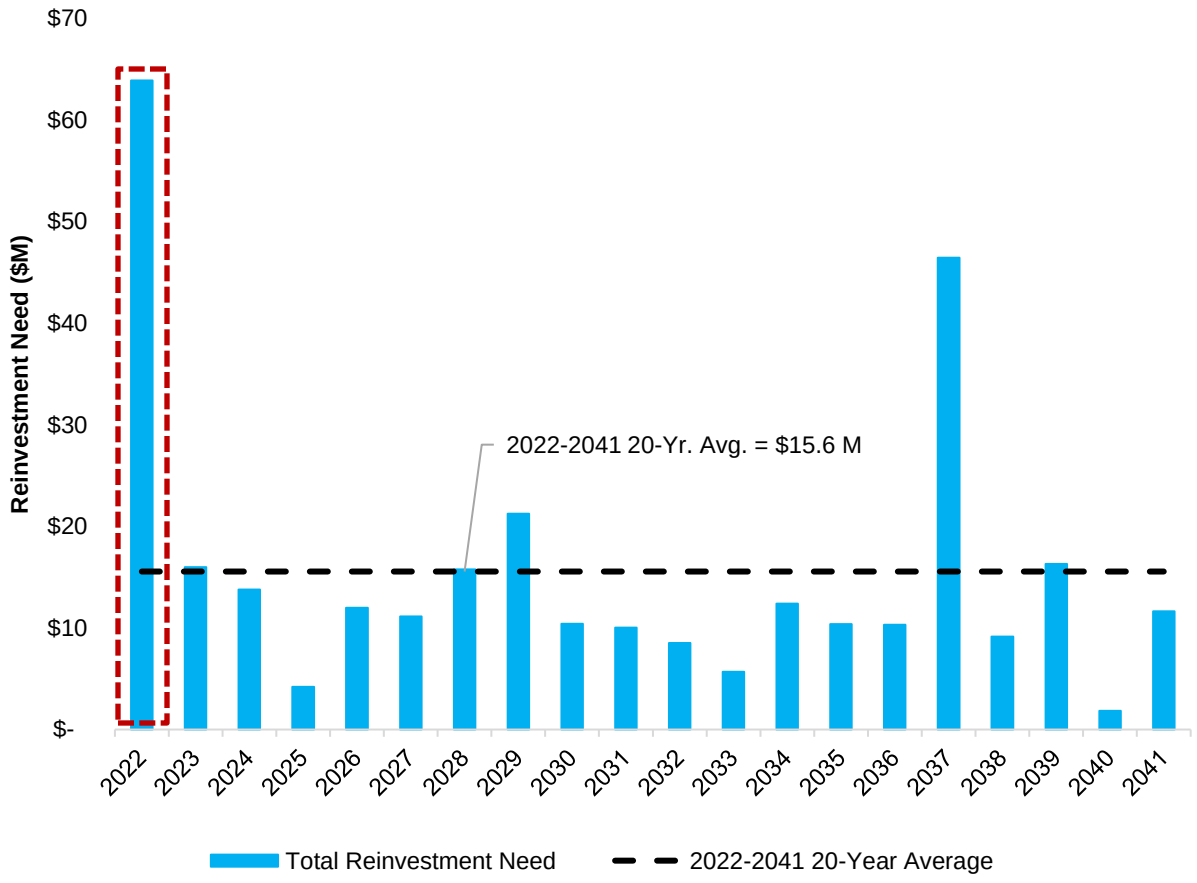

Figure 5-1: Parks Assets 20-Year Reinvestment Need

As shown in **Figure 5-2**, in 2022, the reinvestment needs are primarily from the aged sport fields followed by park amenities and transportation infrastructure. Looking ahead to the year 2037, the City is recommended to prepare for the increased reinvestment need for sport fields as they continue to age and start to approach and exceed their respective ESLs.

The detailed reinvestment needs for sports fields, park amenities, transportation infrastructure, electrical, structures, park facilities are presented in **Table 5-1** in inflated dollar values.

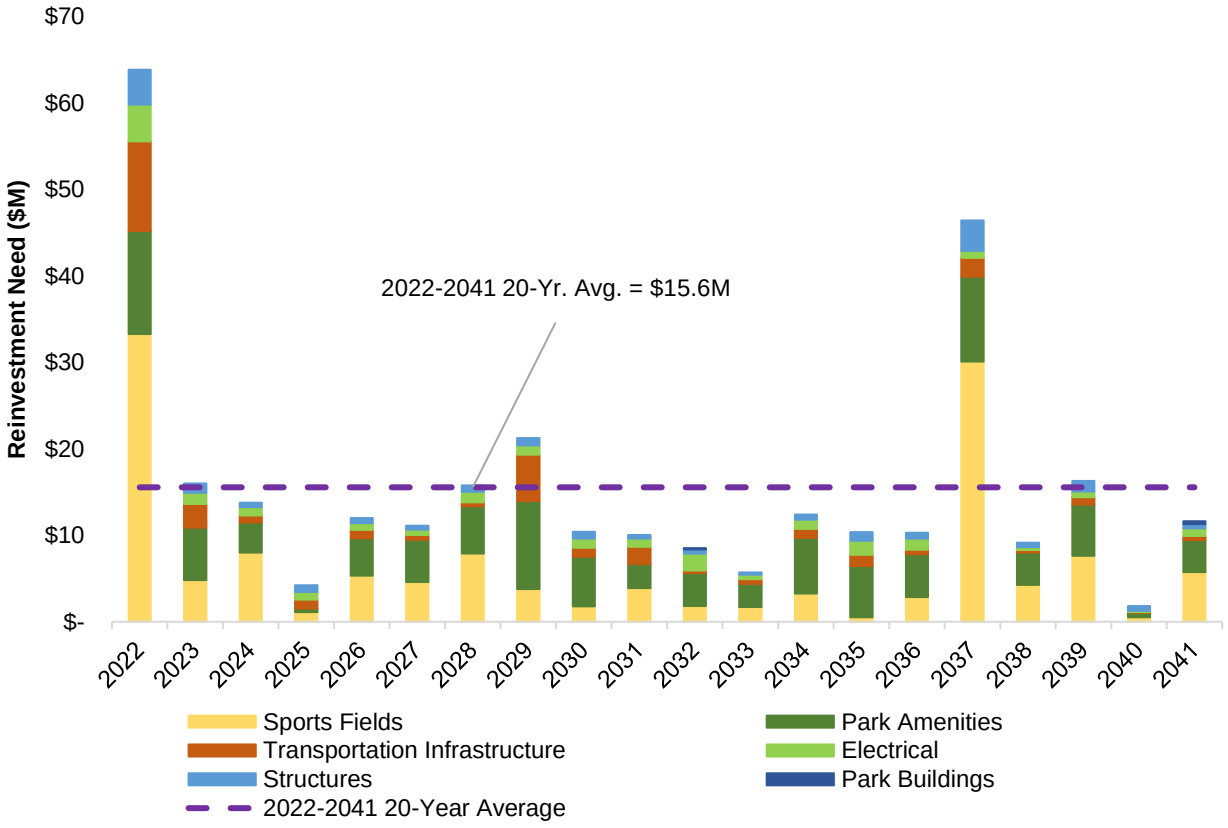

Figure 5-2: Parks 20-Year Reinvestment Need Details

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

	Sports Fields	Park Amenities	Transportation Infrastructure	Electrical	Structures	Park Facilities	Total
Annual Average Need	$6,641,000	$5,143,000	$1,649,000	$1,122,000	$974,000	$25,000	**$15,554,000**
20-Year Total	$132,820,000	$102,860,000	$32,980,000	$22,440,000	$19,480,000	$500,000	**$311,080,000**

5.2 50-Year Parks Assets Reinvestment Need

Looking ahead in the long term, the average annual reinvestment rate for the City's parks assets is $11.4M over the next 50 years in inflated dollar value, for a total of approximately $570M, as presented in **Figure 5-3**.

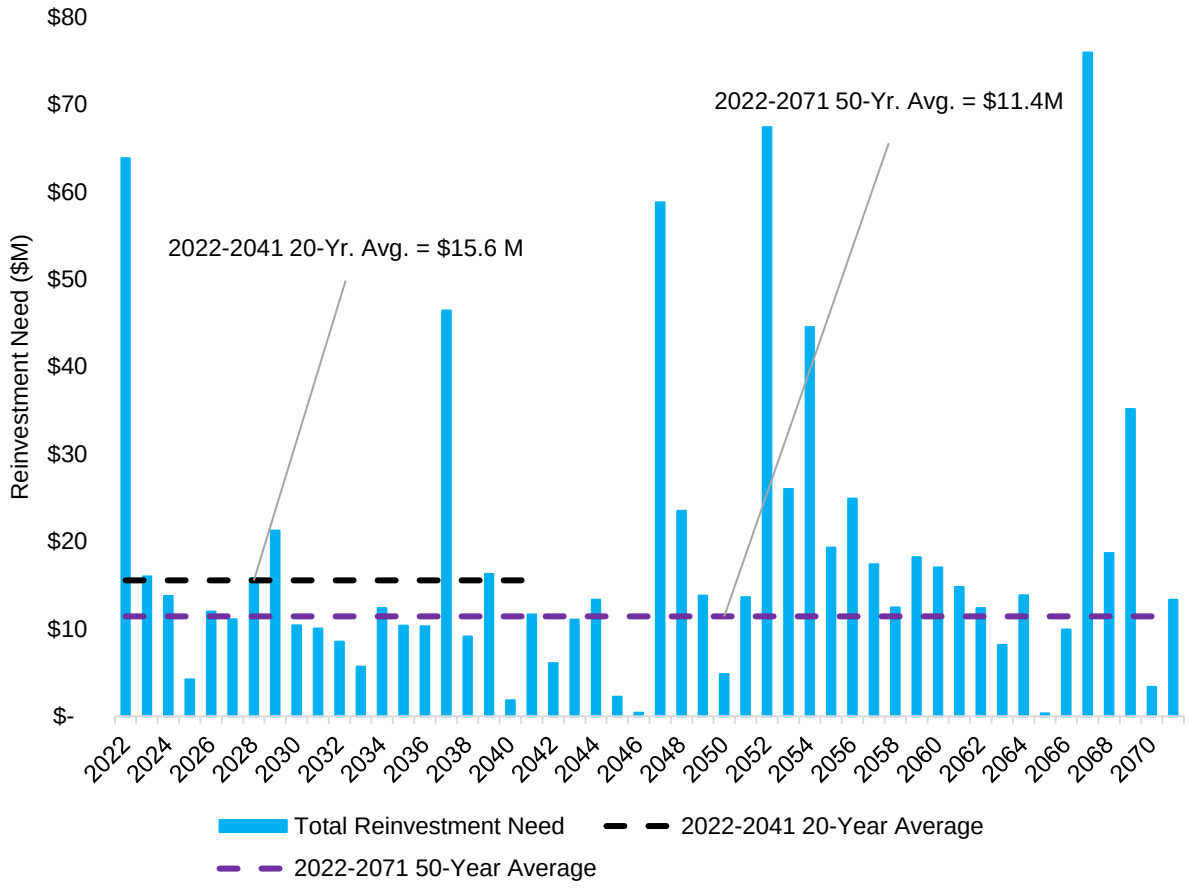

Figure 5-3: Parks Assets 50-Year Total Reinvestment Need (Inflated Dollar Value)

5.3 Full Funding Need Profile

Figure 5-4 shows a full picture of the City's parks assets 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** was overlaid with the City's parks O&M cost (see **Table 4-1**), and annual average parks growth-related development cost provided by the City in inflated dollar values.

Parks assets requires approximately $10M annually over the next 20 years for O&M, equivalent to totally $200M in inflated dollar values. The parks growth-related cost or development cost (DC) requires approximately $236M over the next 20 years, equivalent to roughly $11.8M annually. As such, with the addition of O&M and DC, the total average annual funding need for the City's parks assets increases to approximately $37.4M annually, for a total of $748M over the next 20-year period.

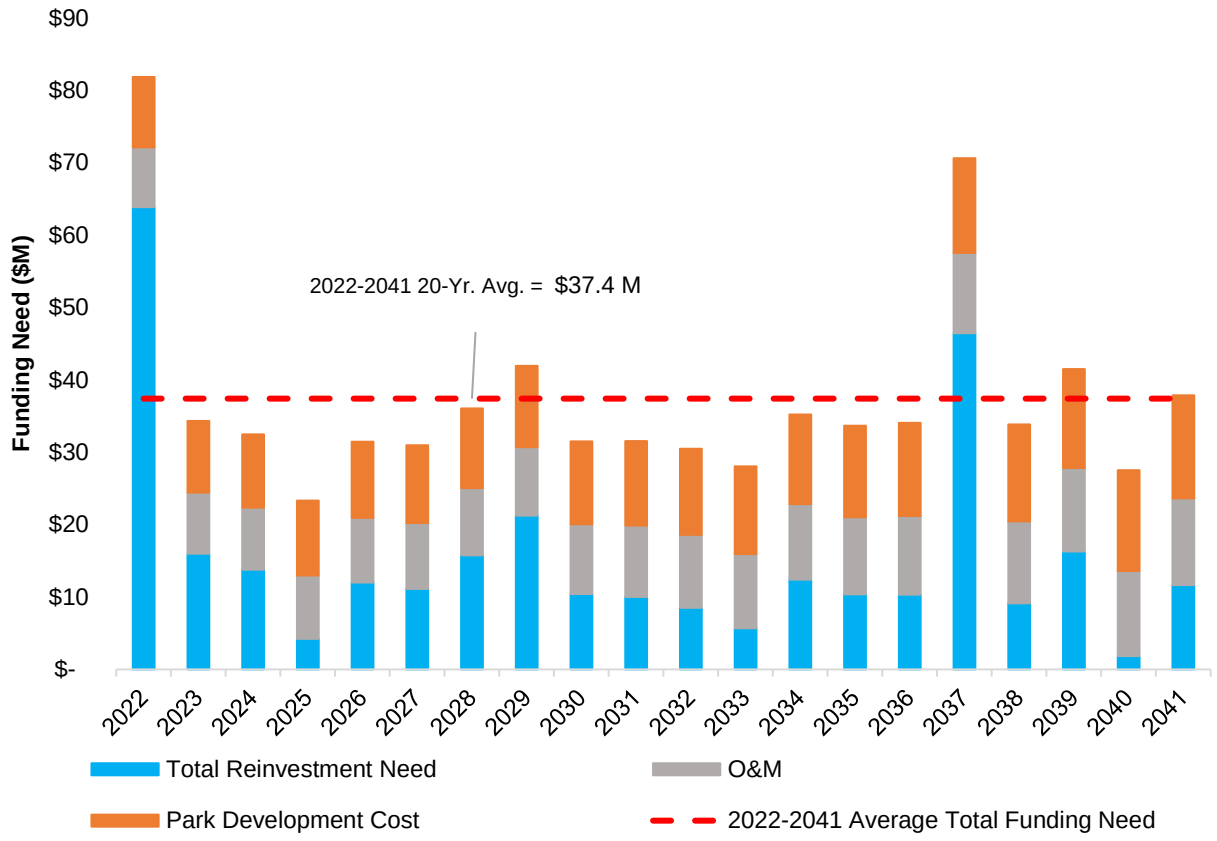

Figure 5-4: Parks 20-Year Capital Investment and O&M Cost Forecast

6. Recommendations for Parks AMP Continuous Improvement

Continuous improvement is an important component of any AM program and is achieved through the implementation of recommended improvement initiatives which support sustainable service delivery. AECOM has identified a set of activities that represents the next stage of AM planning and implementation within the City.

- **Continue to refine the asset inventory and close existing data gaps, so as to have a more accurate representation of the current state of the parks assets; and, ultimately, to make more informed and defensible decisions**.
  - The City made great efforts in maintaining the current parks asset inventory. AECOM recommends the City to continue maintaining the parks inventory, keep updating the inventory as assets are acquired or disposed.
  - It is recommended that the City establish individual inventory for asset types that has components with different ESL (e.g., establish surface and equipment inventory for playgrounds), which could increase the accuracy of AM planning decisions.
  - The City to develop an asset inventory for parks asset types that are not included in this AM plan (e.g., irrigation assets), which will support the funding need forecasts for these assets as they age and deteriorate.
- **Develop a formalized parks assets condition assessment process and use consistent condition grading schemes for parks assets.**
  - AECOM proposes that a consistent condition grading scale be applied across parks asset portfolio to align with other asset categories at the City. The previous condition assessment (2016-2017) for parks assets was using a five-point condition rating scale, while starting from this iteration of AM plan, four-point condition rating system is adopted.
  - The grading system should contain a description of the condition, which is tied directly to each condition grade, and a description of the asset performance and level of corrective and preventive maintenance required for assets falling within a certain condition rating category.
  - Perform condition assessments on the most critical assets first following a systematic risk management approach. This will ensure that the parks assets are assessed using the same methodology, and prioritized according to the asset's criticality, enabling a more defensible business case when raising issues of asset degradation to senior management and Council.
  - Once parks have confirmed its condition rating system, onsite condition assessments should be conducted to fill condition information gaps across its asset inventory. This will support more informed asset management and maintenance decisions based on the specific condition.
- **Refine the LoS Framework.**
  - Collect current asset performance data for key performance indicators (KPIs) that are not currently being tracked, including associated costs for managing the assets and delivering the LoS.
  - Analyze asset performance data to determine trends and establish annual performance benchmarks.
  - Engage in a discussion with key stakeholders to establish service level targets and identify associated costs to meet those targets.
  - Once LoS targets have been decided upon, the City should develop strategies on how to meet service level targets considering its existing operating environment (i.e., staff availability, current funding, resources, etc.).
  - Develop a Customer Consultation Plan to engage the public and other stakeholders on the LoS framework and to better understand customers' willingness to pay for enhanced service levels.

- **Incorporate risk assessment for future iterations of the AM plan, and use the risk assessment results to drive future condition assessments and financial needs forecasting.**
  - Conduct a comprehensive criticality and risk assessment of parks assets to inform work prioritization.
  - Review risk attribute values periodically to ensure alignment with business objectives and appetite.
  - Overlay the risk model with the current state of the assets (i.e., condition), and the financial forecast. Using this approach, the City could focus its monitoring, maintenance, and renewal and replacement budget and activities on high-risk assets. Medium risk infrastructure could be addressed through the mitigation of failure through regular monitoring, and the low-risk assets could be accepted with caution.
- **Establish a sustainable Parks funding model that fits the needs of the community.**
  - In light of the annual funding need outlined in **Figure 5-4,** and based on the assets in scope, the City should budget for totally $37.4M per year, on average, for parks capital reinvestment ($15.5M annually), capital development ($11.8M annually), and O&M expenditures ($10M annually) of over the next 20 years.
  - It is recommended to update the funding needs completed in this assignment based on any additional asset inventories when they are available (e.g., irrigation assets).
  - Review financial modeling assumptions on reinvestment rate and replacement values and update the financial model with new information as it becomes available. The financial model is based on a number of key assumptions that could have a significant impact on the outcomes of the model.
- **Continue to find ways to improve AM initiatives across the City by maintaining a high level of AM awareness through training, communication, and knowledge sharing.**
  - Conduct an AM software assessment to identify future system requirements that may include enhancing existing software, adding-on, or replacing.
  - Develop a Knowledge Retention Strategy and Internal Communications Plan to document staff AM knowledge and experience for reporting and succession planning purposes. Communicate AM improvement initiatives and enhance AM awareness internally through internal communication

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City of Vaughan
Asset Management Plans

(Urban Forestry)

City of Vaughan

Project number: 60641721

May 2021

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1. Introduction

The City of Vaughan ("the City") appointed AECOM Canada Ltd. ("AECOM") to assist in the renewal of the City's Asset Management (AM) Plans for its core infrastructure assets.

1.1 Background

The City of Vaughan (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 one with increasing concentrations of 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, with a population of over 300,000, is rapidly growing and it is projected that the number of residents will continue to increase to 430,000 by 2031. The City is also home to a well-diversified and expanding employment sector and has the largest supply of new employment lands in the Greater Toronto Area (GTA). It is projected that employment numbers within City boundaries will increase from 150,000 to 278,000 by 2031.

1.2 Objectives

In 2018, by City Council approval, the Corporate Asset Management (AM) Policy 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.

As per Ontario Regulation (O. Reg) 588/17, the City updated its AM Strategy and core infrastructure AM Plans (AMPs) in early 2021; now the City is advancing its AM Program further by capturing its non-core infrastructure assets so as to develop a comprehensive understanding of its entire asset portfolio.

The objective of this AMP is to deliver a financial and technical roadmap for the management of the City's Urban Forestry 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 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, 2024 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 LoS 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 asset class, which are owned and maintained by the City, as shown in **Table 1-2**.

Table 1-2: In-Scope Urban Forestry Assets

Asset Category	Sub-Assets
Urban Forestry	Street Trees
	Park Trees
	Woodlots
	Open Spaces

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 activities to maintain identified current LoS, minimize associated asset risks, and to optimize costs over the whole lifecycle of the asset.

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 126,541 street trees and 4,377 hectares of open spaces across the community. 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 City owned urban forests system has a value of approximately $473M. The Urban Forestry inventory is categorized into four types of trees: street trees, park trees, woodlots, and open spaces. The most common species of trees at the City are the Norway Maple, Honeylocust, and Basswood species. Woodlot are open spaces that has designated City's crew to operate and maintain, where open spaces are City owned but they do not need to take care of or there are less maintenance involved. Tree density of woodlots and open spaces are also different. For some open spaces (naturalized areas), the City shares responsibility with Toronto Region and Conservation Authority (TRCA).

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 inflated dollar value to represent current value.

[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 2-1 Asset Inventory & Valuation (Urban Forestry)

Asset Category	Asset Type	No.	Unit of Measure	Average DBH (cm)	New tree Unit Replacement Cost[2]	Mature tree Replacement Cost per DBH class per Species[3]	Total Replacement Cost[4]
Urban Forestry	Street Trees[1]	126,541	Ea.	18	$435 - $510	$1,100 - $12,484,000	$ 114,825,000
	Park Trees	-	Ea.	-	$435 - $510	-	-
	Woodlots	-	Ha.	-	-	-	-
	Open Spaces[5]	4,377	Ha.	43	-	-	$ 357,723,000
Total							**$ 472,548,000**

[1] The number and diameter at breast height (DBH) of live street trees were sourced from City of Vaughan Parks & Urban Forestry 2019 inventory report.
[2] New tree unit replacement cost include supply, delivery, set up of the site, and two-year warranty period.
[3] Mature tree replacement cost per DBH class was sourced from the City's 2019 iTree replacement cost report and inflated to current value; mature trees cost for various DBH groups is available for various tree species; the range of costs is for minimum and maximum cost for DBH groups of 6 to 12 in, which is considered to be approximately the size of mature trees.
[4] Total replacement cost was sourced from the 2016 iTree Analysis reports, inflated to current value.
[5] The number and DBH of open spaces was estimated based on three major assumptions: (1) trees<10cm DBH excluded; (2) Only groups of trees within City boundaries that >¼ ha on City managed lands or >1 ha on lands not managed by the City were included; (3) Only groups of trees where canopy cover was = or > than 20% were included; the average DBH of open space trees are weighted by canopy cover.

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. The analysis is based on several assumptions including trees<10cm DBH excluded; only groups of trees within City boundaries that >¼ ha on City managed lands or >1 ha on lands not managed by the City were included; only groups of trees where canopy cover was = or > than 20% were included. Please refer to the City's 2016 i-Tree report 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	Unit of Measure
Street trees	Pollution removal	13.73	Tons/year	$70,000	Per year
	Carbon Storage	15.63	Thousand tons	$1,799,660	Per year
	Carbon Sequestration	459.6	Tons	$52,890	Per year
	Oxygen production	1.226	Thousand tons/year	-	-
	Avoided runoff	1.408	Million cubic feet/year	$102,350	Per year
Open spaces	Pollution removal	28.3	Tons/year	$146,850	Per year
	Carbon Storage	43.4	Thousand tons	$4,692,350	Per year
	Carbon Sequestration	982	Tons	$112,620	Per year
	Oxygen production	2.619	Thousand tons/year	-	-
	Avoided runoff	2.907	Million cubic feet/year	$210,880	Per year
Total				**$7,187,600**	Per year

2.2 Age & Remaining Service Life

There are a variety of tree species that are planted and maintained at the City with differing lifespans. The trees are also grown under different environmental conditions. Therefore, estimating expected service life (ESL) for urban forestry assets is complicated. Based on workshop discussion with the City staff and information from similar municipalities, the average expected service life for street trees, park trees, and open street trees are determined to be 40, 40, and 100 years on average, respectively. Street trees often do not last as long as open space trees because of inadequate moisture, nutrition, more exposure to salt conditions, and other environmental factors. It should be noted that trees can achieve ages greater than 100 years if they are planted in the right place, monitored regularly, maintained proactively, and protected from development.

As the City's tree age information is not documented comprehensively, the age was estimated based on the DBH and tree growth factor for different species. When there is no adequate data for the estimation, the group median was used as shown below.

$$Age\ of\ Tree = DBH\ (in) \times Growth\ Factor$$

Figure 2-1 illustrates the average tree ages and remaining service life for street trees. The street trees are on average 80% through their expected service life.

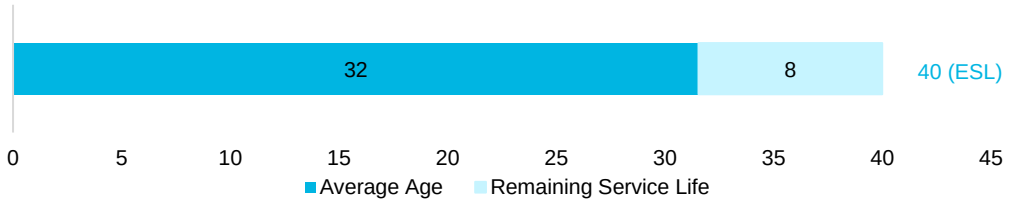

Figure 2-1: Average Asset Age as a Proportion of Average Expected Service Life (Street Trees)

For park trees, woodlots, and open space trees, age information has not been systematically documented or the information is not readily available.

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 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 2-3 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	>=3.5	Poor	93% - >100%	61% - 100%

2.3.2 Condition Summaries

Figure 2-2 presents the condition profile for street trees based on the assumption of 40 years life expectancy. The City has 64% of street trees in Very Good to Good condition. There are approximately more than a quarter of trees in 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 8% 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.

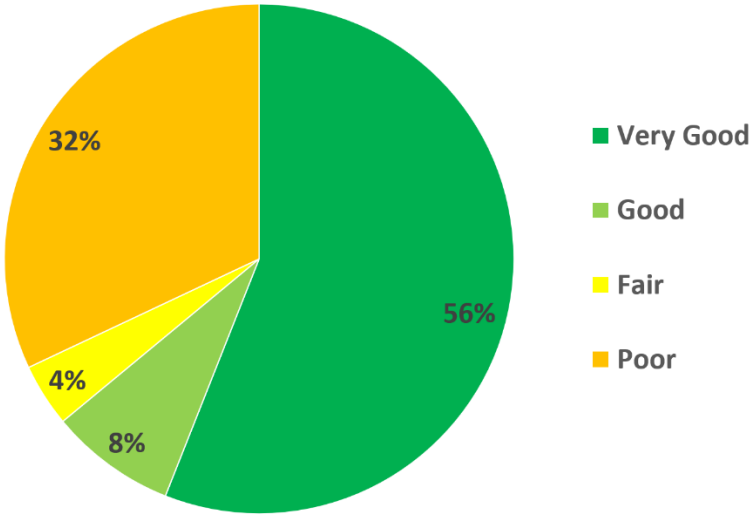

Figure 2-2: Asset Condition Summary (Street Trees)

For park trees, woodlots, and open space trees, age information has not been systematically documented or the information is not readily available, thus the condition profiles are not presented.

3. Levels of Service

3.1 Purpose

LoS supports every aspect of the overall AM System as shown in 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.

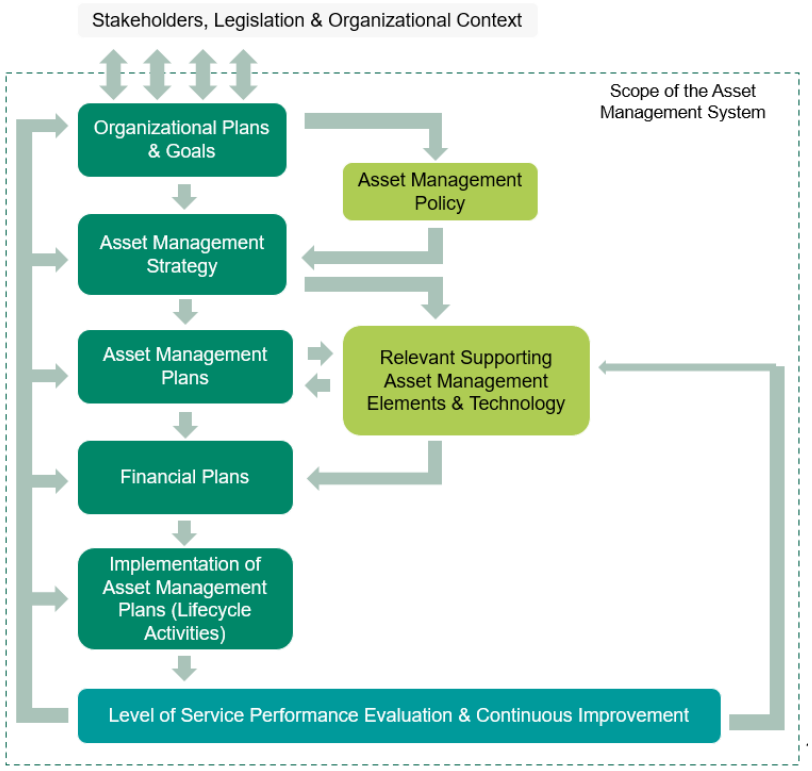

Figure 3-1: LoS within the AM System

In AECOM'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**).

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 & 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 & Capacity	Customers can easily access the service with minimal inconvenience.
Health & 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 & 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 Levels of Service 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 oppose 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.

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: Levels of Service Metrics (Urban Forestry)

Customer levels of service	Technical levels of service
• 5,771 new trees per year (2020).	• 11,252 trees inspected per year (2020).
• 21.9% canopy coverage (2020).	• 10,083 trees pruned per year (2020).

4. Asset Lifecycle Strategies

Asset lifecycle management focuses on the specific activities we must undertake during all phases of the asset lifecycle. Considering entire asset lifecycles can ensure we make sound decisions that consider present and future service delivery needs.

The overarching goal of life cycle management is to maximize the long-term benefits and services 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.

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.

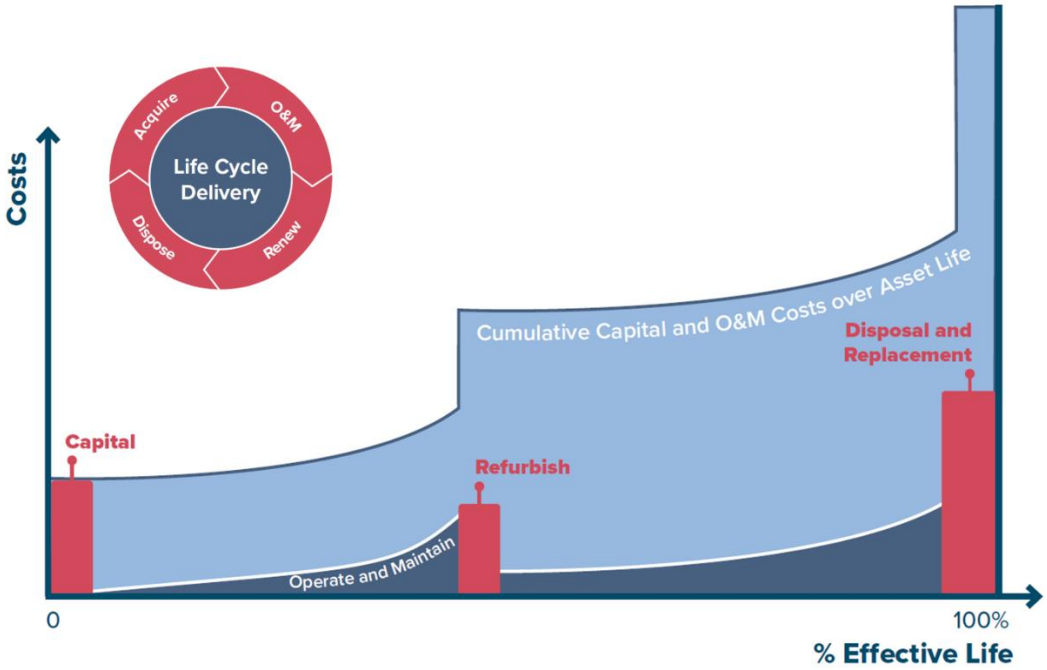

Figure 4-1: Life Cycle Cost Accumulation Over Asset Life

4.1 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.
- Availability and management of spares.

- 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.

4.2 Asset Operations and Maintenance (O&M) Strategies

Urban Forestry asset O&M activities consists of two major components: pure urban forestry activities and other urban forestry O&M Activities. **Figure 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 cost is approximately $1,029,000 and the average annual other activity cost is on average approximately $690,000 in the last five years. The City's pure tree O&M costs include forest maintenance (74%), forest enhancement (17.3%), tree mulching (0.1%), forest management (1.6%), tree fertilizing (0.2%), storm clean-up (1.8%), and invasive species management (5%).

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

O&M Activities	Description	Five-year Average Cost
Pure Urban Forestry O&M Activities	Include forest maintenance, forest enhancement, tree mulching, forest management, tree fertilizing, storm clean-up, and invasive species management.	$1,029,000
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.	$690,000
Total		**$1,719,000**

The following sections present the details of tree inspections and tree pruning that are the major urban forestry O&M activity at the City.

4.2.1 Street Trees and Park 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 routinely 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.

4.2.2 Woodlots

There are very limited O&M activities at the woodlots. It should be noted that the Baker's Woods (maple sugar bush), jointly own by the City, TRCA and the Region, is a woodlot where the City is responsible for maintenance work.

4.2.3 Open Spaces

The City generally do not maintain the trees in open spaces.

4.3 Asset Renewal and Replacement Strategies

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 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 and park 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. The period between tree cutting down and planting in place is up to nine months including 30 days threshold of site inspection and eight months threshold of tree removal and planting or maintenance.

The City typically do not have planned tree planting at open spaces and woodlots.

4.4 Decommissioning and Disposal Activities

For street trees and park trees, when tree removal is considered necessary, disposal activities include tree brush and wood removal, stump removal, site restoration to prepare for replacement.

For woodlots and open spaces, trees are typically left in situ (original location) when they are deceased to decompose naturally. However, trees should be moved if the tree is deemed a hazard to a managed and well-used path, trail, or a house, etc. Disposal costs includes cutting logs and safety-related activities.

4.5 Risk Assessment

Risk assessment and prioritization approach can be an effective approach to develop prioritization plans. The City is a young, as time goes and tree growing, the urban forests management will become a greater component. The City needs to prioritize proactive maintenance activities when the trees are young to effectively reduce future damages.

Risk scores can be calculated for each street tree by using its Probability of Failure (PoF) and Consequence of Failure (CoF) score. PoF can be estimated using the health condition and a condition rating system. 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.
- Operational: Impact of the asset's failure on operational ability e.g., street location, AADT.
- 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 constrains given prioritization under limited resources is very important for urban forestry at the City.

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 and 50 years.

The annual reinvestment need for the urban forestry assets were based on age & ESL in years (i.e., replacing assets that has exceeded their ESL) in inflated dollar values.

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 Urban Forestry 20-Year Funding Need Analysis

The average annual reinvestment rate for the City's urban forestry service is $3.5M over the next 20 years in inflated dollar values. This is equivalent to a total of approximately $70M over the next 20 year period, as presented in **Figure 5-1**. Looking ahead to the decade between 2031 and 2040, the City should prepare for more reinvestment funding as street trees continue to age and be exposed to the adverse urban environment.

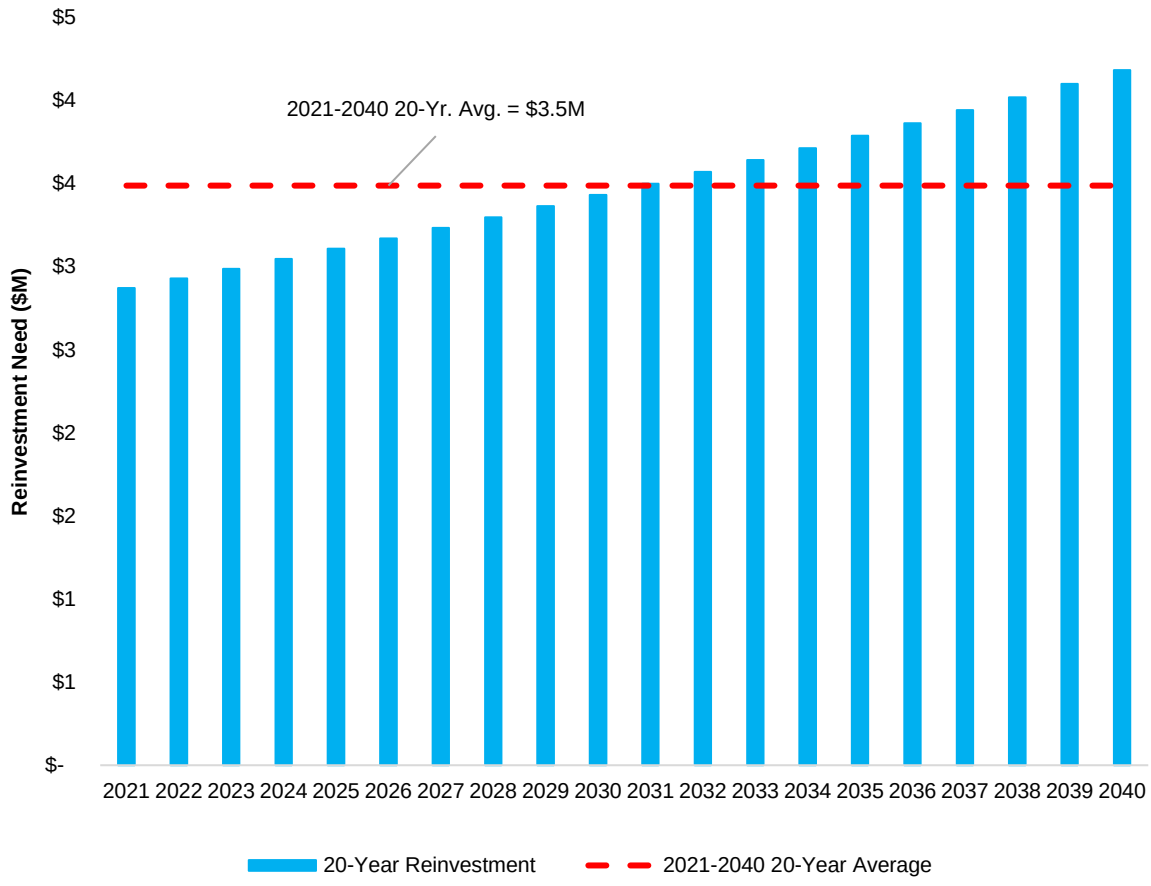

Figure 5-1: Urban Forestry 20-Year Total Reinvestment Need

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 $78M O&M cost over the next 20 years, equivalent to approximately $3.9M per year in inflated dollar value. It is important to note that the City is taking the initiative to reduce the pruning

cycle from 20 to 22 year to seven years, which indicates more funding need for O&M cost in the next 20 years. The annual O&M was estimated by adding the extra cost for maintenance activities to the City's last five-year annual average O&M cost.

Unlike other service areas, urban forestry development costs in the last five years were close o zero as the new development trees were mostly acquired from developers. As such, with the additional of O&M, the total average annual reinvestment rate for the City's urban forestry assets increases to approximately $7.4M annually, for a total of $148M over the next 20-year period, as presented in **Figure 5-2**.

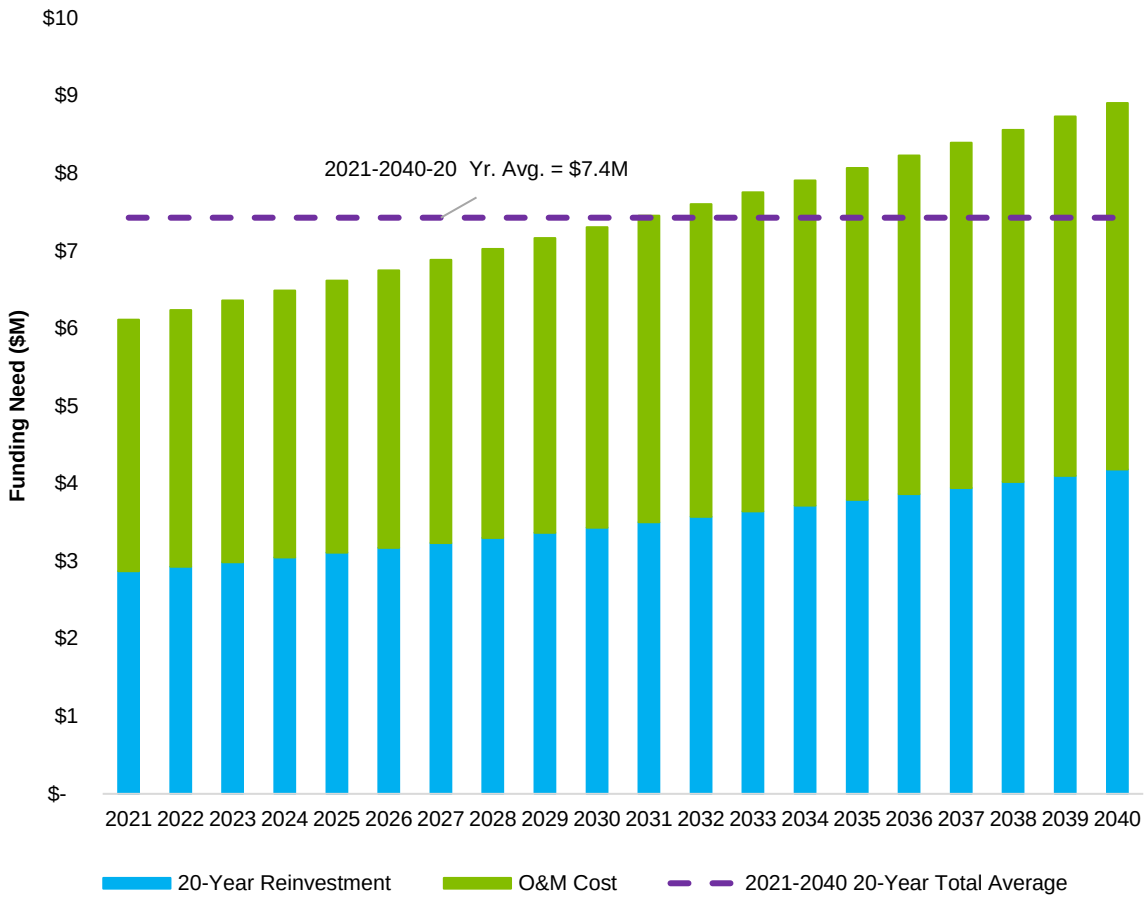

Figure 5-2: Urban Forestry 20-Year Reinvestment and O&M Cost Forecast

6. Recommendations for Urban Forestry AMP Continuous Improvement

Continuous improvement is an important component of any AM program and is achieved through the implementation of recommended improvement initiatives which support sustainable service delivery. While the City's urban forestry assets are young, there are current and future challenges that must be contended with. It is important to address these challenges thoroughly and promptly to leave a positive legacy for future generations.

AECOM has identified a set of activities that represents the next stage of AM planning and implementation within the City.

- **Continue to refine the asset inventory and close existing data gaps, so as to have a more accurate representation of the current state of the urban forestry assets; and, ultimately, to make more informed and defensible decisions**.
  - The City has made great efforts in establishing the street tree inventory. AECOM recommends the City to establish separate inventories for all urban forestry asset categories by developing park trees, woodlots, and open spaces inventories. Consideration should also be given to vegetation and other natural assets occurring within woodlots and open spaces.
  - The more robust asset data for Forestry assets along streets, parks, woodlots and open spaces would be leveraged in the development of the City's first Forestry Management Plan, which would be wider in scope than the accompanying Asset Management Plan for Urban Forestry.
  - Continue to collect missing asset information (or correct those that are known to be erroneous) through geospatial analysis, review of paper records, and verification by O&M personnel. The tree planting dates are not available in GIS records and will require inputting this information into the GIS database to enhance the completeness of the asset age data. In addition, there are a number of trees with DBH of 0 in the GIS record.
  - The City should ensure that out-of-service tree assets are accurately represented in the inventory. Old legacy asset ID's from the GIS inventory should be removed or properly labeled. Assign a unique ID for a new asset and link the ID across data sources so that assets can be tracked throughout their whole lifecycle.
  - Develop a Data Governance Framework to define clear roles on data ownership and accountability, improve confidence in decision-making, improve asset data integrity and streamline information workflows.
- **Develop a consistent and structured health condition assessment process across all urban forestry assets.** This process will allow the City to:
  - Better forecast urban forestry assets replacement needs.
  - Avoid tree failures and the resulting economic, social, and environmental costs.
- **Continue the City's proactive tree maintenance approach including rotational tree pruning and early age structural pruning.**
  - Develop a rotational tree maintenance program to manage the change of tree pruning cycle. With the rotational tree pruning cycle reduced from 20- or 22-year to seven years, the City will need more staff resources and funding to implement the tree maintenance activities. The annual O&M cost is predicted to increase from $1.7M to $3.9M in inflated dollar values (**Figure 5-2**).
  - Continue the early age structural pruning activities. Early age strategic structural pruning for tree assets is very important as this proactive activity can effectively lessen the overall maintenance as trees grow. One of the leading practices is scheduling 3 pruning events for all trees within their first 10 years of life.
- **Continue to improve the living environment of street trees to extend their service life.** Salts are used at the City for winter control to keep roads and sidewalks clear of winter snow and ice, but it brings with it some side effects such as the damage (and even death) of trees and shrubs. The City has taken the initiative to reduce the usage of salts from an average of 1,000 tons / event to 700 tons / event using information supplied

from the MDSS system. It is recommended that the City continues the initiative to achieve a balance between effectiveness of winter maintenance and extended service life of street trees.

- **Refine the Levels of Service Framework.**
  - Collect current asset performance data for key performance indicators (KPIs) that are not currently being tracked, including associated costs.
  - Analyze asset performance data to determine trends and to establish annual performance benchmarks.
  - Engage in a discussion with key stakeholders to establish service level targets and identify associated costs to meet those targets.
  - Once LoS targets have been decided upon, the City should develop strategies on how to meet service level targets considering its existing operating environment (i.e., staff availability, current funding, resources, etc.).
  - Develop a Customer Consultation Plan to engage the public and other stakeholders on the LoS framework and to better understand customers' willingness to pay for enhanced service levels.
- **Establish Urban Forestry risk assessment for future iterations of the AM plan, and use the risk assessment results to drive future condition assessments and financial needs forecasting.**
  - Calculate a risk score for each tree by using its Probability of Failure (PoF) and Consequence of Failure (CoF) score, to assess the ability of the assets to meet current and future operational requirements including capacity, regulatory, resilience and other LoS needs.
  - Continuing from previous bullet, incorporate more accurate expected service life information based on City's experience to better predict when trees need to be replaced.
  - Assess criticality and risk comprehensively for urban forestry assets in the inventory.
  - Frequently revisit and revise probability of failure and criticality model as needed.
  - Review risk attribute values periodically to ensure alignment with business objective and appetite.
  - Overlay the risk models with the current state of the assets (i.e., condition), and the 20-year financial forecast. Using this approach, the City could focus its monitoring, maintenance, and renewal and replacement budget and activities on high risk assets. Medium risk infrastructure could be addressed through the mitigation of failure through regular monitoring, and the low risk assets could be accepted with caution.
- **Establish a sustainable urban forestry funding model that fits the needs of the community.**
  - In light of the annual capital investment reinvestments outlined in **Figure 5-2**, the City should budget for Urban Forestry expenditures on asset replacement and O&M, to an average of $7.4M estimated per year over the next 20 years.
  - Review financial modeling assumptions on ESL and replacement values and update the financial model with new information as it becomes available. The financial model is based on a number of key assumptions that could have a significant impact on the outcomes of the model.
- **Continue to find ways to improve AM initiatives across the City by maintaining a high level of AM awareness through training, communication, and knowledge sharing.**
  - Conduct an AM Software Assessment to identify future system requirements that may include enhancing existing software, adding-on, or replacing.
  - Develop a Knowledge Retention Strategy & Internal Communications Plan to document staff AM knowledge and experience for reporting and succession planning purposes. Communicate AM improvement initiatives and enhance AM awareness internally through internal communication.
  - Align the Financial and Non-Financial Functions of Urban Forestry AM.

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Asset Management Plan

Non-Core Assets
Active Transportation

City of Vaughan

September 2022 (version 2)

Delivering a better world

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1. Introduction

1.1 Background

The City of Vaughan (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 one with increasing concentrations of 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, with a population of over 300,000, is rapidly growing and it is projected that the number of residents will continue to increase to 430,000 by 2031. The City is also home to a well-diversified and expanding employment sector and has the largest supply of new employment lands in the Greater Toronto Area (GTA). It is projected that employment numbers within City boundaries will increase from 150,000 to 278,000 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 capture the non-core infrastructure assets so as to provide the City with a comprehensive AM Program.

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 the Active Transportation AMP is one of the steps to guide the City towards meeting the July 1st, 2024 deadline for assets not included under the definition of core assets (water, wastewater, stormwater, road and bridge assets).

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, wastewater, stormwater, road and bridge assets).
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 as shown in **Table 1-2**.

Table 1-2: In-Scope Active Transportations Assets

Asset Category	Asset Types
Pedestrian Facilities	Sidewalks and Walkways[1].
Cycling Facilities	Signed Bike Routes[2], Painted Bike Lanes[3], Cycle Tracks[4].
Shared-use Pathways	In-boulevard Multi-use Pathways[5].
Multi-use Recreational Trails	Multi-use Trails[6], TRCA Trails[7] and Park Pathways[8].

[1]Sidewalks (in-boulevard within road allowance) – dedicated space for walking, in concrete. Walkways are used to connect sidewalks through development.
[2]Signed Bike Routes (on shared road pavement) – signage is only indication for cycling.
[3]Painted Bike Lanes (on road pavement) – dedicated space for cycling using pavement markings.
[4]Cycle Tracks (in-boulevard within road allowance) – adjacent to the sidewalk and adjacent to the curb, in asphalt.
[5]In-boulevard Multi-use Pathways (in-boulevard within road allowance) – shared space for walking/cycling, in either asphalt or concrete.
[6]Multi-use Trails (within open spaces) – shared space for walking/cycling, various materials including asphalt, granular and natural, etc.
[7]TRCA Trails (within open spaces) – owned by the Toronto and Region Conservation Authority, not by the City.
[8]Park Pathways (shared space within parks) – shared space for walking/cycling, in either asphalt or concrete within public park boundaries.

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.

2. State of Infrastructure

The City's current network of active transportation include over 1,500 km of pedestrian facilities, cycling facilities, multi-use recreational trail infrastructure, and shared-use pathways which are designed to bring the community together, establish transit connections and get more people moving.

2.1 Asset Inventory & Hierarchy

Table 2-1 presents the City's Active Transportations assets inventory and hierarchy. Active transportations assets are categorized into four categories: pedestrian facilities, cycling facilities, multi-use recreational trails, and shared-use pathways.

The City's pedestrian facilities include Sidewalks and Walkways covering approximately 1.7 km^2. Cycling facilities include 84 km Signed Bike Routes, 4 km Painted Bike Lanes, and 12 km Cycle Tracks. The City has 32 km shared-use pathways that are intended for pedestrians and cyclists, which run along the roadway but are separated from the vehicular-traveled portion of a road by a curb or other physical barrier. The City's multi-use recreational trails are areas completely outside of the road right-of-way and often passes through parks or other green spaces. There are a total of 219 km multi-use recreational trails at the City (including TRCA owned trails).

Table 2-1: Active Transportation Asset Inventory & Hierarchy

Asset Category	Asset Type	Quantity	Unit of Measure
Pedestrian Facilities	Sidewalks	1,669,400	m^2
	Walkways	16,200	m^2
Cycling Facilities	Signed Bike Routes (shared roadway)[1]	83.8	km
	Painted Bike Lanes (roadway)[1]	3.8	km
	Cycle Tracks (in-boulevard)	11.5	km
Shared-use Pathways	Multi-use Pathways (in-boulevard)	32.4	km
Multi-use Recreational Trails	Multi-use Trails (open spaces)	41.5	km
	TRCA Trails (open spaces)[2]	77.9	km
	Park Pathways[3]	99.7	km

[1]AM planning for Signed Bike Routes and Painted Bike Lanes is included in the AM Plan for Roads.

[2]TRCA Trails are not owned by the City.

[3]AM planning for Park Pathways is included in the AM Plan for Parks.

2.2 Current Replacement Value

The estimated replacement value is the cost of replacing an existing asset in today's dollars, considering inflation. These costs are developed based on the City's records and jurisdictional scan at neighbouring municipalities. Where applicable, a 2% annual inflation rate was used to estimate the 2022 values. Total replacement values in this section are rounded to the nearest thousand.

Table 2-2 shows that the City's active transportation assets is valued at approximately $217M, with sidewalks comprising approximately 92% of the total replacement value.

Table 2-2: Active Transportations Assets Replacement Costs

Asset Category	Asset Type	Unit Cost	Total Replacement Cost
Pedestrian Facilities	Sidewalks	$120 / m^2	$200,328,000
	Walkways	$120 / m^2	$1,944,000
Cycling Facilities	Signed Bike Routes (shared roadway)[1]	-	-
	Painted Bike Lanes (roadway)[1]	-	-
	Cycle Tracks	$250 / m	$2,875,000
Shared-use Pathways	Multi-use Pathways (in-boulevard)	$250 / m	$8,100,000
Multi-use Recreational Trails	Multi-use Trails (open spaces)	$102 / m	$4,233,000
	TRCA Trails (open spaces)[2]	-	-
	Park Pathways[3]	-	-
Total			**$217,480,000**

[1]Replacement cost of Signed Bike Routes and Painted Bike Lanes is included in the AM Plan for Roads.

[2]TRCA Trails are not owned by the City.

[3]Replacement cost of Park Pathways is included in the AM Plan for Parks.

2.3 Age and Remaining Service Life

The 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 for each asset.

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 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., extreme rainfalls), while other assets are in relatively benign conditions, thus the deterioration of assets is affected differently.
- **Maintenance:** Assets are 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.

Figure 2-1 shows the average asset age and RSL as a proportion of average ESL weighted by replacement value. 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.

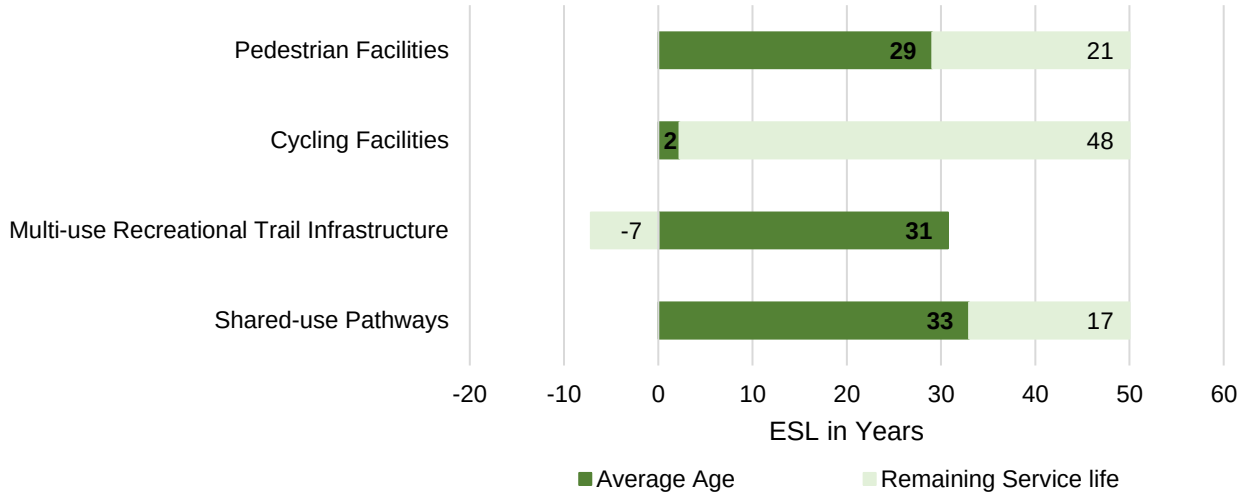

Figure 2-1: Active Transportation Asset Average Age and Remaining Service Life

2.4 Asset Condition

2.4.1 Age-Based Condition Assessment

Two-parameter Weibull distribution function was used to assess the current condition of the City's 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 2-3 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	>=3.5	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 84% of the assets are in Very Good to Good condition. However, 11% of the active transportation assets are in Poor condition indicating that they have reached or exceeded their ESL and require to be renewed or replaced in the short term.

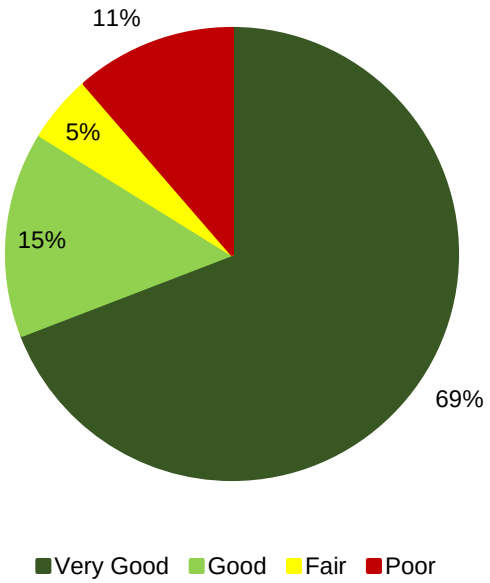

Figure 2-2: Active Transportation Asset Condition Summary

Figure 2-3 presents the condition distribution by asset types weighed by replacement value. Approximately 72% 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. Roughly 89% of the multi-use recreational trail infrastructure is in Very Poor condition.

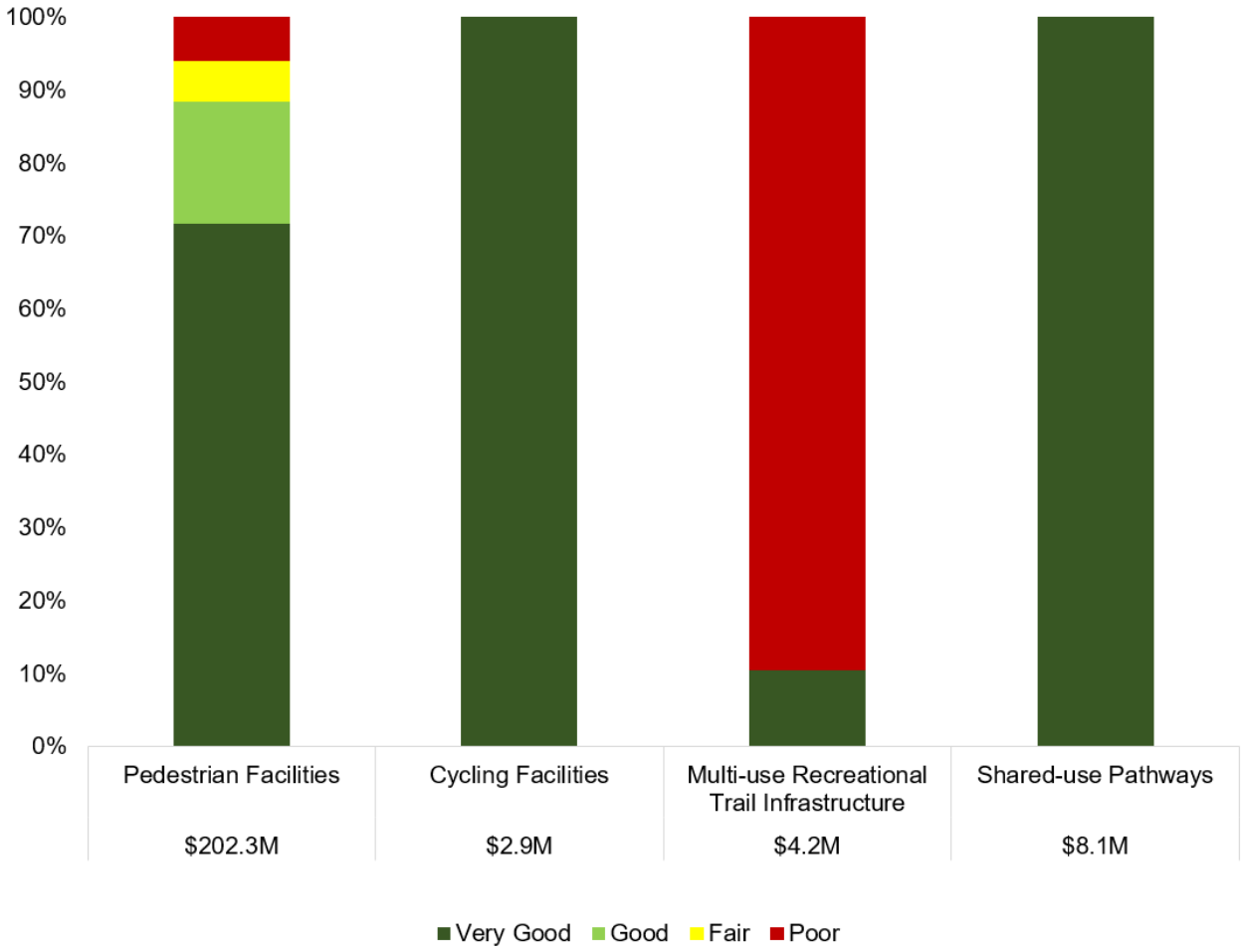

Figure 2-3: Distribution of Active Transportation Asset Condition

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.

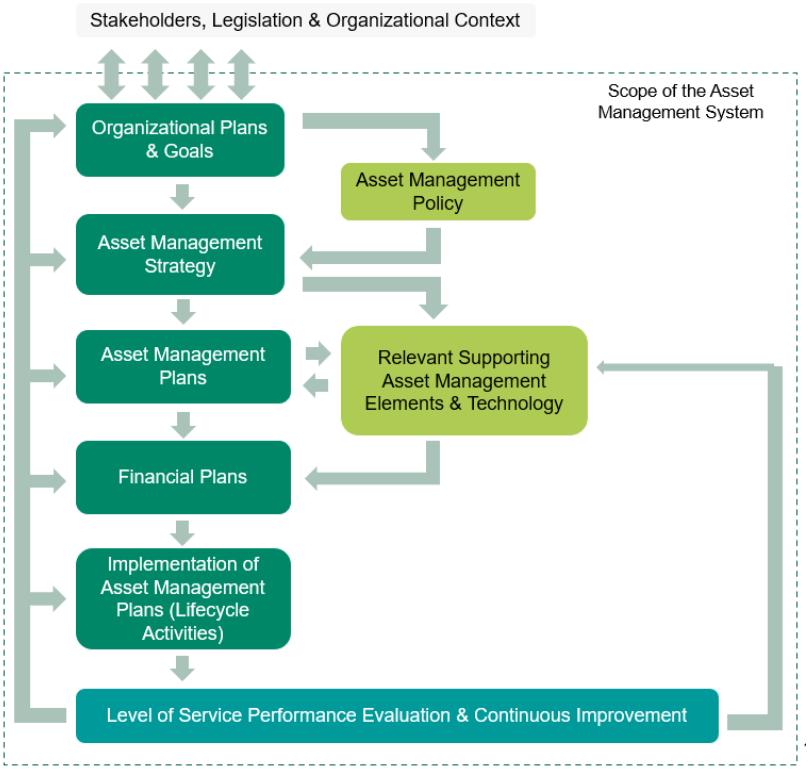

Figure 3-1: LoS within the AM System

In AECOM'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**).

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 & 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 & Capacity	Customers can easily access the service with minimal inconvenience.
Health & 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 & 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, upper tier or 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 Levels of Service 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.

Measured in the most recent Citizen Satisfaction Survey conducted by Ipsos, the percentage of respondents satisfied with Cycling Infrastructure and Bike Lanes was 61% and regarding Off-road Multi-use and Natural Trails, the percentage was 91%. Additionally, the Active Transportation network consisting of City-owned assets (with the exception of TRCA trail segments) is illustrated in **Figure 3-2**.

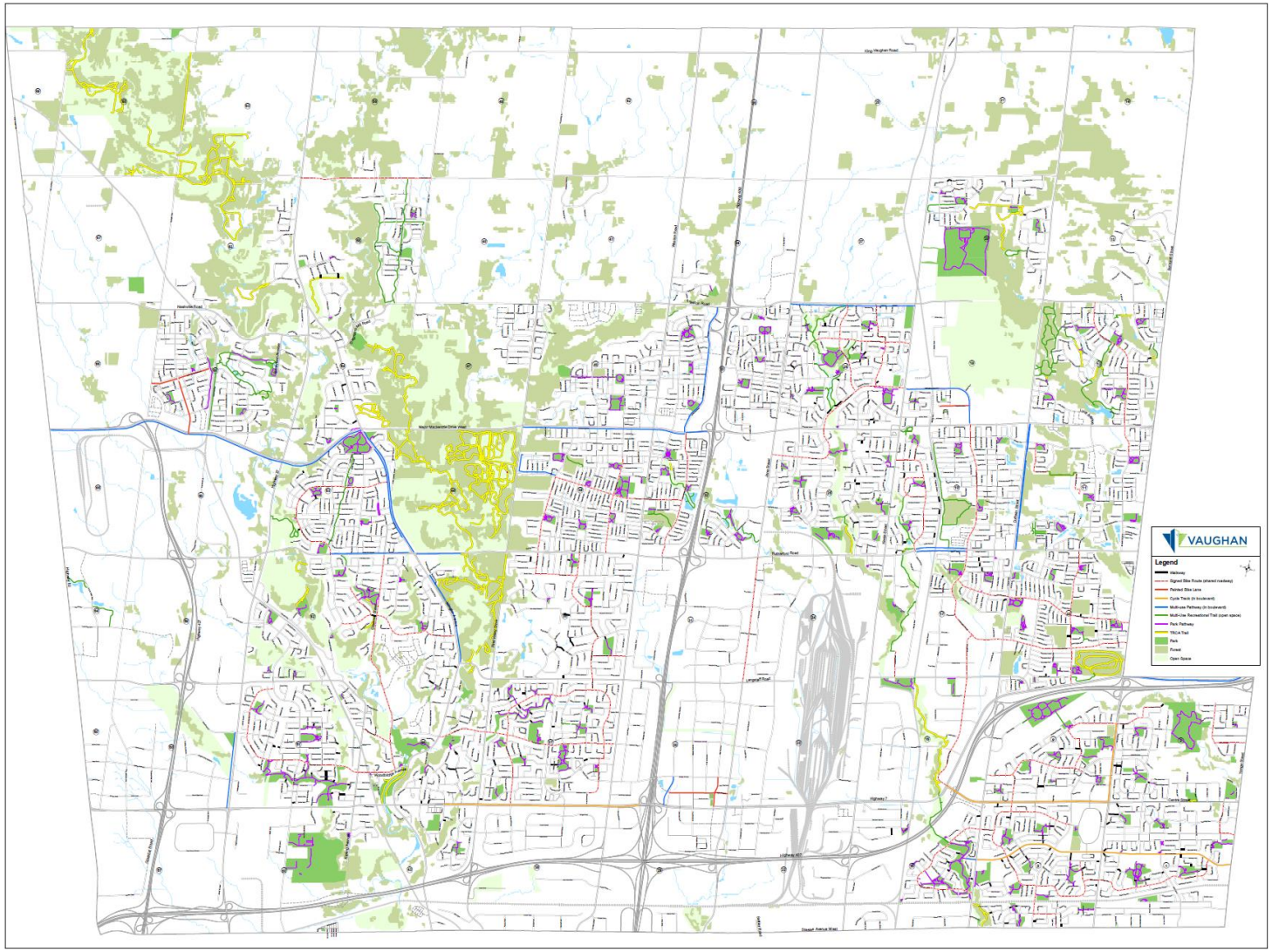

Figure 3-2: Active Transportation Network

3.5 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 LoS 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.

The future demand drivers presented in **Table 3-3** may impact the City's existing LoS. Some may require additional funding or resources to be allocated to meet future needs; others, 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

Future Demand Driver	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 10 years and in particular in light of the recent global pandemic. • With the rapid emergence of micro-mobility 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, that may impact future demand, the City has the advantage to proactively plan and prepare 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., changing habits through education, providing service alternatives, etc.).

A hybrid solution often works well 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 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. Considering entire asset lifecycles can ensure that the City makes sound decisions 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.

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 ongoing operation and maintenance as well as corrective 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.

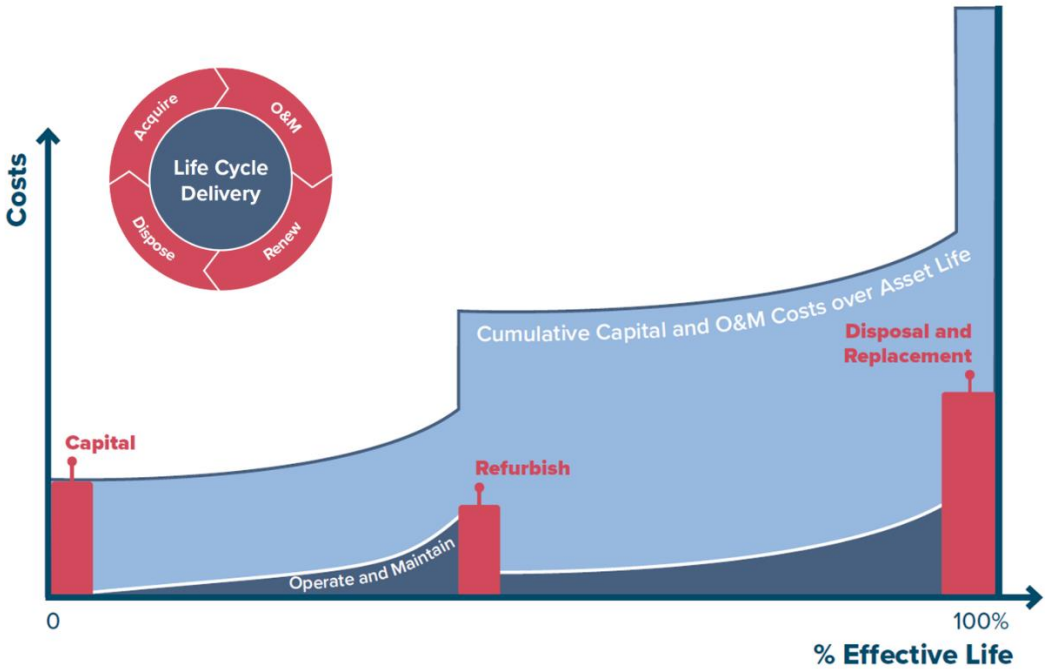

Figure 4-1: Life Cycle Cost Accumulation Over Asset Life

4.1 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[1] which identifies a two-pronged

[1] Pedestrian and Cycling Strategy (vaughan.ca)

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.

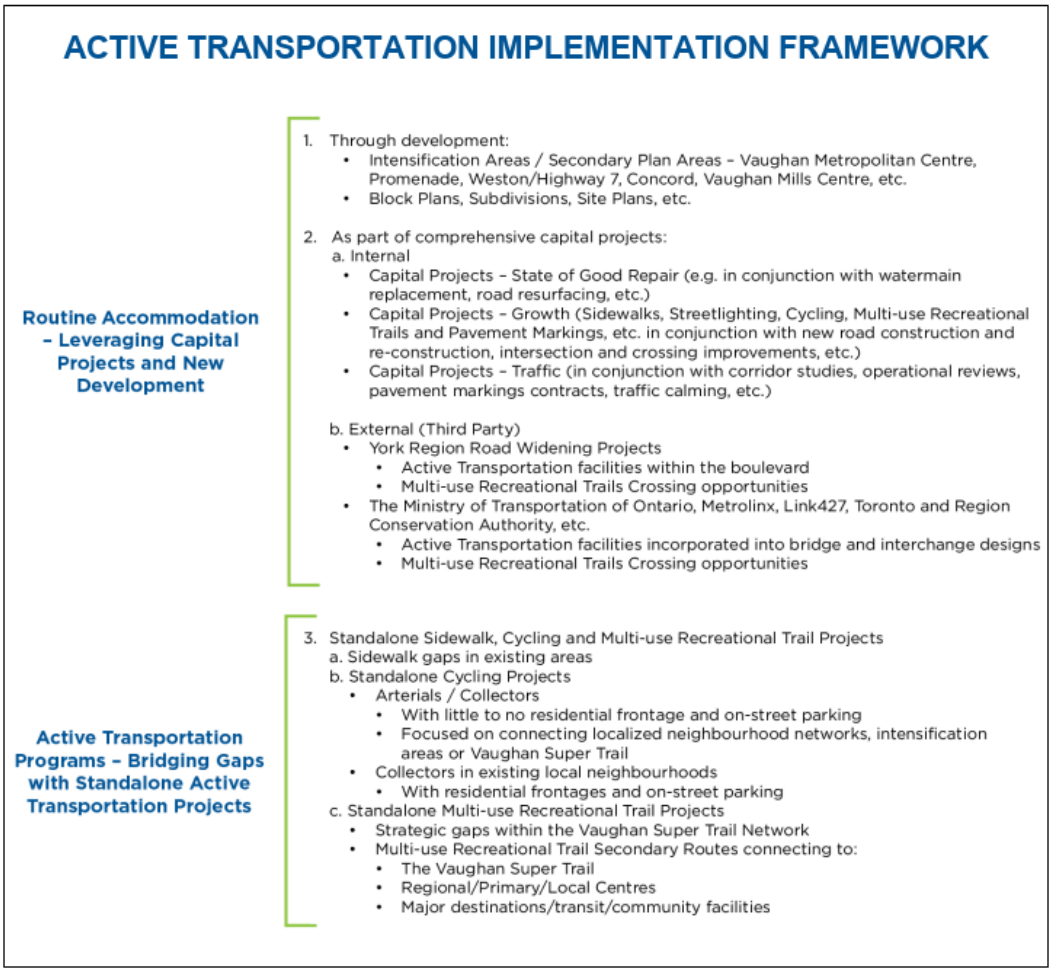

Figure 4-2: Active Transportation Implementation Framework[1]

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.

4.2 Operations and Maintenance Strategies

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. 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 number 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.

The active transportation assets such as sidewalks, in-boulevard multi-use pathways, cycling facilities and multi-use recreational 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.

4.3 Renewal and Replacement Strategies

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., replacement of a sidewalk bay or resurfacing of a in-boulevard multi-use pathway. 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. 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 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 sidewalk bay replacement program in place, which historically cost approximately $150,000 annually for sidewalk repair as part of the capital project budget.

4.4 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. 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 disposal activities are infrequent and related to rerouting and in some cases be driven by improved material alternatives or new technology in design processes.

[2] Operation and Maintenance Tech Paper_2019-02-11.pdf (vaughan.ca)

5. Funding Need Analysis

The lifecycle analysis was implemented in an MS Excel Asset Lifecycle Model, which integrated asset inventory, age, expected service life (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.

The annual reinvestment need for the active transportation assets were based on age & ESL in years (i.e., replacing assets that have exceeded their ESL), in inflated dollar values. The inflation rate is selected to be 2% based on consultation with the City staff.

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 $8.9M over the next 20 years in inflated dollar values. This is equivalent to a total of approximately $178M over the next 20-year period, as presented in **Figure 5-1**.

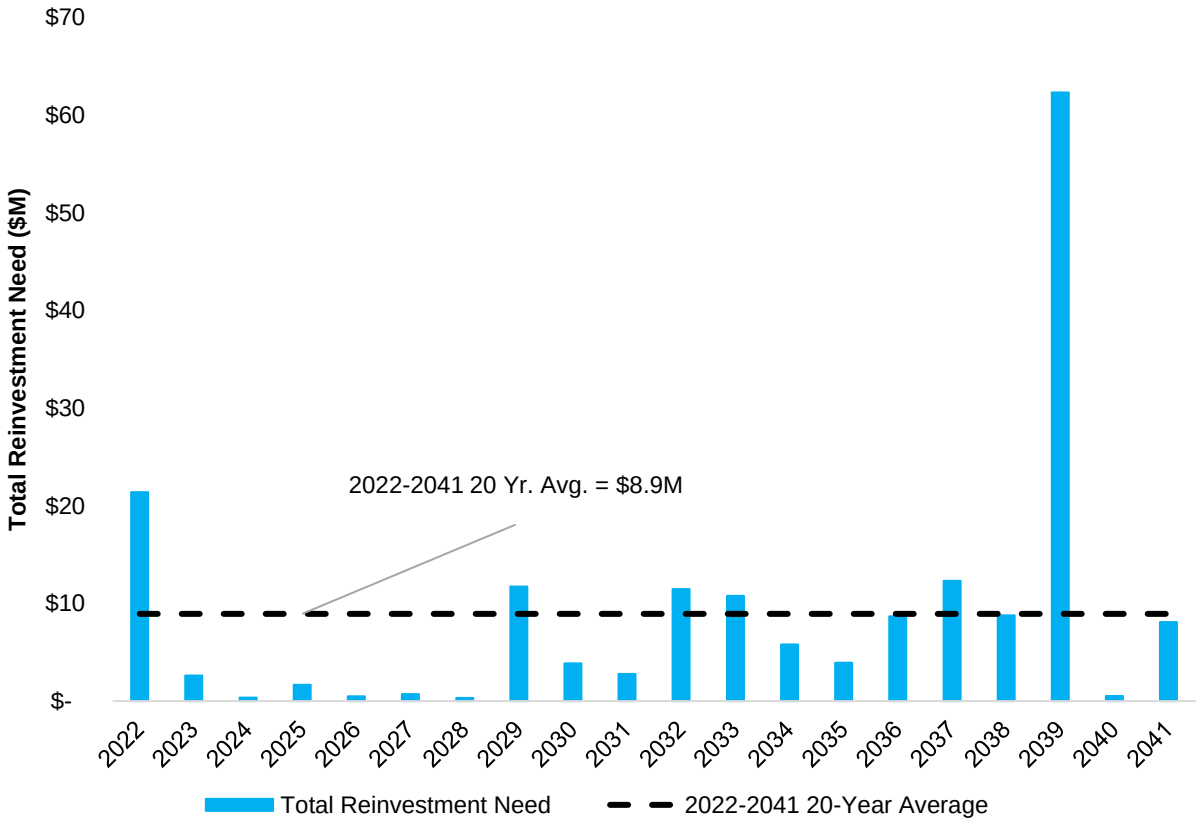

Figure 5-1: Active Transportation 20-Year Reinvestment Need

As shown in **Figure 5-2**, in 2022, the reinvestment needs are primarily from the aged multi-use recreational trail infrastructure, followed by pedestrian facilities (e.g. sidewalks). Looking ahead to the period starting 2029, and especially the year 2039, the City is recommended to prepare for the increased level of reinvestment need for pedestrian 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 inflated dollar values.

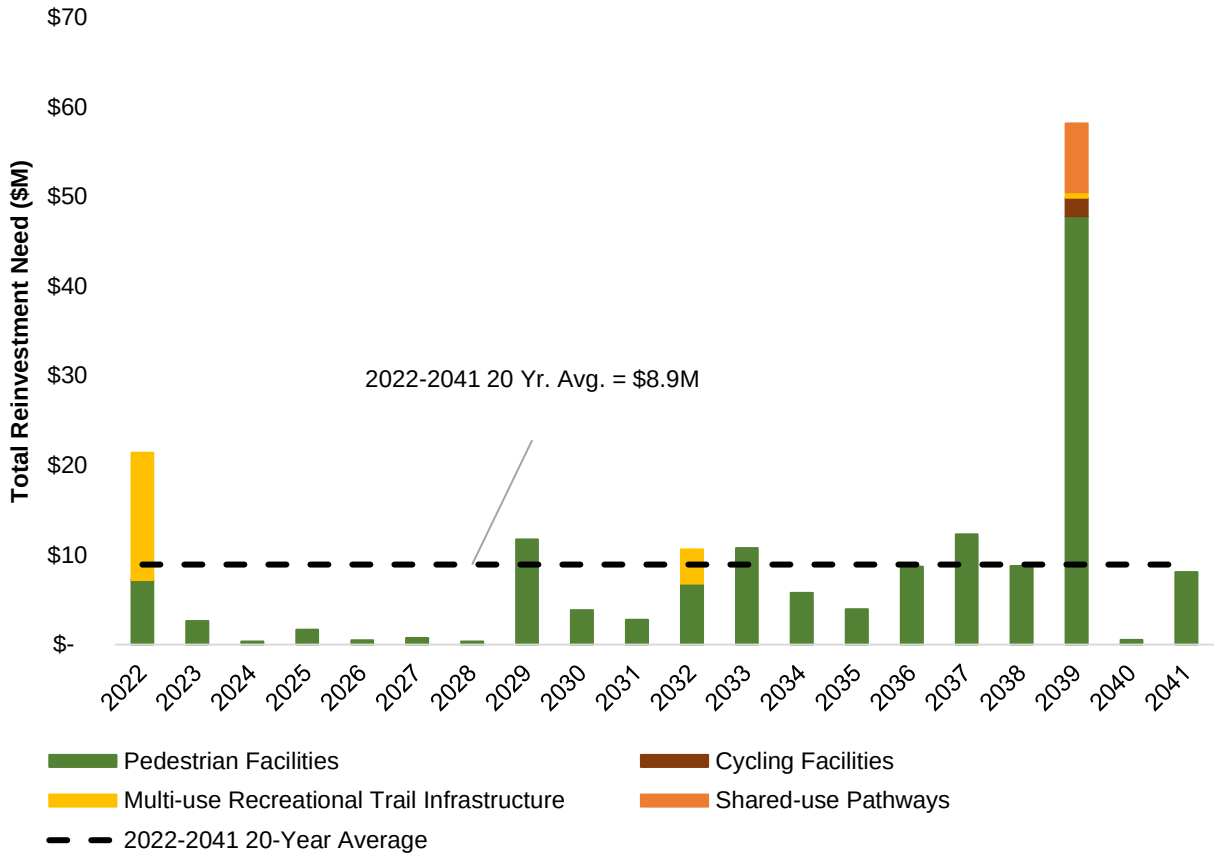

Figure 5-2: Active Transportation 20-Year Reinvestment Need Details

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

	Pedestrian Facilities	Cycling Facilities	Multi-use Recreational Trail Infrastructure	Shared-use Pathways	Total
Annual Average Need	$7,262,000	$145,000	$984,000	$540,000	$8,931,000
20-Year Total	$145,236,000	$2,895,000	$19,669,000	$10,787,000	$178,620,000

5.2 60-Year Active Transportation Assets Reinvestment Need

Looking ahead in the long term, the average annual reinvestment rate for the City's active transportation assets is $9.4M over the next 60 years in inflated dollar value, for a total of approximately $564M, as presented in **Figure 5-3**.

It should be noted that the 63.2 km cycle tracks that are expected to be constructed during 2022 and 2026 from the GIS record are also considered in the reinvestment need analysis.

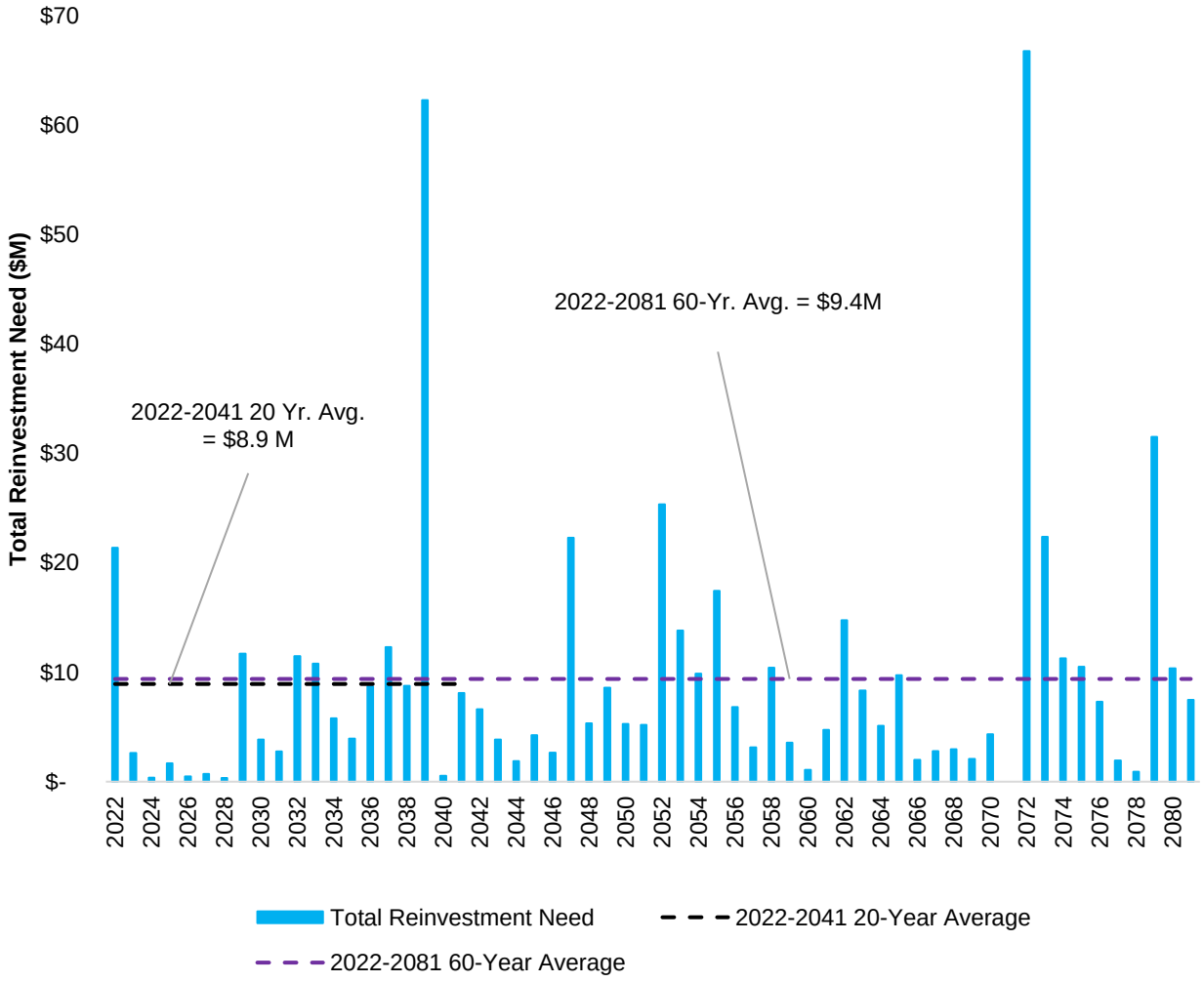

Figure 5-3: Active Transportation 60-Year Total Reinvestment Need (Inflated Dollar Value)

5.3 Full Funding Need Profile

Figure 5-4 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 in order 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, and annual average active transportation growth-related development cost in inflated dollar values.

Active transportation assets require approximately $187,000 annually over the next 20 years for O&M, equivalent to totally $3.7M in inflated dollar value. The active transportation growth-related cost or development cost (DC) requires approximately $102M over the next 20 years, equivalent to $5.1M annually. As such, with the addition of O&M and DC, the total average annual funding need for the City's active transportation assets increases to approximately $14.2M annually, for a total of $284 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.

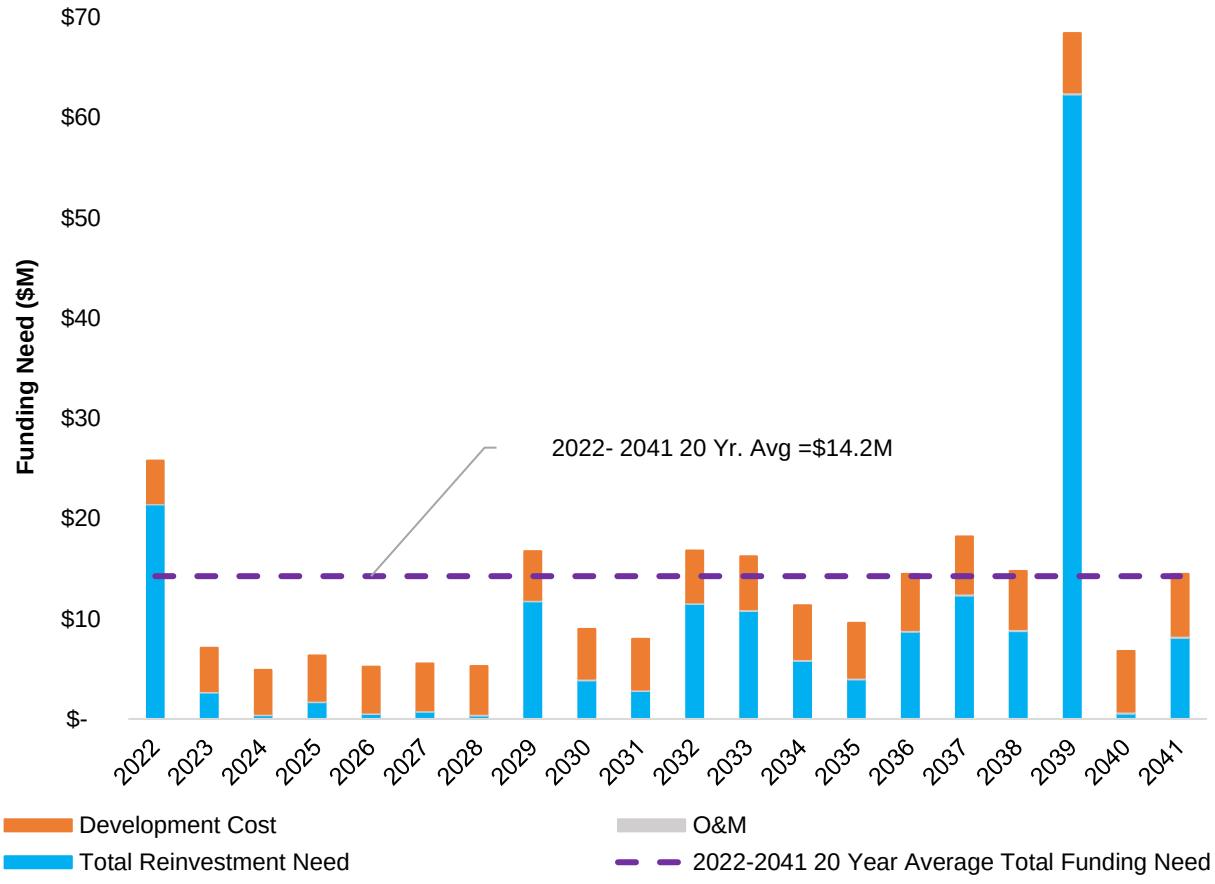

Figure 5-4: Active Transportation 20-Year Capital Investment and O&M Cost Forecast

6. Recommendations for Active Transportation AMP Continuous Improvement

Continuous improvement is an important component of any AM program and is achieved through the implementation of recommended improvement initiatives which support sustainable service delivery. AECOM has identified a set of activities that represents the next stage of AM planning and implementation within the City.

- **Continue to refine the asset inventory and close existing data gaps, so as to have a more accurate representation of the current state of the active transportation assets; and, ultimately, to make more informed and defensible decisions**.
  - ACOM recommends the City to refine and continue maintaining the active transportation inventory and keep updating the inventory as assets are acquired or disposed.
  - The City to define the ownership and whether it is the responsibility of the City to maintain each of the active transportation assets in the GIS inventory (e.g., school sidewalks are not City-owned assets), which will help with better asset management planning.
- **Develop a formalized active transportation assets condition assessment process and use consistent condition grading schemes.**
  - AECOM proposes that a consistent condition grading scale be applied across active transportation asset portfolio to align with other asset categories at the City.
  - The grading system should contain a description of the condition, which is tied directly to each condition grade, and a description of the asset performance and level of corrective and preventive maintenance required for assets falling within a certain condition rating category.
  - Perform condition assessments on the most critical assets first. This will ensure that the active transportation assets are assessed using the same methodology, and prioritized according to the asset's criticality, enabling a more defensible business case when raising issues of asset degradation to senior management and Council.
  - Once the active transportation condition rating system is confirmed, onsite condition assessments should be conducted to fill condition information gaps across the asset inventory. This will support more informed asset management and maintenance decisions based on the specific condition.
- **Refine the LoS Framework.**
  - Collect current asset performance data for key performance indicators (KPIs) that are not currently being tracked, including associated costs.
  - Analyze asset performance data to determine trends and to establish annual performance benchmarks.
  - Engage in a discussion with key stakeholders to establish service level targets and identify associated costs to meet those targets.
  - Once LoS targets have been decided upon, the City should develop strategies on how to meet service level targets considering its existing operating environment (i.e., staff availability, current funding, resources, etc.) and determine operating environment needs.
  - Develop a Customer Consultation Plan to engage the public and other stakeholders on the LoS framework and to better understand customers' willingness to pay for enhanced service levels.
- **Incorporate risk assessment for future iterations of the AM plan and use the risk assessment results to drive future condition assessments and financial needs forecasting.**
  - Conduct a comprehensive criticality and risk assessment of active transportation assets to inform work prioritization.

  - Review risk attribute values periodically to ensure alignment with business objectives and appetite.
  - Overlay the risk model with the current state of the assets (i.e., condition), and the financial forecast. Using this approach, the City could focus its monitoring, maintenance, and renewal and replacement budget and activities on high-risk assets. Medium risk infrastructure could be addressed through the mitigation of failure through regular monitoring, and the low-risk assets could be accepted with caution.

- **Establish a sustainable active transportation funding model that fits the needs of the community.**
  - In light of the annual funding need outlined in **Figure 5-4**, the City should budget for a total of $14.2M per year, on average, for capital reinvestment ($8.9M annually), capital development ($5.1M annually), and O&M expenditures ($187K annually) over the next 20 years.
  - Review financial modeling assumptions on reinvestment rate and replacement values and update the financial model with new information as it becomes available. The financial model is based on a number of key assumptions that could have a significant impact on the outcomes of the model.
- **Continue to find ways to improve AM initiatives across the City by maintaining a high level of AM awareness through training, communication, and knowledge sharing.**
  - Conduct an AM Software Assessment to identify future system requirements that may include enhancing existing software, adding-on, or replacing.
  - Develop a Knowledge Retention Strategy & Internal Communications Plan to document staff AM knowledge and experience for reporting and succession planning purposes. Communicate AM improvement initiatives and enhance AM awareness internally through internal communication

aecom.com

Asset Management Plan

Non-Core Assets
Fleet

City of Vaughan

September 2022 (version 2)

Delivering a better world

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1. Introduction

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 such services as fire protection, public works, water distribution and wastewater collection, parks and recreation, and buildings.

The next 25 years will see the City transition from a growing suburban municipality to one with increasing concentrations of 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, with a population of over 300,000, is rapidly growing and it is projected that the number of residents will continue to increase to 430,000 by 2031. The City is also home to a well-diversified and expanding employment sector and has the largest supply of new employment lands in the Greater Toronto Area (GTA). It is projected that employment numbers within City boundaries will increase from 150,000 to 278,000 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 capture the non-core infrastructure assets so as to provide the City with a comprehensive AM Program.

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, 2024 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 LoS 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 asset class, which are owned and maintained by the City, as shown in **Table 1-2**.

Table 1-2: In-Scope Fleet Assets

Asset Category	Sub-Assets
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 activities to maintain identified current LoS, minimize associated asset risks, and to optimize costs over the whole lifecycle of the asset.

2. State of Infrastructure

Fleet assets are managed by the Fleet Management Division, who provides service for all City vehicles and equipment, except those used by Vaughan Fire and Rescue Service. Almost all other City department utilize vehicles/equipment for their day-to-day operation activities, and Fleet Management is responsible for maintaining these fleet assets in a timely and efficiently manner to support the continuous delivery of City services every day.

Fleet Management Division manages over 1,100 assets that range significantly in both complexity and value. Fleet Management Services provides all the licensing, registration, and insurance of the vehicles and maintains preventative maintenance activities.

2.1 Fleet Asset Inventory & Hierarchy

The City owns and manages over 1,100 fleet assets, which are divided into vehicles, equipment, trailers, and others (e.g., Traffic counters, Motorcycles, etc.). In addition, the City also manages rental agreements for approximately 30 rental vehicles including ½ ton pickups, and a few cars and Sport Utility Vehicles (SUVs) during COVID restriction periods.

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 consultation with City staff. Vehicles are categories by gross weight in kilogram and equipment are classified by replacement cost ranges.

Table 2-1 present the fleet assets hierarchy and asset inventory summary. Vehicles range from standard cars and trucks to chipper truck with dump body, and flusher. They are further grouped into light, medium, and high vehicles according to their gross weights. Equipment assets are further grouped into small, medium, and large equipment according to their current replacement values. They range from handheld blowers and line trimmers (small equipment), to aerator and snow plow tractors (medium equipment), to ice resurfacer and front end loader (heavy vehicles).

The fleet asset management plan (AMP) deals only with the assets of core fleet City services and not the assets of Fire & Rescue, as there is a separate AMP for Fire & Rescue.

Table 2-1: Fleet Asset Inventory & Hierarchy

Asset Category	Asset Type	Quantity	Unit of Measurement
Vehicles	Light Vehicles	195	Ea.
	Medium Vehicles	10	Ea.
	Heavy Vehicles	108	Ea.
Equipment	Small Equipment	582	Ea.
	Medium Equipment	64	Ea.
	Large Equipment	65	Ea.
Trailers	Trailer with Plates	54	Ea.
	Trailer without Plates	13	Ea.
Others	Motorcycles	3	Ea.
	Bicycles	5	Ea.
	Traffic Counters	13	Ea.
	Solar Battery Box	1	Ea.

Asset Category	Asset Type	Quantity	Unit of Measurement
Fleet Total		**1,113**	Ea.

2.2 Current Asset Replacement Value

The estimated replacement value is the cost of replacing an existing asset in today's dollars. These costs are developed based on the City's purchase records and current market price. Where applicable, a 2% annual inflation rate was used to estimate the 2022 values.

The City owned fleet assets is valued at approximately $33M, as represented in **Table 2-2**. The estimated total replacement value for the vehicles is approximately $19M, which accounts for the largest share of the total replacement value among the fleet asset categories.

Table 2-2: Fleet Assets Total Replacement Value

Asset Category	Asset Type	Unit Cost ($/Ea.)	Total Replacement Cost
Vehicles	Light Vehicles	$14,858 - $225,512	$7,676,000
	Medium Vehicles	$26,376 - $170,702	$656,000
	Heavy Vehicles	$29,684 - $655,990	$10,546,000
Equipment	Small Equipment	$149 - $26,951	$1,913,000
	Medium Equipment	$30,201 - $69,848	$4,027,000
	Large Equipment	$70,126 - $ 349,435	$6,319,000
Trailer	Trailer with Plates	$6,363 - $ 175,535	$911,000
	Trailer w/o Plates	$3,352 - $225,670	$709,000
Others	Motorcycle	$1,457	$8,000
	Bicycles	$6,704- $9,534	$26,000
	Traffic Counter	$3,167	$42,000
	Solar Battery Box	$609	$1,000
Fleet Total			**$32,833,000**

2.3 Age & Remaining Service Life

The average age was based on the purchase year of the assets, and the remaining service life (RSL) was estimated by using age and expected service life (ESL) in years.

The ESL is defined as the period over which an asset is available for use and able to provide the required level of service (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 fleet assets are operated intermittently or even infrequently or is being operated at a lower demand than its expected annual mileage, thus the actual operating "age" of the asset is reduced.
- **Surrounding Environment:** Some fleet assets could corrode due to salt and de-icing increasing the corrosion activity on the asset's parts (especially if anti-corrosion is not regularly applied); thus, the deterioration of assets is affected differently.
- **Maintenance:** Fleet assets are maintained through replacement of components, which prolongs the service life of the asset.

- **Technological Obsolescence:** Some fleet assets can theoretically be maintained for a longer period of time, although considerations such as maintenance cost, energy inefficiency and new technologies are likely to render this approach uneconomical (e.g., electrically operated vehicles).

Figure 2-1 shows the average asset age and RSL, weighted by replacement value. 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.

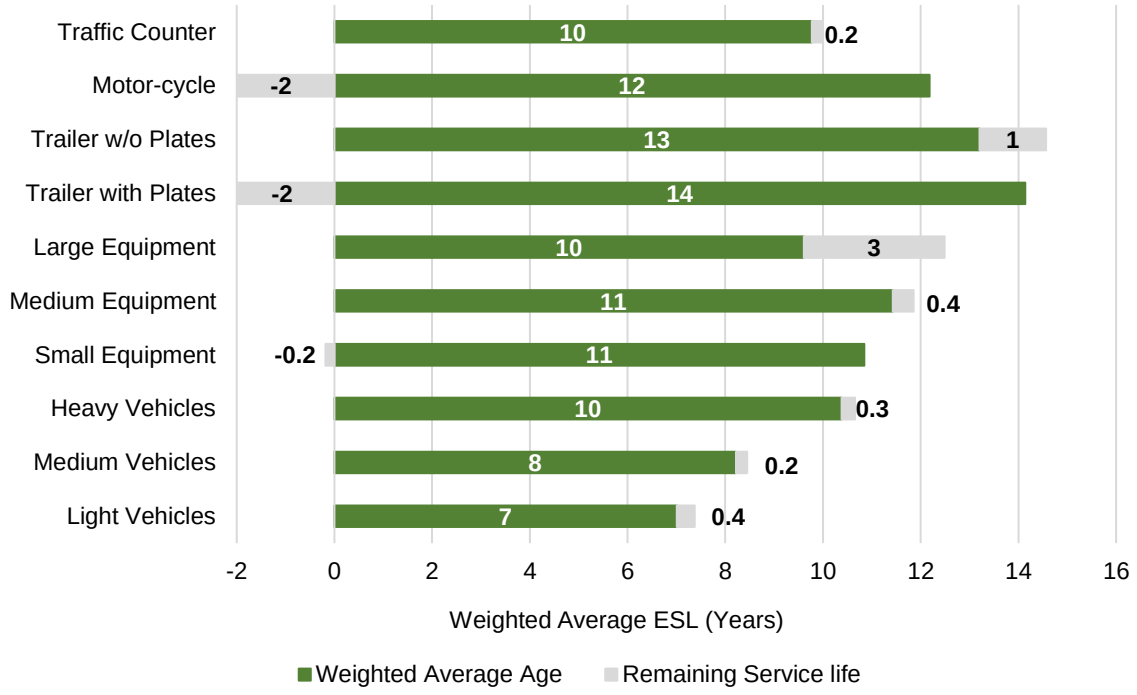

Figure 2-1: Average Fleet Asset Age and Remaining Service Life

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 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 2-3 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	>=3.5	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 40% of the assets are in Very Good to Good condition. However, 48% 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.

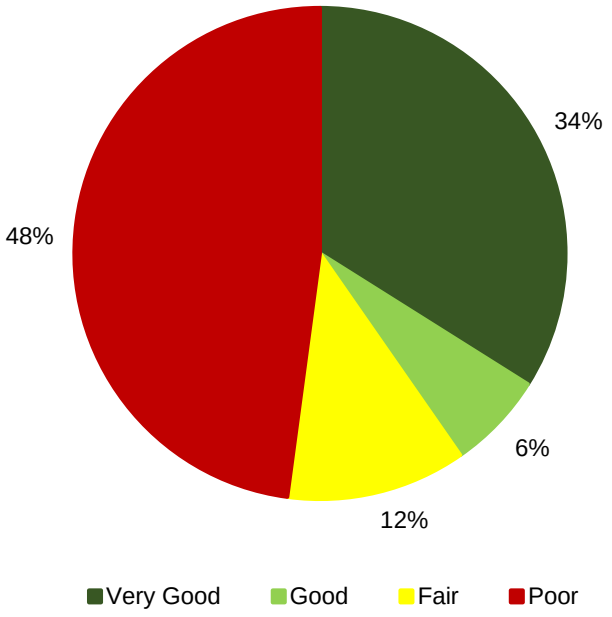

Figure 2-2: Fleet Asset Condition Summary

Figure 2-3 presents the condition distribution by fleet asset types weighted by replacement cost. The City's fleet assets are largely either in Very Good condition or Poor condition.

Approximately 48% of the City's light vehicles are in Very Good condition, while 32% of the light vehicles are in Poor condition approaching their expected replacement date. For heavy and medium vehicles, more than half of the assets are in Poor condition indicating the needs for renewal in the short term.

Large equipment, accounts for the largest share of the equipment total replacement value has approximately 52% of assets in Very Good to Good condition weighted by current replacement cost. However, more than 67% of the medium equipment is in Poor condition

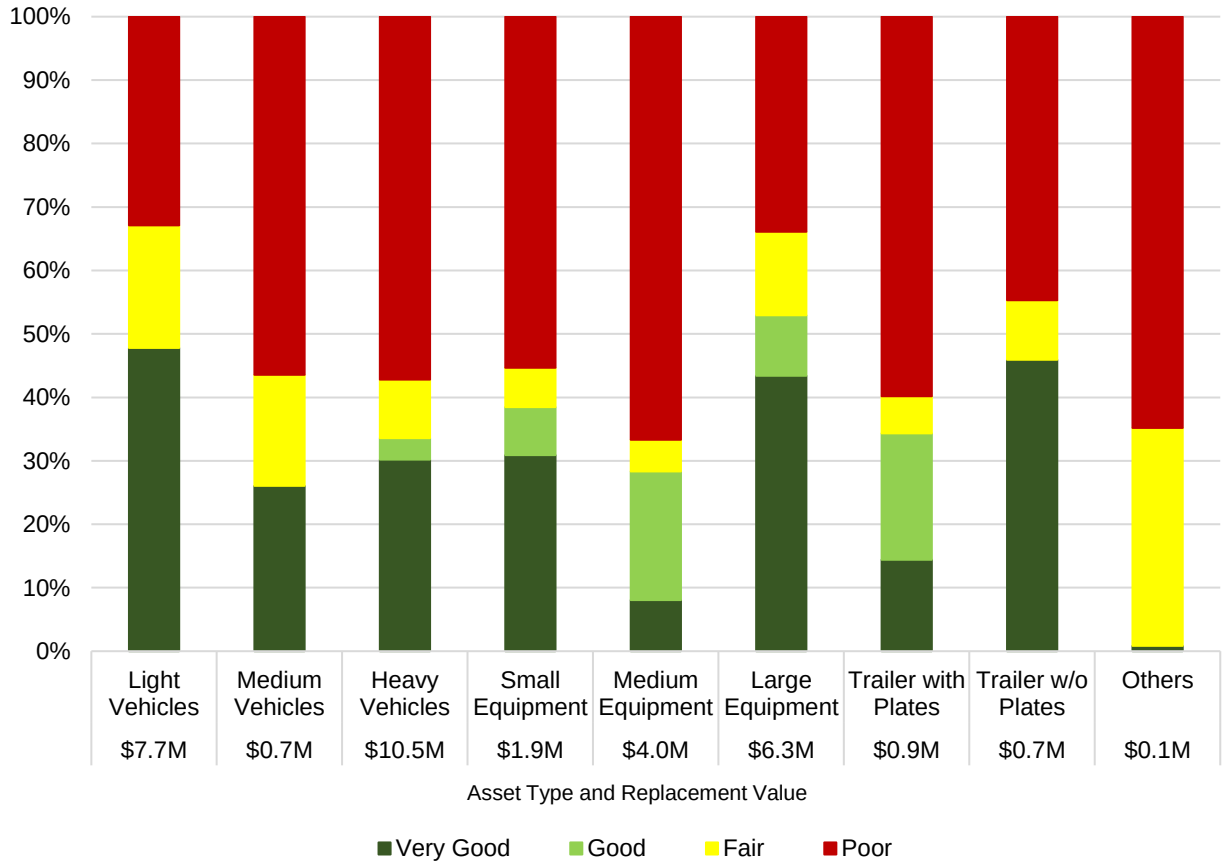

Figure 2-3: Distribution of Fleet Asset Condition

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.

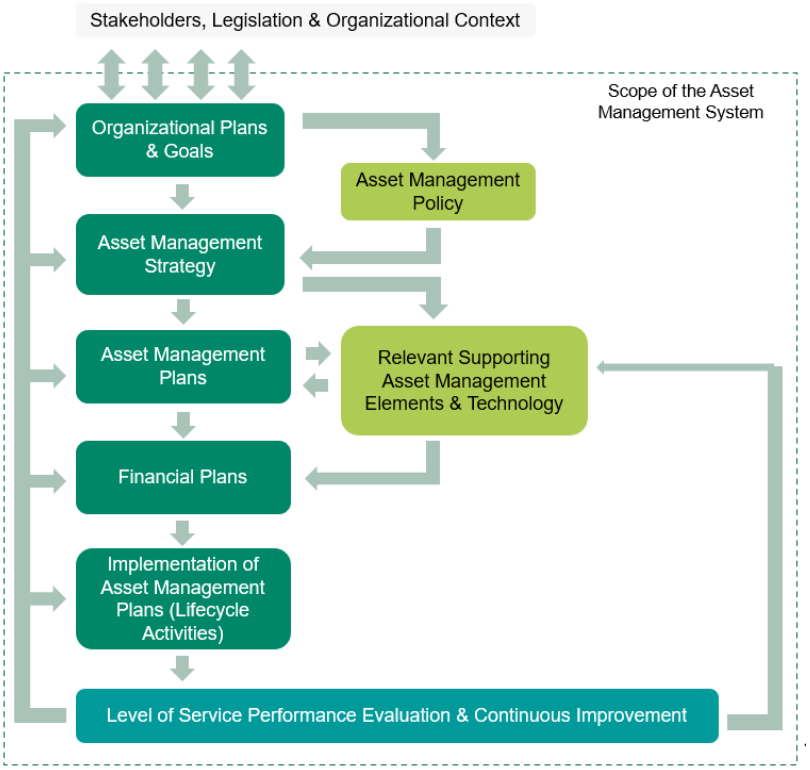

Figure 3-1: LoS within the AM System

In AECOM'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 factors (e.g., staff availability) and external factors (e.g., new technologies) 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)**.

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 & 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 (e.g., other City departments).
Environmental Sustainability	The service is delivered in a manner that does not compromise the ability of future generations to meet their needs.
Access & Capacity	Customers can easily access the service with minimal inconvenience.
Health & 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 & 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:

- **Other Service Providers** – Stakeholders that require the municipal service/assets to provide their own services (e.g., other City departments that rely on Fleet vehicles for their operational activities).
- **Regulatory Agencies** – Stakeholders that set standards, compliance regulations or other legislation that govern service delivery.

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 & Their Interests

Key Stakeholder Group	Stakeholder Examples	Stakeholder Interests / Priorities
Internal Departments	Almost all City departments utilize fleet or equipment for their day-to-day operational activities which are maintained through the Fleet Department. Parks, Roads, and Bylaw trucks 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, there are currently approximately 30 rental vehicles in service. As such, the rental companies are a stakeholder in the City's fleet asset class. Preventive Maintenance (PM) is primarily completed in-house; although depending how busy the Fleet Department is or if there is no in-house capability, certain PM work is sometimes outsourced.	• 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 Levels of Service 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 oppose 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.

The average fuel consumption for light, medium and heavy vehicles is 17.7 L/100 km, 26.4 L/100 km and 64.9 L/100 km respectively. In addition, the City has procured 2 electric vehicles and 1 hybrid vehicle with further plans to continue greening the Fleet in the future.

3.5 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	Fleet has many different manufactures that require varying maintenance once the vehicle is no longer under warranty. The department is finding it challenging to train mechanical experts to ensure alignment with the varying manufacturer requirements; as such, 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. The City would ideally like to add three additional vendors to its roster.
Technological advancements	As equipment becomes more sophisticated, the cost of keeping up with the technology is not easy to support. The City is finding it difficult to conduct work in-house that can meet the requirements of advancements in fleet technology.
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.
Funding	Fleet is tasked with replacing vehicles and equipment even when funding is limited, which is a challenge. As such, the department has increased costs to repair vehicles across the City, which affects the financial sustainability of other departments that use Fleet services, such as Parks and Roads, etc. In addition, the fleet reserve fund is not able to be 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.

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, outsourcing, 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. Considering entire asset lifecycles can ensure we make sound decisions that consider present and future service delivery needs.

The overarching goal of life cycle management is to maximize the long-term benefits and services 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.

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.

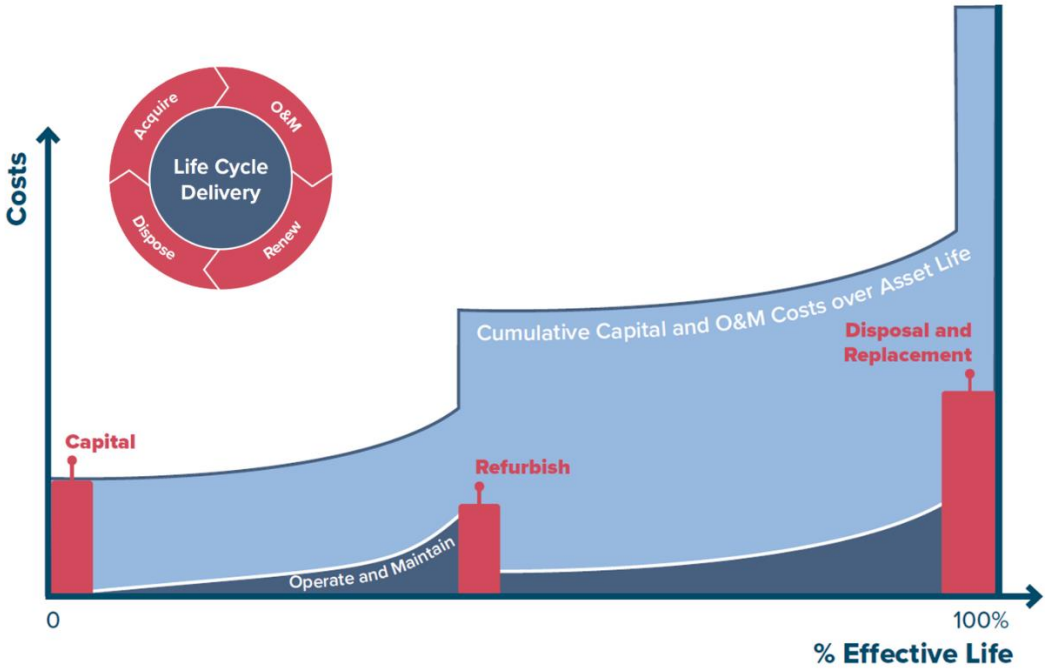

Figure 4-1: Life Cycle Cost Accumulation Over Asset Life

4.1 Asset Acquisition Strategies

The City has made significant investments in the acquisition of its fleet assets. These assets are acquired through request for proposal process based on annual replacement cycles and different departmental requests. These requests aim to meet the technical requirements for various user groups. For such requests, the responsibility of the fleet department is limited to the replacement of vehicles and excludes the requests pertaining to growth. Every department has its own capital budget in place and the City has cross-consultation processes for growth-related

requests. The City aims to go through a fleet audit in the summer of 2022, to clearly define the ownership of these vehicles across departments.

The City performs annual 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 other departments 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 anti-idling technology to reduce pollution[1].

Looking towards the future, when acquiring new assets, the City should 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.

4.2 Operations and Maintenance Strategies

As the City accepts the responsibility of operating and maintaining the asset according to O&M standards to ensure that the asset is safe and reliable. Maintenance expenses include periodic preventive maintenance to ensure that the assets can provide reliable service throughout the life and corrective maintenance that is required to repair defective fleet assets as and when needed.

Inadequate funding for fleet O&M will have an adverse impact on the lifespan of assets and may cause interruption to City's core services (e.g., snow clearing). The O&M resources required in any period is a function of the current inventory of asset and total O&M needs required for each asset. As the asset inventory 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 $2.8M.

Table 4-1: Historical Fleet O&M Budget Expenditures

Year	Total O&M Expenditures
2020	$ 2,408,000
2019	$ 3,627,000
2018	$ 3,107,000
2017	$ 2,689,000
2016	$ 2,378,000
Five-Yr. Average	**$ 2,842,000**

All City's vehicles must be road tested before 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 (KGS GVW), medium diesel vehicles up to 5,999 KGS GVW, and light and medium gas vehicles up to 5,999 KGS GVW.

The City outsources the O&M activities to private contractors, who are awarded work through the request for proposals process. Currently, the City has awarded work to four vendors, two for heavy vehicles, one for medium-

[1] Green Directions Vaughan

heavy vehicles and one for light vehicles, for a period of five years. Repair work is carried out in-house by the fleet department, which has spare vehicles in-place. The resources consist of a shop with four bays and three technicians. The City also has work orders based on usage thresholds for which vehicles get inspected on a set cycle.

The City tracks all vehicles failures as incidents for continuous improvements in its operations. Most of the accidental repairs are documented. The corrective maintenance is driven by the in-house capacity based on the highest priority vehicle such as a sidewalk tractor and the other vehicles are sent over to vendors.

4.3 Renewal and Replacement Strategies

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. 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 asset renewal or replacement and develop a strategy to respond in a manner that is fair, affordable, and sustainable.

The City has regular preventive maintenance programs for all light, medium and heavy-duty vehicles to assist in determination of any upcoming renewals and rehabilitation activities. The City also undertakes review of its vehicles to repurpose any add on equipment, attachments and outfitting that have past the lifecycle for the parent asset.

4.4 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 practice at the City looks at disposal of the vehicles through auctions. On an average, a vehicle is disposed at a cost between $2,000 to $5,000.

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. For certain fleet assets, the City harvests the vehicle parts, and fewer than one percent of vehicles is sold as scrap.

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. For now, the City has no procedures in place to track any environment costs associated with vehicle disposal activities.

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 fleet assets.

The annual reinvestment need for the fleet assets were based on age & ESL in years (i.e., replacing assets that has exceeded their ESL) in inflated dollar values. In the context of the economic outfall following the onset of the COVID-19 pandemic, the inflation rate between 2022 and 2025 is selected to be 5% and thereafter 2% base on the consultation with the City staff. 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 $4.2M over the next 20 years in inflated dollar values. This is equivalent to a total of approximately $88M over the next 20-year period, as presentedin **Figure 5-1**. It should be noted that there are significant backlogs ($15.6M) for reinvestment on the fleet assets that has already exceeded their ESL, as highlighted in red in the 2022 reinvestment need.

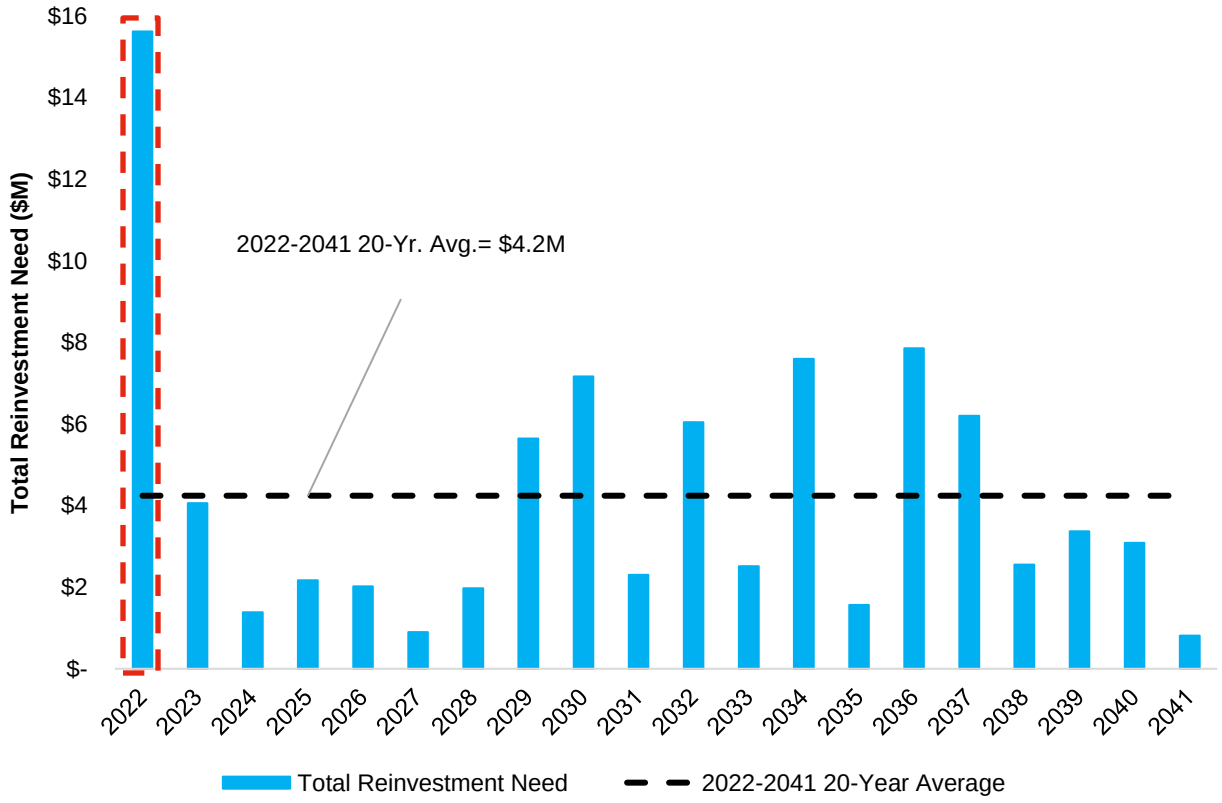

Figure 5-1: Fleet 20-Year Reinvestment Need

The detailed reinvestment needs in inflated dollar values for vehicles, equipment, trailers, and other fleet assets are presented in **Figure 5-2** and **Table 5-1**. As shown in **Figure 5-2**, in 2022, the reinvestment needs are primarily from the aged vehicles followed by equipment assets. Looking ahead to the year starting 2029, the City is recommended

to prepare for the increased reinvestment need for vehicles and equipment as they continue to age and start to approach and exceed their respective ESLs.

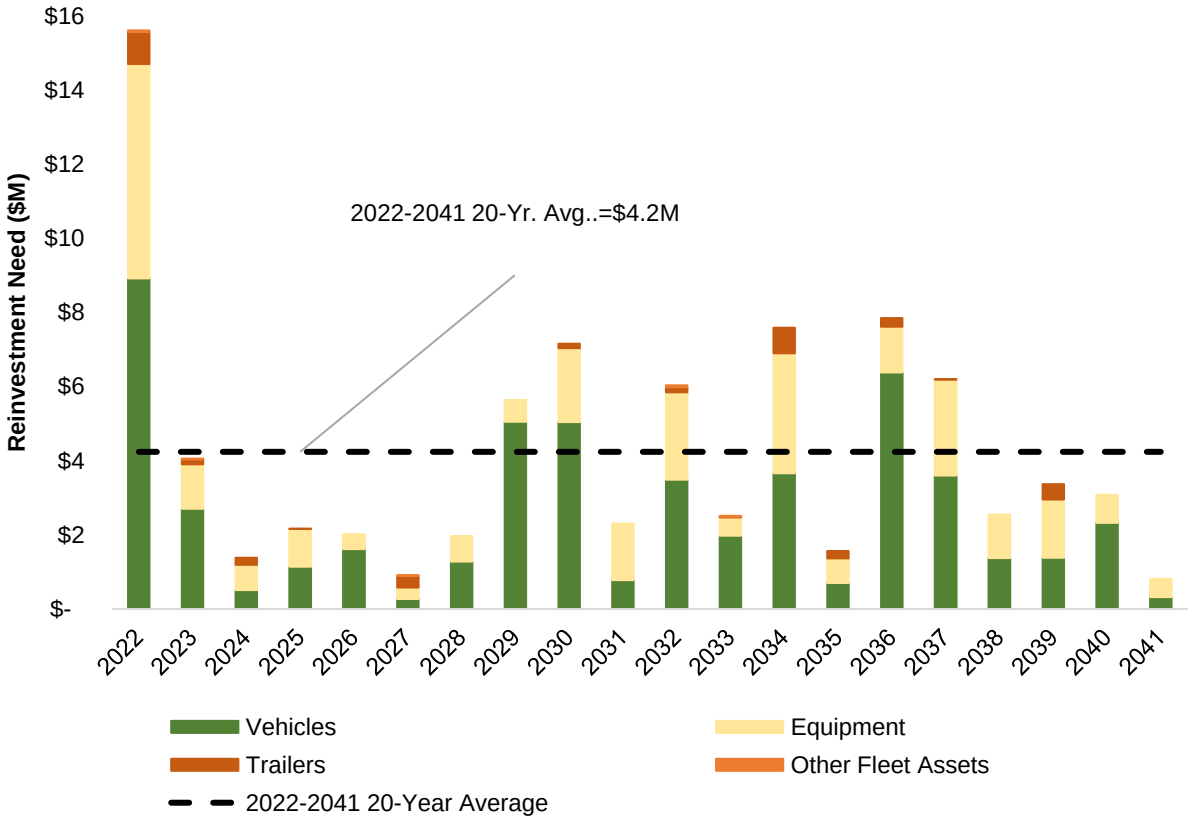

Figure 5-2: Fleet 20-Year Reinvestment Need Details

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

	Vehicles	Equipment	Trailers	Other Fleet Assets	Total
Annual Average Need	$2,628,000	$1,440,000	$167,000	$9,000	**$4,244,000**
20-Year Total	$52,560,000	$28,800,000	$3,340,000	$180,000	**$84,880,000**

5.2 40-Year Fleet Assets Reinvestment Need

Looking ahead in the long term, the average annual reinvestment rate for the City's fleet assets is $5.3M over the next 40 years in inflated dollar value, for a total of approximately $212M, as presented in **Figure 5-3**.

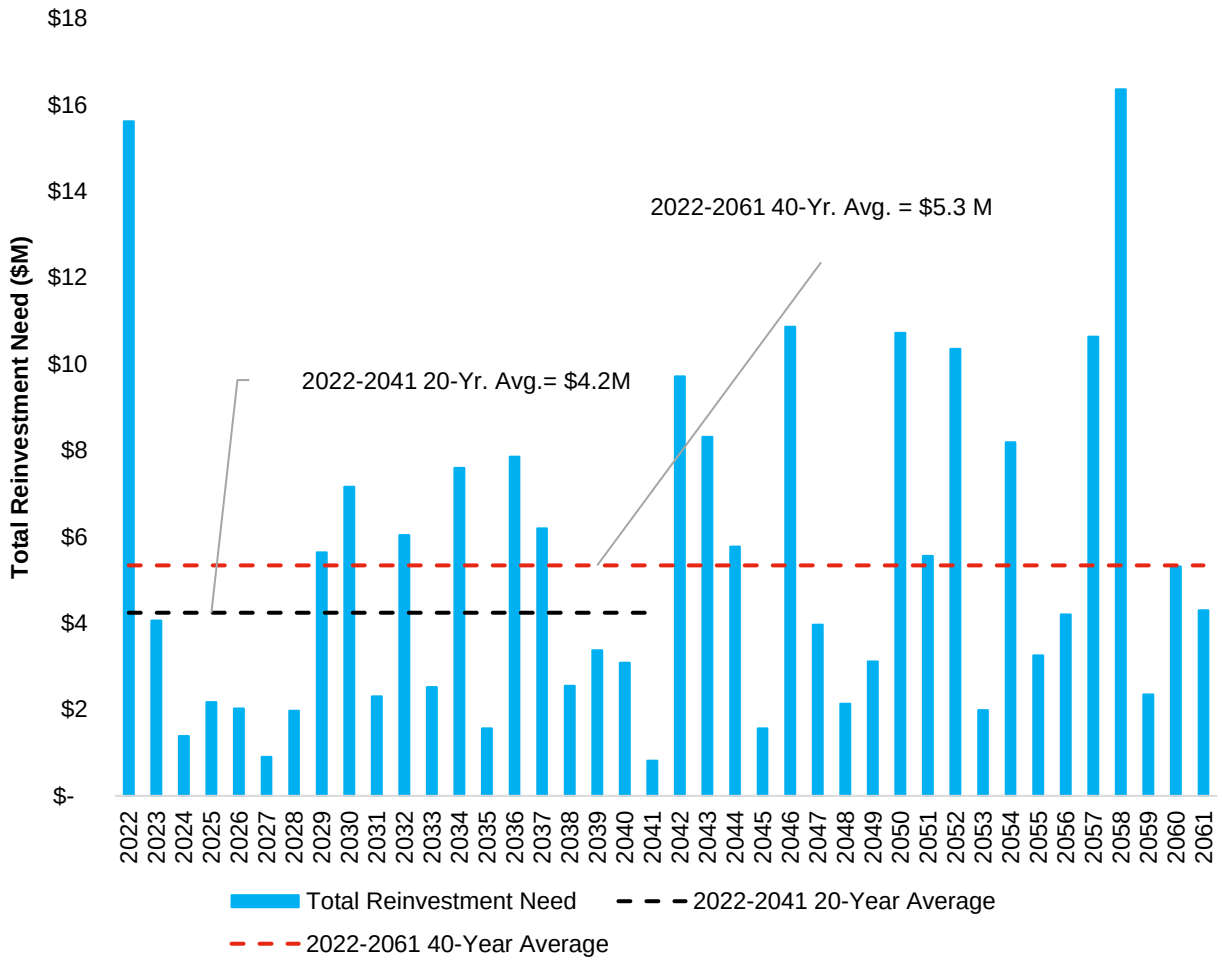

Figure 5-3: Fleet 40-Year Total Reinvestment Need (Inflated Dollar Value)

5.3 20-Year Full Funding Need Profile

Figure 5-4 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 in order 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 (see **Table 4-1**), and annual average fleet growth-related development cost in inflated dollar values.

Fleet assets requires approximately $3.7M annually over the next 20 years for O&M (see **Table 4-1**) in inflated dollar value, equivalent to $74M. The fleet growth-related cost or development cost (DC) is predicted to require $10.7M over the next 20 years, equivalent to roughly $0.54M annually. As such, with the addition of O&M and DC, the total average annual funding need for the City's fleet assets increases to approximately $8.6M annually, for a total of $172M over the next 20-year period.

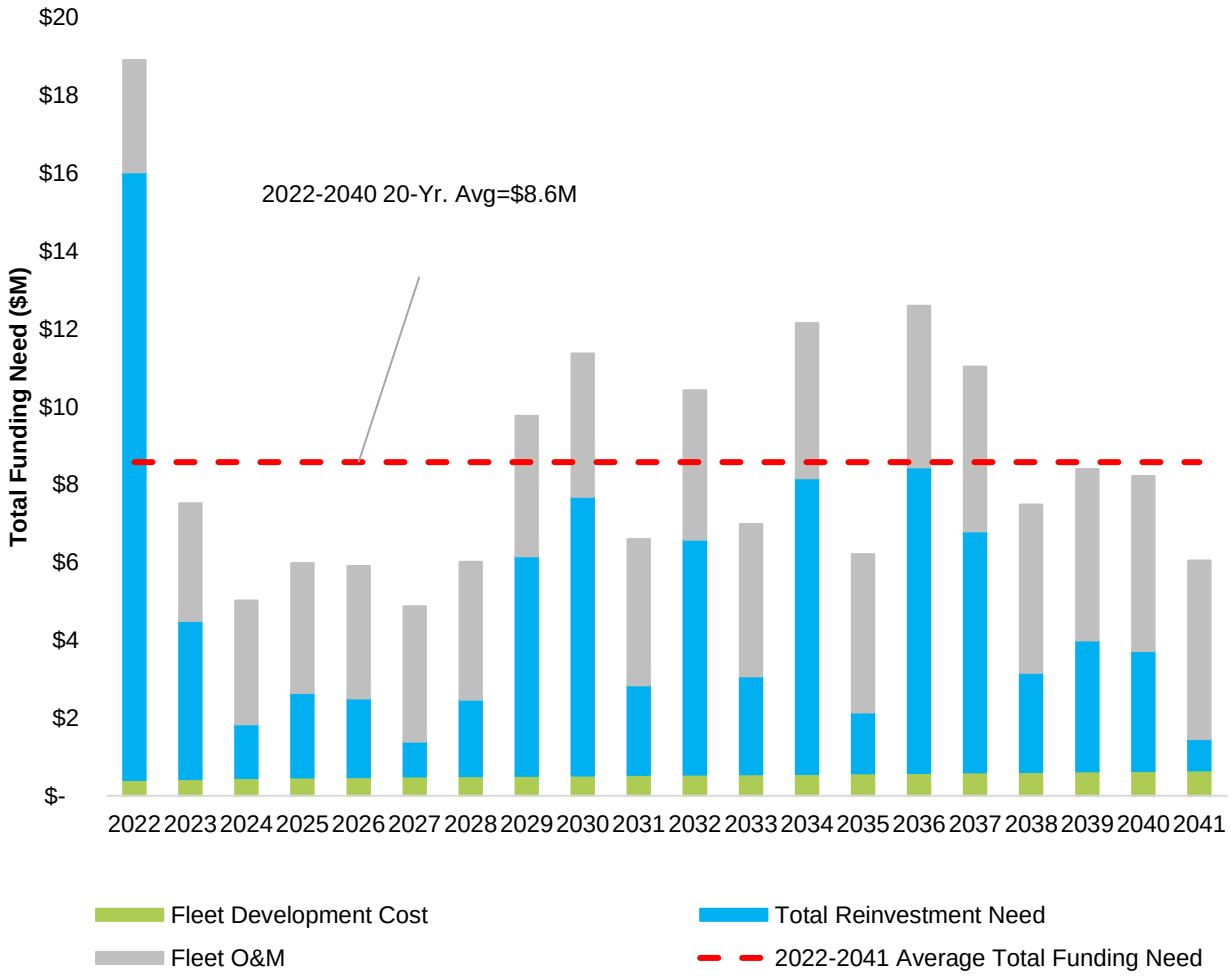

Figure 5-4: Fleet 20-Year Capital Investment and O&M Cost Forecast

6. Recommendations for Fleet AMP Continuous Improvement

Continuous improvement is an important component of any AM program and is achieved through the implementation of recommended improvement initiatives which support sustainable service delivery. AECOM has identified a set of activities that represents the next stage of AM planning and implementation within the City, as follows:

- **Continue to refine the asset inventory and close existing data gaps, so as to have a more accurate representation of the current state of the fleet assets; and, ultimately, to make more informed and defensible decisions**.
  - Continue maintaining the fleet inventory, keep updating the inventory as assets are acquired or disposed.
  - Refine the gross weight of vehicles to better group the vehicles and align with preventive maintenance activities.
  - Keep tracking mileage / hours for vehicle and equipment in fleet asset inventory to better align with the actual asset condition.
- **Develop a formalized fleet condition assessment process and use condition grading schemes for fleet assets.**
  - The grading system should contain a description of the condition, which is tied directly to each condition grade, and a description of the asset performance and level of corrective and preventive maintenance required for assets falling within a certain condition rating category. This process will allow the City to keep track of and better forecast fleet asset renewal needs.
  - Perform condition assessments on the most critical assets first. This will ensure that the fleet assets are assessed using the same methodology, and prioritized according to the asset's criticality, enabling a more defensible business case when raising issues of asset degradation to senior management and Council.
- **Refine the LoS Framework.**
  - Collect current asset performance data for key performance indicators (KPIs) that are not currently being tracked, including associated costs.
  - Analyze asset performance data to determine trends and to establish annual performance benchmarks.
  - Engage in a discussion with key stakeholders to establish service level targets and identify associated costs to meet those targets.
  - Once LoS targets have been decided upon, the City should develop strategies on how to meet service level targets considering its existing operating environment (i.e., staff availability, current funding, resources, etc.).
  - Develop a Customer Consultation Plan to engage the public and other stakeholders on the LoS framework and to better understand customers' willingness to pay for enhanced service levels.
- **Incorporate risk assessment for future iterations of the AM plan, and use the risk assessment results to drive future condition assessments and financial needs forecasting.**
  - Conduct a comprehensive criticality and risk assessment of fleet assets to inform work prioritization.
  - Review risk attribute values periodically to ensure alignment with business objectives and appetite.
  - Overlay the risk model with the current state of the assets (i.e., condition), and the financial forecast. Using this approach, the City could focus its monitoring, maintenance, and renewal and replacement budget and activities on high-risk assets. Medium risk infrastructure could be addressed through the mitigation of failure through regular monitoring, and the low-risk assets could be accepted with caution.
- **Establish a sustainable fleet funding model that fits the needs of the community.**

  - In light of the annual funding need outlined in **Figure 5-4**, the City should budget for totally $8.6M per year, on average, for fleet capital reinvestment, capital development, and O&M expenditures of over the next 20 years.
  - It is recommended the City to adjust the ESLs or RSLs for vehicles when the information on mileage and hours is available to better align with the actual asset condition, which will eventually impact the asset life cycle management decisions.
  - Review financial modeling assumptions on reinvestment rate and replacement values and update the financial model with new information as it becomes available. The financial model is based on a number of key assumptions that could have a significant impact on the outcomes of the model, such as the inflation rate.
  - A lack of adequate staff resource prevents businesses from achieving performance target. As the City shifts business priorities and grows over time, it is recommended to assess the fleet staff resource level periodically in order to meet the dynamic demand for supporting the City's core service.

- **Continue to find ways to improve AM initiatives across the City by maintaining a high level of AM awareness through training, communication, and knowledge sharing.**
  - Conduct an AM Software Assessment to identify future system requirements that may include enhancing existing software, adding-on, or replacing.
  - Develop a Knowledge Retention Strategy & Internal Communications Plan to document staff AM knowledge and experience for reporting and succession planning purposes. Communicate AM improvement initiatives and enhance AM awareness internally through internal communication

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Asset Management Plan

Non-Core Assets
Traffic Control and Streetlights

City of Vaughan

September 2022 (version 2)

Delivering a better world

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1. Introduction

1.1 Background

The City of Vaughan (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 one with increasing concentrations of 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, with a population of over 300,000, is rapidly growing and it is projected that the number of residents will continue to increase to 430,000 by 2031. The City is also home to a well-diversified and expanding employment sector and has the largest supply of new employment lands in the Greater Toronto Area (GTA). It is projected that employment numbers within City boundaries will increase from 150,000 to 278,000 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 capture the non-core infrastructure assets so as to provide the City with a comprehensive AM Program.

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, 2024 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 roadway appurtenances assets, which are owned and maintained by the City, as shown in **Table 1-2**.

Table 1-2: In-Scope Roadway Appurtenance Assets

Asset Category	Asset Types
Traffic Signal Controls	Traffic Signal Controls
Traffic Signs	Traffic Signs
Traffic Calming	Traffic Calming assets
Streetlights	Streetlight Poles, Streetlight Light Emitting Diode (LED), Streetlight High Pressure Sodium Vapor (HPS), Streetlight Brackets, Streetlight Nodes, 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.

2. State of Infrastructure

Roadway Appurtenance 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 & Hierarchy

Table 2-1 presents the summary of the City's roadway appurtenances inventory. The City has a total of 96 traffic signal controls including mid-block signals and independent pedestrian signals. The City-owned streetlights assets are further categorized into poles, lightings, 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: Roadway Appurtenances Asset Inventory & Hierarchy

Asset Category	Asset Type	Quantity	Unit of Measure
Traffic Signal Controls	Traffic Signal Controls	96	Ea.
Traffic Signs	Traffic Signs	22,217	Ea.
Traffic Calming	Traffic Calming Assets	435	Ea.
Streetlights	Streetlight Poles	22,674	Ea.
	Streetlight LED	23,417	Ea.
	Streetlight HPS	1281	Ea.
	Streetlight Brackets	24,698	Ea.
	Streetlight Nodes	24,698	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 today's dollars. These costs are collected from the City's GIS record. Where applicable, a 2% annual inflation rate was used to estimate the 2022 values.

The City-owned roadway appurtenance assets is valued at approximately $185M, as represented in **Table 2-2**. The estimated total replacement value for the streetlights is approximately $145M, which accounts for the largest share (78%) of the total replacement value among the roadway appurtenance asset categories.

Table 2-2: Roadway Appurtenances Current Replacement Costs

Asset Category	Asset Type	Unit Cost ($ / Unit)	Total Replacement Value (2022)
Traffic Signal Controls	Traffic Signal Controls	$258,000 / Unit	$24,768,000
Traffic Signs	Traffic Signs	$350 / Unit	$7,776,000
Traffic Calming	Traffic Calming	$1,750 / Unit	$762,000
Streetlights	Streetlight Poles	$3,370 - $4,800 / Unit	$89,722,000
	Streetlight LED	$321 - $793 / Unit	$11,079,000
	Streetlight HPS	$321 - $793 / Unit	$417,000

Asset Category	Asset Type	Unit Cost ($ / Unit)	Total Replacement Value (2022)
	Streetlight Brackets	$110 - $320 / Unit	$4,171,000
	Streetlight Nodes	$83 / Unit	$2,050,000
	Underground Cables	$75 / m	$37,500,000
	Gateway and Backhaul	$8,500 / Unit	$102,000
Barriers	Barriers	$75 - $1,000 / m	$5,527,000
	Barrier End Treatments	$100 - $5,000 / Unit	$770,000
Total			**$184,644,000**

2.3 Age & 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. It should be noted that the recent upgrade of traffic signal controls is not available in GIS and therefore, not included in this analysis. The RSL can be refined further when the assets upgrade information is incorporated for traffic signal controls. Traffic calming and streetlight HPS assets have exceeded their ESL by 13 years. Streetlight LED, and nodes are early in their life, while poles consumed 83% of their ESL.

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.

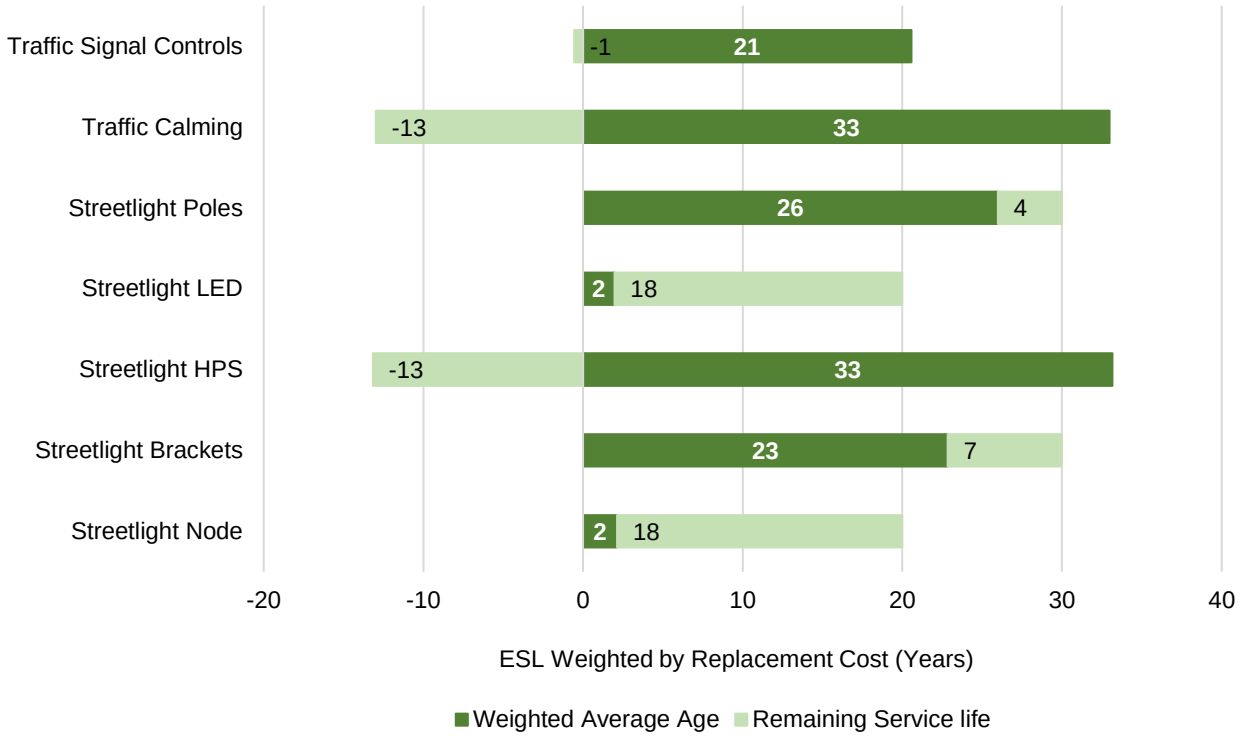

Figure 2-1: Roadway Appurtenances Asset Average Age and Remaining Service Life

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 roadway appurtenances. 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	>=3.5	Poor	93% - >100%	61% - 100%

2.4.2 Condition Summaries

Figure 2-2 provides a summary of the condition weighted by replacement value for roadway appurtenance assets. It shows that almost 60% of the assets are in Very Good to Good condition. However, 38% of the roadway appurtenance 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.

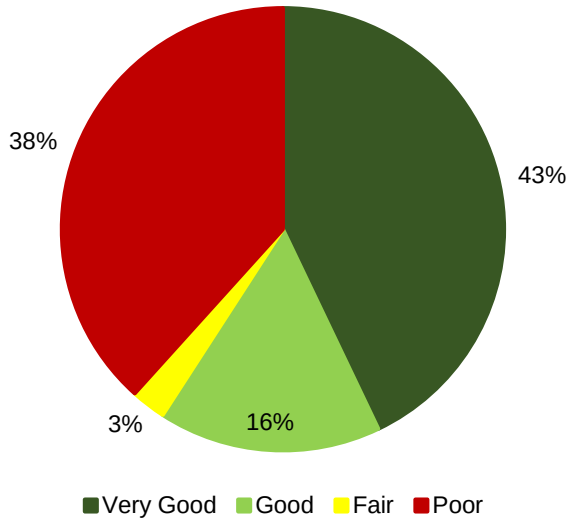

Figure 2-2: Roadway Appurtenances Asset Condition Summary

Figure 2-3 presents the condition distribution for each roadway appurtenance asset type weighted by replacement value. Approximately 60% of the City's streetlight poles are in Very Good to Good condition, while 34% are in Poor condition approaching their expected replacement date. The streetlight HPS are mostly in Poor condition indicating the needs for renewal in the short-term. Similarly, traffic calming assets are in Poor condition. 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 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.

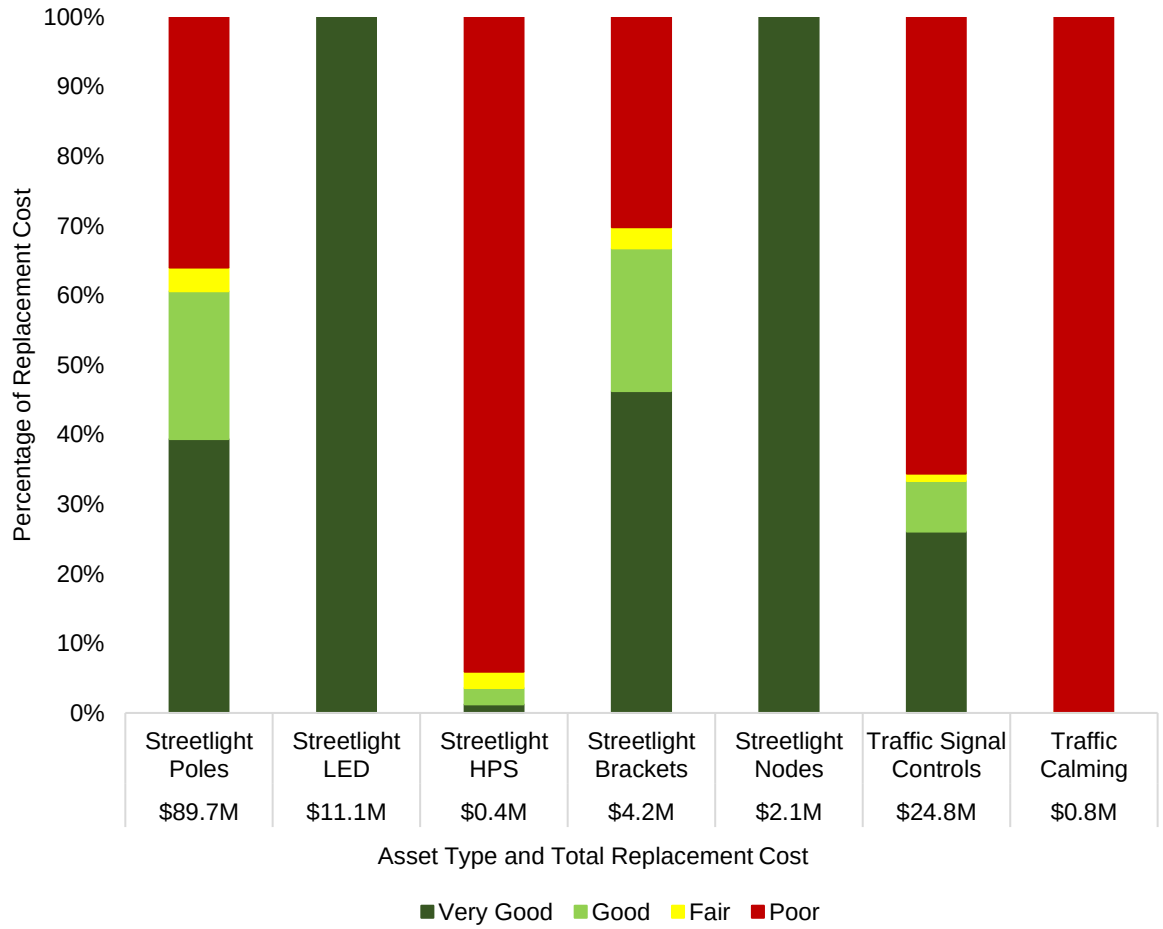

Figure 2-3: Distribution of Roadway Appurtenances Asset Condition

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.

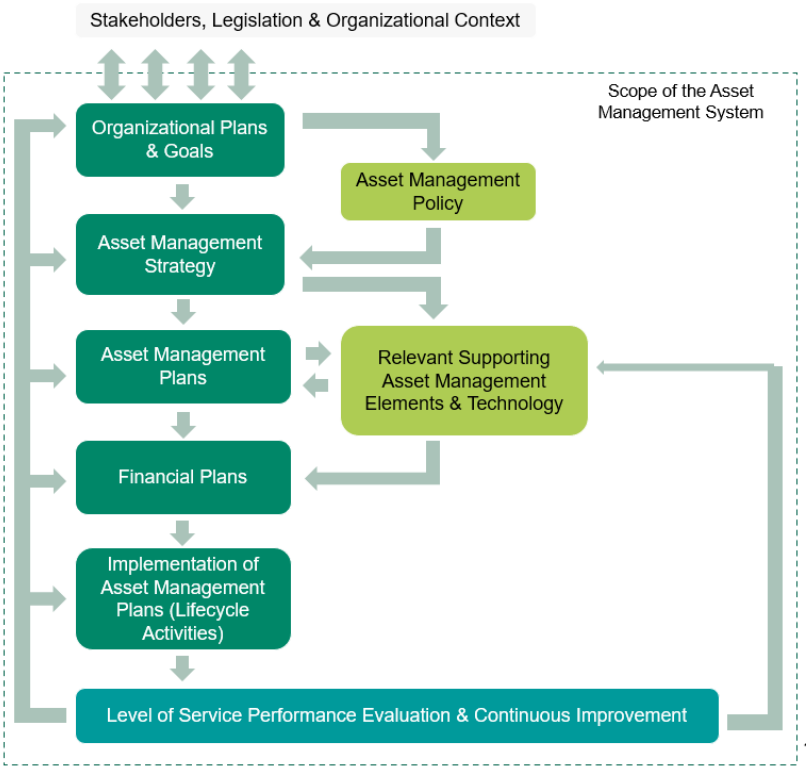

Figure 3-1: LoS within the AM System

In AECOM'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**).

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 & 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 & Capacity	Customers can easily access the service with minimal inconvenience.
Health & 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 & 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 roadway appurtenances. 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 Roadway Appurtenances Stakeholders & 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 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.

Measured in the most recent Citizen Satisfaction Survey conducted by Ipsos, the percentage of respondents satisfied with Sidewalks and Streetlighting was 88%. Additionally, as illustrated **Figure 3-2**, the percentage of eligible Streetlights that have been converted to LED technology is 99%.

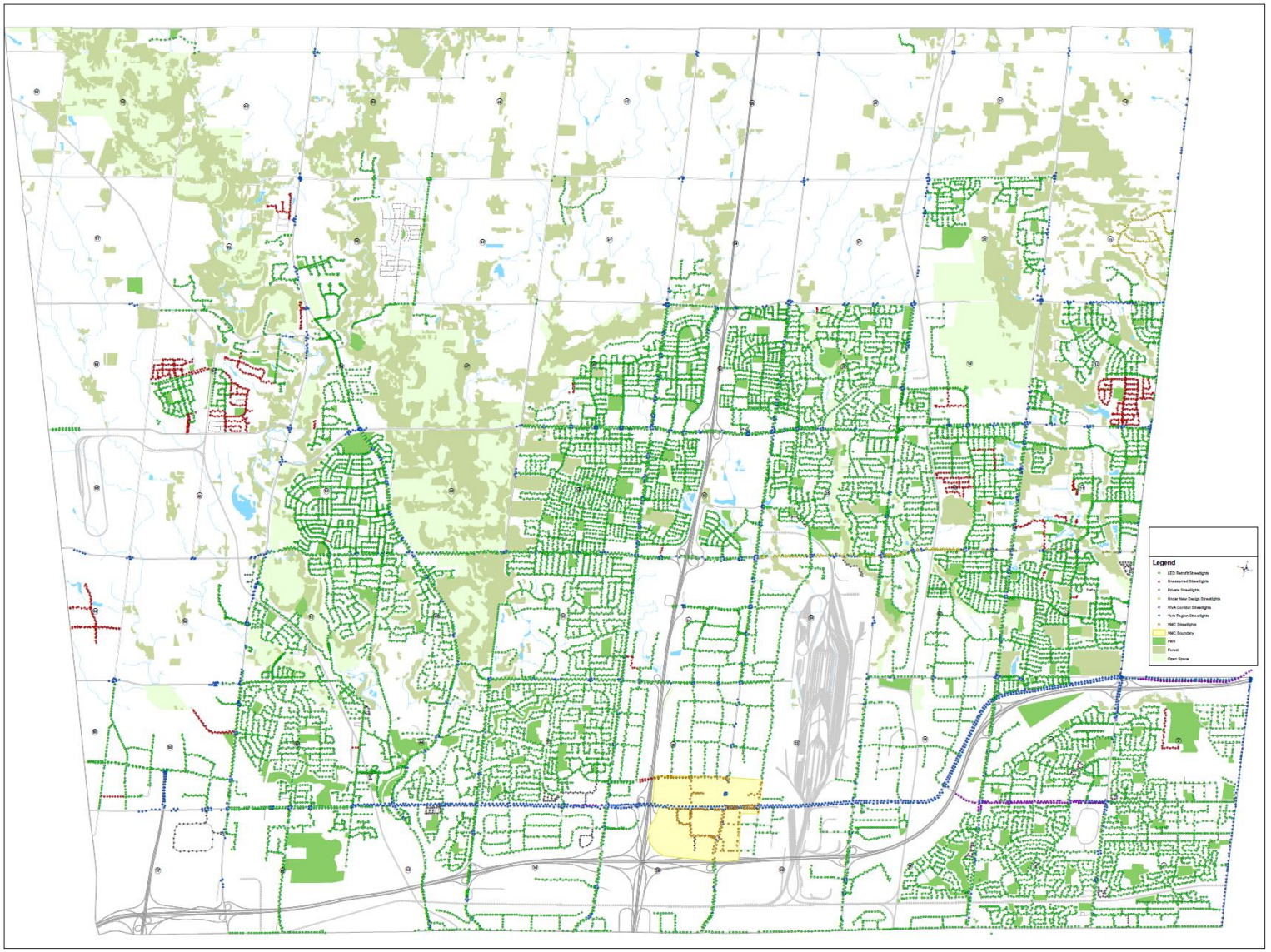

Figure 3-2: Conversion of Streetlights to LED Technology

3.5 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
Population Growth & 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 roadway appurtenances 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.

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.

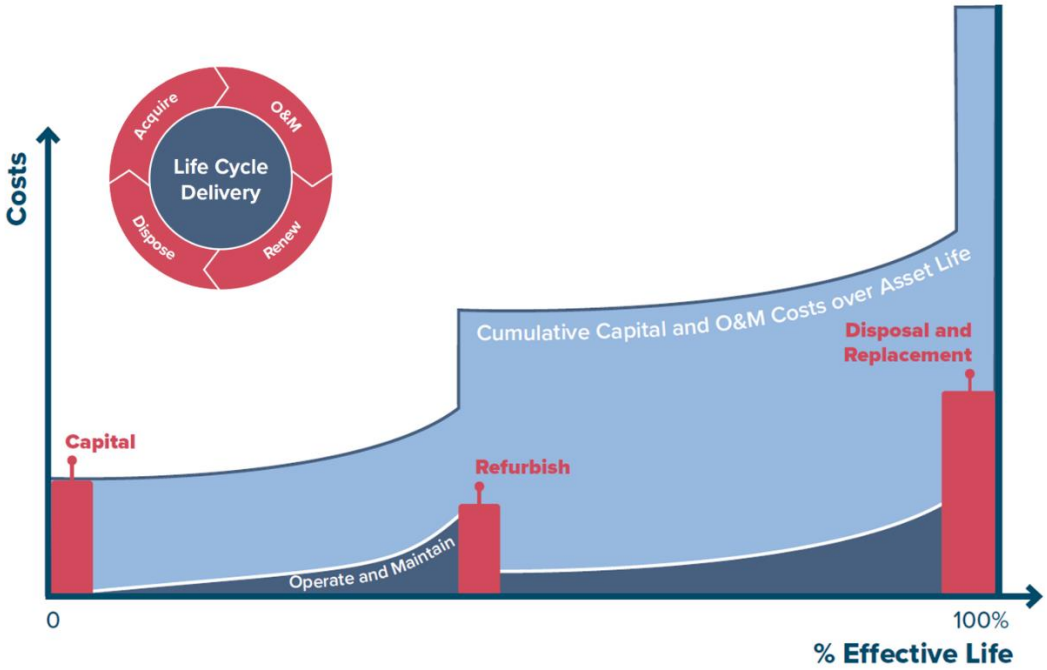

Figure 4-1: Life Cycle Cost Accumulation Over Asset Life

4.1 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)[1] 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.

4.2 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 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 $6.1M and Table 4-3 provides a breakdown of the O&M activities for traffic signal controls, traffic signs, traffic calming and streetlights.

[1] MoveSmart Mobility Management Strategy (vaughan.ca)

Table 4-2: Historic Traffic O&M Expenditures

Year	Total O&M Actuals
2019	$ 6,822,000
2018	$ 7,686,000
2017	$ 5,737,000
2016	$ 5,552,000
2015	$ 4,796,000
5-Yr. Average	**$ 6,131,000**

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.	$ 4,822,000
Overhead	All overhead costs (e.g., traffic engineering admin costs, Crossing guards, utility coordination Bell FTTH related projects.)	$ 1,309,000
Total		**$6,131,000**

The O&M cost for barriers was primary for guiderail maintenance. Guiderail maintenance constitutes major portion of the barriers O&M activities and comes to an overall five-year average O&M actual cost of $31,000 as shown in **Table 4-4**.

Table 4-4: Historical Barriers O&M Actuals

Year	Total O&M Actuals
2020	$ 20,000
2019	$ 23,000
2018	$ 17,000
2017	$ 47,000
2016	$ 48,000
5-Yr. Average	**$ 31,000**

4.3 Renewal and Replacement Strategies

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. 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 roadway appurtenance assets renewal need is based on age and ESLs.

4.4 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 roadway appurtenances 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 roadway appurtenance disposal activities.

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 roadway appurtenance 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 roadway appurtenance assets.

The annual reinvestment needs for the roadway appurtenance assets were based on age and ESL in years (i.e., replacing assets that have exceeded their ESL) in inflated dollar values. Where the installation date data is not available, an annual change-out rate is applied to estimate the asset replacement need. A change out rate of 3.6% is used for traffic signs assuming their ESL is 28 years. For Barriers with no install dates, a change out rate of 1.7% is applied to retaining walls (equivalent to a life cycle of 60 years), and 3.3% (equivalent to a life cycle of 30 years), for other barrier assets.

The inflation rate is 2% based on the consultation with City staff. 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 roadway appurtenances is $9.5M over the next 20 years in inflated dollar values. This is equivalent to a total of approximately $190M over the next 20-year period, as presented in **Figure 5-1**. It should be noted that there are significant backlogs ($52M) for reinvestment on the streetlight assets (**Figure 5-2**), primarily for streetlight poles that have already exceeded their ESL as highlighted in red in the 2022 reinvestment need.

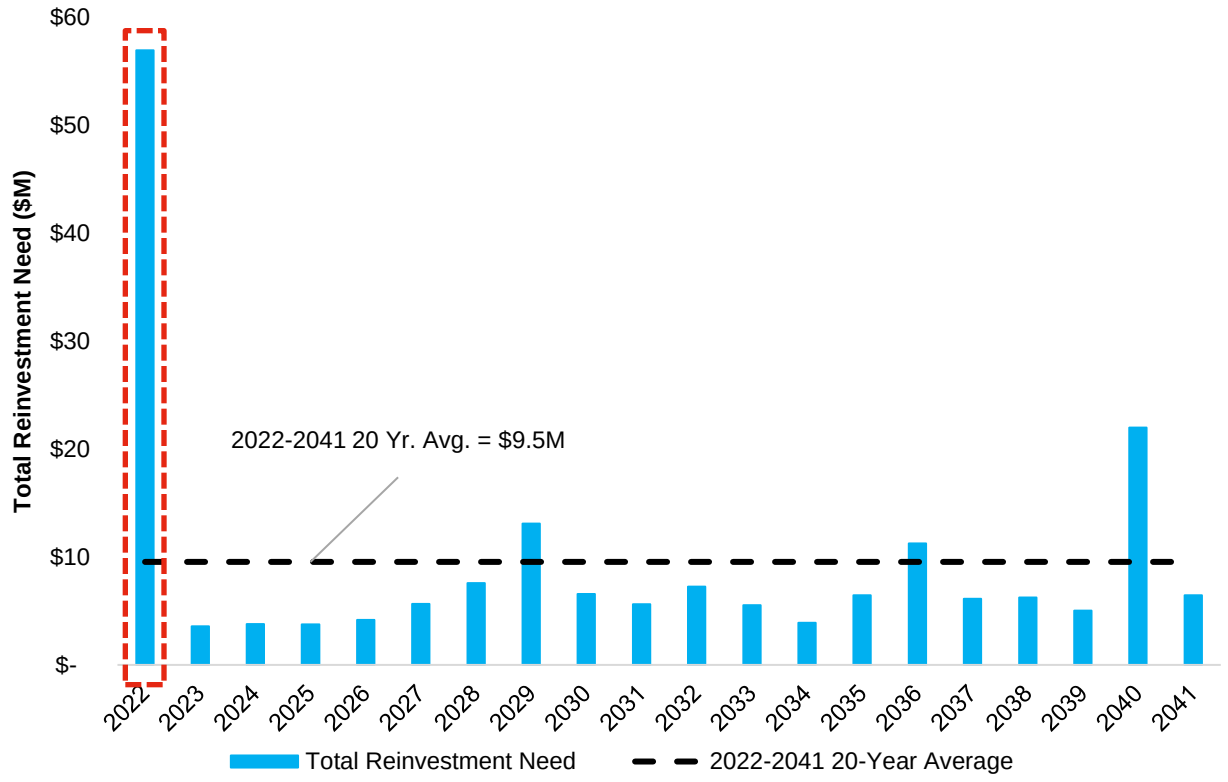

Figure 5-1: Roadway Appurtenances 20-Year Reinvestment Need

As shown in **Figure 5-2**, in 2022, the reinvestment needs are primarily from the aged streetlights and traffic signal control assets. It should be noted that the reinvestment need for traffic signal controls will be decreased when the recent upgrade information is incorporated.

Looking ahead to the period starting 2029, the City is recommended to 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 inflated dollar values.

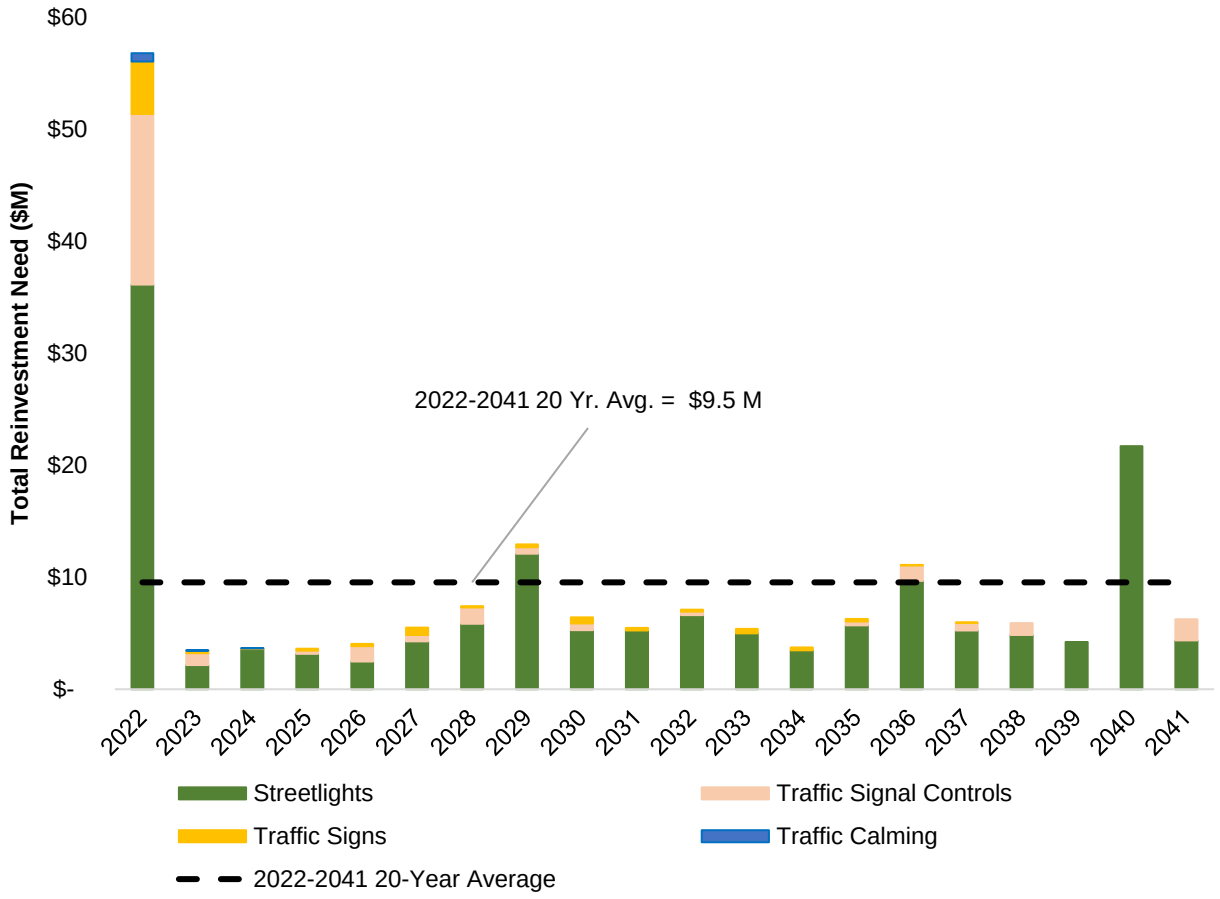

Figure 5-2: Roadway Appurtenances 20-Year Reinvestment Need Details

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

	Streetlights	Traffic Signal Controls	Traffic Signs	Traffic Calming	Barriers	Total
Annual Average Need	$7,551,000	$1,341,000	$338,000	$39,000	$197,000	**$9,466,000**
20-Year Total	$151,020,000	$26,820,000	$6,760,000	$780,000	$3,940,000	**$189,320,000**

5.2 60-Year Roadway Appurtenance Assets Reinvestment Need

Looking ahead in the long term, the average annual reinvestment rate for the City's roadway appurtenance assets is $12M over the next 60 years in inflated dollar value, for a total of approximately $720M, as presented in **Figure 5-3**. It

is noticeable that there are increasing asset reinvestment needs starting from 2052, where the major driver is the continued aging of the streetlight assets (reaching their respective ESLs).

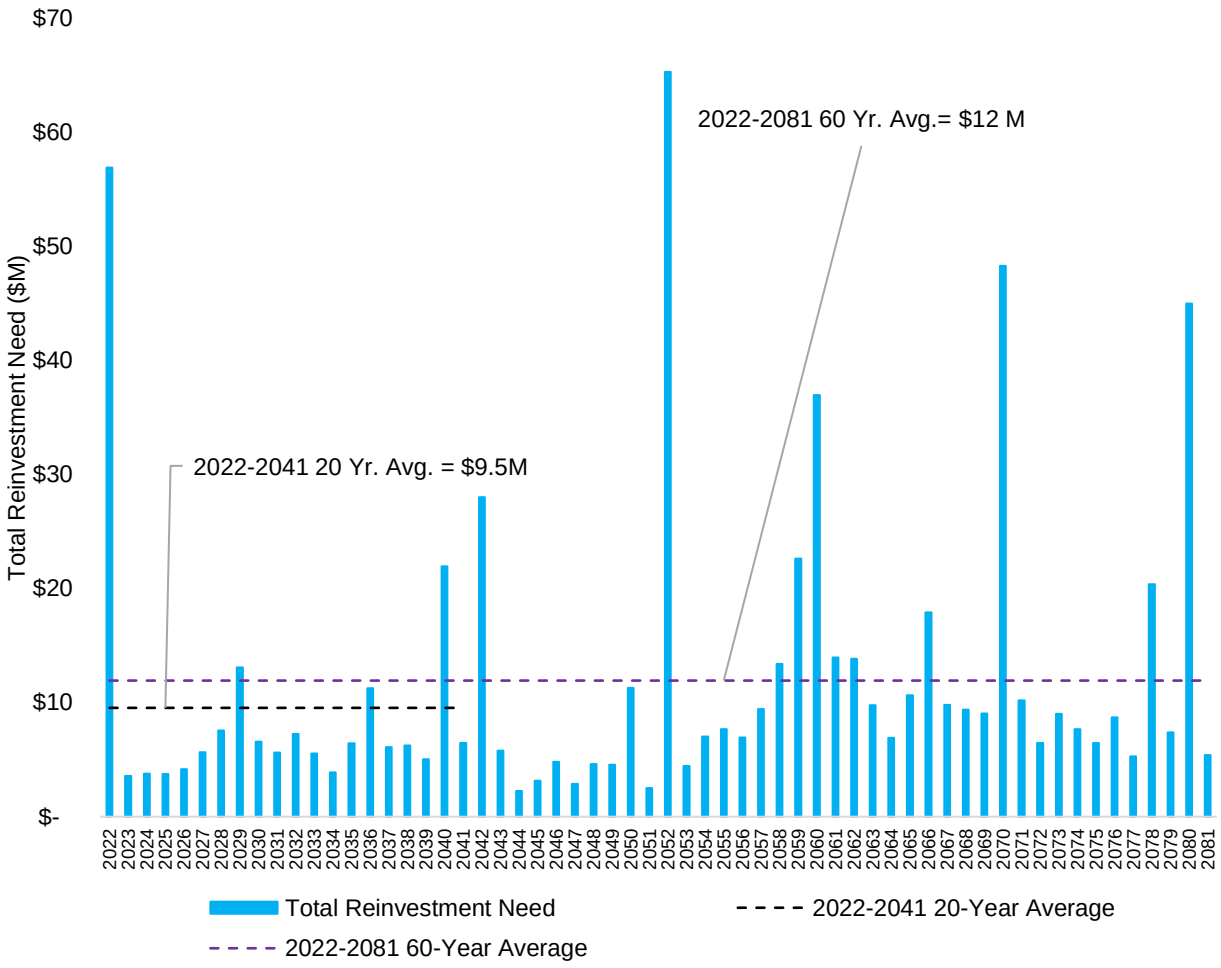

Figure 5-3: Roadway Appurtenances 60-Year Total Reinvestment Need (Inflated Dollar Value)

5.3 Full Funding Need Profile

Figure 5-4 shows a full picture of the City's roadway appurtenances 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 roadway appurtenances O&M cost, and annual average roadway appurtenances growth-related or development cost in inflated dollar values.

Roadway appurtenance assets require approximately $7.9M annually over the next 20 years for O&M, equivalent to totally $158M in inflated dollar value. The roadway appurtenances growth-related cost or development cost (DC) requires approximately $60M over the next 20 years, equivalent to roughly $3M annually. As such, with the addition of O&M and DC, the total average annual funding need for the City's roadway appurtenance assets increases to approximately $20M annually, for a total of $400M over the next 20-year period. It is noted that the DC for barriers has been included in the Roads AM plan.

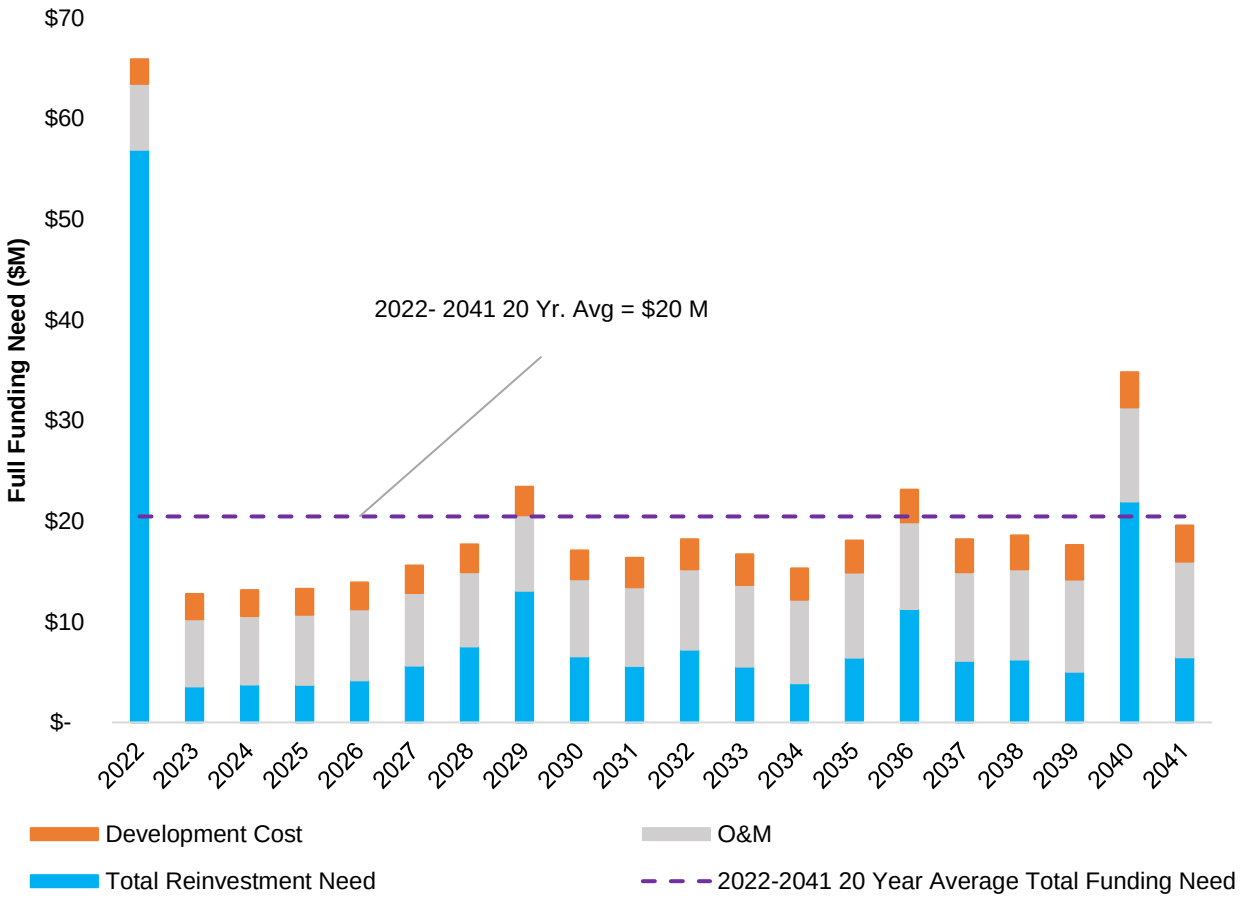

Figure 5-4: Roadway Appurtenances 20-Year Capital Investment and O&M Cost Forecast

6. Recommendations for Roadway Appurtenances AMP Continuous Improvement

Continuous improvement is an important component of any AM program and is achieved through the implementation of recommended improvement initiatives which support sustainable service delivery. AECOM has identified a set of activities that represents the next stage of AM planning and implementation within the City.

- **Continue to refine the asset inventory and close existing data gaps, so as to have a more accurate representation of the current state of the roadway appurtenance assets; and, ultimately, to make more informed and defensible decisions**.
  - AECOM recommends the City to continue maintaining the roadway appurtenances inventory, keep updating the inventory as assets are acquired or disposed.
  - Refine the install date or upgrade information of traffic signal control assets to better estimate the remaining service life.
- **Develop a formalized with the roadway appurtenances condition assessment process and use condition grading schemes for roadway appurtenance assets.**
  - AECOM proposes that a consistent condition grading scale be applied across transportation asset portfolio. The grading system should contain a description of the condition, which is tied directly to each condition grade, and a description of the asset performance and level of corrective and preventive maintenance required for assets falling within a certain condition rating category.
  - Perform condition assessments on the most critical assets first following a systematic risk management approach. This will ensure that the roadway appurtenance assets are assessed using the same methodology, and prioritized according to the asset's criticality, enabling a more defensible business case when raising issues of asset degradation to senior management and Council.
  - Once the roadway appurtenances condition rating system is confirmed, onsite condition assessments should be conducted to fill condition information gaps across the asset inventory. This will support more informed asset management and maintenance decisions based on the specific condition.
- **Refine the LoS Framework.**
  - Collect current asset performance data for key performance indicators (KPIs) that are not currently being tracked, including associated costs for managing the assets and delivering the LoS.
  - Analyze asset performance data to determine trends and establish annual performance benchmarks.
  - Engage in a discussion with key stakeholders to establish service level targets and identify associated costs to meet those targets.
  - Once LoS targets have been decided upon, the City should develop strategies on how to meet service level targets considering its existing operating environment (i.e., staff availability, current funding, resources, etc.).
  - Develop a Customer Consultation Plan to engage the public and other stakeholders on the LoS framework and to better understand customers' willingness to pay for enhanced service levels.
- **Incorporate risk assessment for future iterations of the AM plan and use the risk assessment results to drive future condition assessments and financial needs forecasting.**
  - Conduct a comprehensive criticality and risk assessment of transportation and roadway appurtenance assets to inform work prioritization.
  - Review risk attribute values periodically to ensure alignment with business objectives and appetite.

  - Overlay the risk model with the current state of the assets (i.e., condition), and the financial forecast. Using this approach, the City could focus its monitoring, maintenance, and renewal and replacement budget and activities on high-risk assets. Medium risk infrastructure could be addressed through the mitigation of failure through regular monitoring, and the low-risk assets could be accepted with caution.

- **Establish a sustainable roadway appurtenances funding model that fits the needs of the community.**
  - In light of the annual funding need outlined in **Figure 5-4**, the City should budget for totally $20M per year, on average, for roadway appurtenances capital reinvestment, capital development, and O&M expenditures over the next 20 years.
  - Update the traffic signal controls' upgrade information to adjust the RSLs for the assets to better inform future capital and O&M need for traffic signal controls.
  - Review financial modeling assumptions on reinvestment rate and replacement values and update the financial model with new information as it becomes available. The financial model is based on a number of key assumptions that could have a significant impact on the outcomes of the model.
- **Continue to find ways to improve AM initiatives across the City by maintaining a high level of AM awareness through training, communication, and knowledge sharing.**
  - Conduct an AM software assessment to identify future system requirements that may include enhancing existing software, adding-on, or replacing.
  - Develop a Knowledge Retention Strategy and Internal Communications Plan to document staff AM knowledge and experience for reporting and succession planning purposes. Communicate AM improvement initiatives and enhance AM awareness internally through internal communication.

aecom.com

Asset Management Plan

Non-Core Assets
Fire & Rescue

City of Vaughan

September 2022 (version 2)

Delivering a better world

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1. Introduction

1.1 Background

The City of Vaughan (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 such services as fire protection, public works, water distribution and wastewater collection, parks and recreation, and buildings.

The next 25 years will see the City transition from a growing suburban municipality to one with increasing concentrations of 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, with a population of over 300,000, is rapidly growing and it is projected that the number of residents will continue to increase to 430,000 by 2031. The City is also home to a well-diversified and expanding employment sector and has the largest supply of new employment lands in the Greater Toronto Area (GTA). It is projected that employment numbers within City boundaries will increase from 150,000 to 278,000 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 capture the non-core infrastructure assets so as to provide the City with a comprehensive AM Program.

The objective of this AMP is to deliver a financial and technical roadmap for the management of the City's Fire & 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 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, 2024 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 LoS 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 & Rescue asset group, which are owned and maintained by the City, as shown in **Table 1-2**.

Table 1-2 In-Scope Fire & Rescue Assets

Asset Category	Sub-Assets
Emergency Response Vehicles	Aerial 105ft, Aerial 55ft, Air/Light Trucks, Commands, Haz-Mat, Mechanical Service Vehicles, Platforms, Pumpers, Rescues, and Tankers
Passenger Vehicles	Cars, SUVs, and Pick-up Trucks
Equipment	Self-Contained Breathing Apparatus, Hose, Communications, Fire Truck Equipment, Fitness Equipment, Bunker Gear Washer, Radio, Rescue Equipment, Bunker Gear Rak, Bunker Gear, Air Fill Stations, Camera Truck Hoist, Fire Station Equipment, Hose Nozzles, Megablast Drying Machine, Washer Extractor, and Other such as utility trailers.

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 activities to maintain identified current LoS, minimize associated asset risks, and to optimize costs over the whole lifecycle of the asset.

2. State of Infrastructure

Fire & 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 & 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 & Hierarchy

Table 2-1 presents the City's Fire & Rescue inventory and a tabulated asset hierarchy. There is a wide range of Fire & Rescue asset types. VFRS manages over 31 emergency response vehicles, 27 Passenger Vehicles, and over 1,800 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 18 types. They range from self-contained breathing apparatus to truck hoists.

Table 2-1: Fire & Rescue Asset Inventory & Hierarchy

Asset Category	Asset Type	Quantity	Unit of Measure
Emergency Response Vehicles	Aerial 105ft	2	Ea.
	Aerial 55ft	6	Ea.
	Air/Light Truck	1	Ea.
	Command	2	Ea.
	Haz-Mat	1	Ea.
	Mechanical Service Vehicle	1	Ea.
	Platform	2	Ea.
	Pumper	8	Ea.
	Rescue	6	Ea.
	Tanker	2	Ea.
Passenger Vehicles	Car	10	Ea.
	SUV	12	Ea.
	Pick-up Truck	5	Ea.
Equipment	Self-Contained Breathing Apparatus	919	Ea.
	Hose	252	Ea.
	Communications	59	Ea.
	Fire Truck Equipment	188	Ea.
	Fitness Equipment	30	Ea.
	Bunker Gear Washer	3	Ea.
	Radio	5	Ea.
	Rescue Equipment	14	Ea.
	Bunker Gear Rak	16	Ea.
	Bunker Gear	258	Ea.
	Air Fill Stations	1	Ea.
	Camera	2	Ea.
	Truck Hoist	10	Ea.
	Fire Station Equipment	1	Ea.
	Hose Nozzles	70	Ea.
	Megablast Drying Machine	10	Ea.
	Washer Extractor	1	Ea.
	Other	9	Ea.

2.2 Current Asset Replacement Cost

The estimated replacement value is the cost of replacing an existing asset in today's dollars. These costs are developed based on the City's purchase records and consultation with City staff. A 2% annual inflation rate was used to estimate the replacement cost from purchase year to year 2022. In the context of the economic outfall following the onset of the COVID-19 pandemic, 10% and 5% inflation rates were applied to emergency response vehicles and other Fire & Rescue asset categories, respectively, accounting for the inflation from 2021 to 2022. The replacement costs were then calculated by considering the inventory and quantities in **Table 2-1** and the unit costs in **Table 2-2.**

The City-owned Fire & Rescue assets is valued at approximately $40M, as represented in **Table 2-2**. The estimated total replacement value for the emergency vehicles is approximately $34M, which accounts for the largest share of the total replacement value among the Fire & Rescue asset categories.

Table 2-2: Fire & Rescue Assets Total Replacement Costs

Asset Category	Asset Type	Unit Cost ($ / Unit)	Current Replacement Cost (2022)
Emergency Response Vehicles	Aerial 105ft	$1,760,000 - $2,750,000	$4,510,000
	Aerial 55ft	$1,045,000 - $1,320,000	$7,370,000
	Air/Light Truck	$800,000	$800,000
	Command	$550,000	$1,100,000
	Haz-Mat	$880,000	$880,000
	Mechanical Service Vehicle	$220,000	$220,000
	Platform	$1,980,000 - $2,800,000	$4,780,000
	Pumper	$880,000	$6,160,000
	Rescue	$660,000 - $1,200,000	$6,180,000
	Tanker	$750,000 – 1,040,000	$1,790,000
Passenger Vehicles	Car	$50,000	$500,000
	SUV	$50,000 - $84,000	$784,000
	Pick-up Truck	$84,000 - $94,500	$441,000
Equipment	Self-Contained Breathing Apparatus	$340 - $77,000	$2,235,000
	Hose	$140 - $1,400	$121,000
	Communications	$240 - $20,000	$119,000
	Fire Truck Equipment	$140 - $144,000	$291,000
	Fitness Equipment	$530 - $20,000	$128,000
	Bunker Gear Washer	$4,400 - $9,000	$19,000
	Radio	$9,500 - $35,000	$77,000
	Rescue Equipment	$9,200 - $21,000	$244,000
	Bunker Gear Rak	$2,600 - $3,400	$47,000
	Bunker Gear	$910 - $2,000	$376,000
	Air Fill Stations	$81,000	$81,000
	Camera	$12,000	$23,000
	Truck Hoist	$15,000	$146,000
	Fire Station Equipment	$17,100 - $18,000	$18,000
	Hose Nozzles	$1,300 - $1,400	$89,000
	Megablast Drying Machine	$6,400	$64,000
	Washer Extractor	$11,000	$11,000
	Other	$5,200 - $111,000	$178,000
Fire & Rescue Total			**$39,773,000**

2.3 Age & Remaining Service Life

The average age per asset was based on the purchase year of the assets and the year of analysis (2022), and the remaining service life (RSL) was estimated by using age and expected service life (ESL) in years. The ESL for each asset is obtained from the City's TCA record.

The ESL is defined as the period over which an asset is available for use and able to provide the required level of service (LoS) at an acceptable risk (i.e., without unforeseen costs of disruption for maintenance and repair). It should be noted that 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 Fire & Rescue assets are operated intermittently or even infrequently or is being operated at a lower demand than its expected annual mileage, thus the actual operating "age" of the asset is reduced.
- **Surrounding Environment:** Some Fire & Rescue assets could corrode due to salt and de-icing increasing the corrosion activity on the asset's parts (especially if anti-corrosion is not regularly applied); affecting the mode of deterioration.
- **Maintenance:** Fire & Rescue assets are maintained through replacement of components, which prolongs the service life of the asset.
- **Technological Obsolescence:** Some Fire & Rescue assets can theoretically be maintained for a longer period of time, although considerations such as maintenance cost, energy inefficiency and new technologies are likely to render this approach uneconomical (e.g., electrically operated vehicles).

Figure 2-1 shows the summary of average asset age, ESL, and RSL, 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.

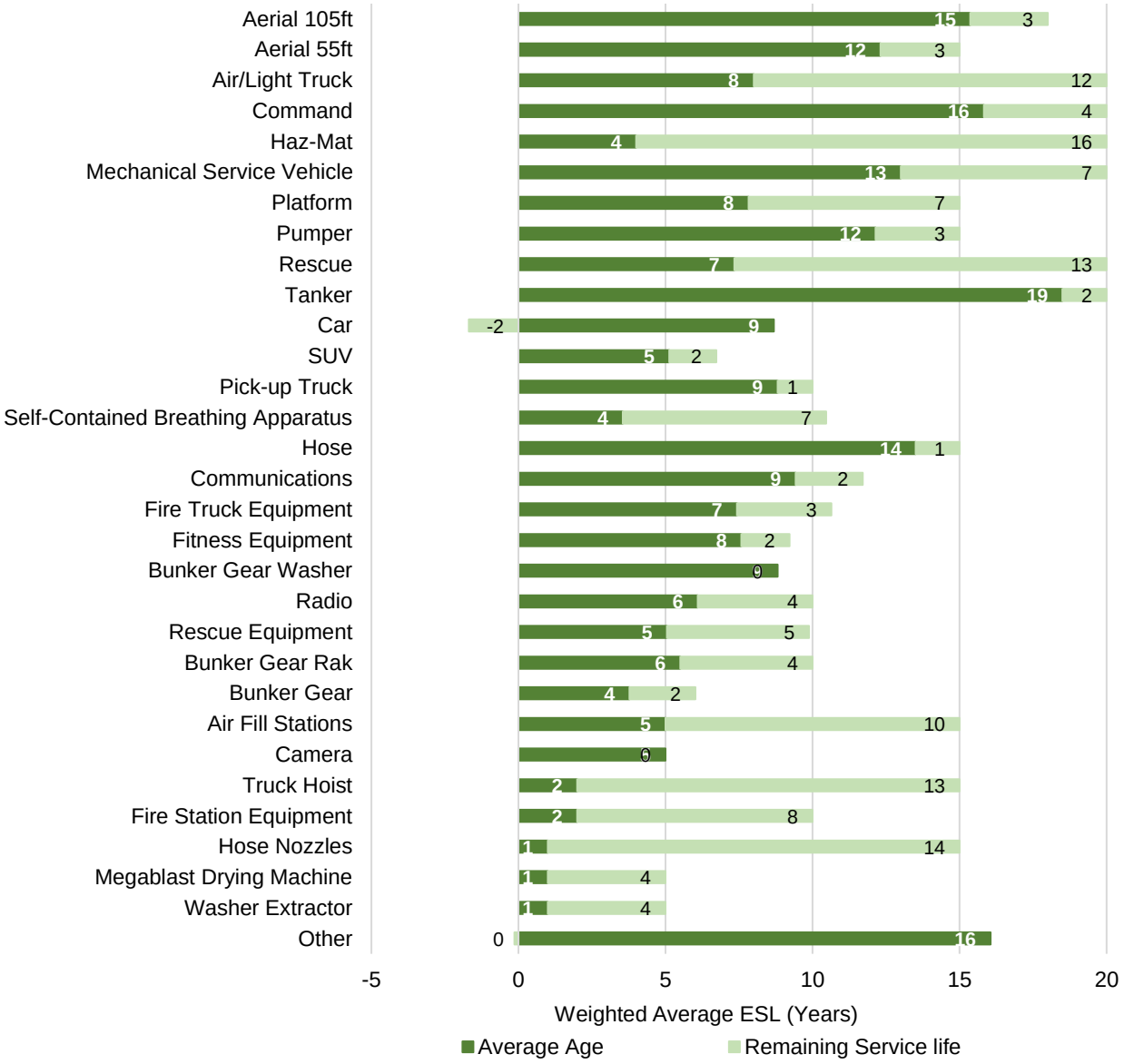

Figure 2-1: Average Fire & Rescue Asset Age as a Proportion of Average ESL

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 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; 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	>=3.5	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 & Rescue assets. It shows that 64% of the assets are in Good to Very Good condition. However, 15% 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 2-3 presents the condition distribution by Fire & Rescue asset types weighted by replacement cost. Approximately 47% of the City's emergency response vehicles are in Very Good condition, while 14% 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. The highest percentage of Poor condition by replacement value in a category is observed in Passenger Vehicles with a percentage of approximately 37%. The analysis suggests that the inventory of the same category does not possess a distribution of the four condition ratings; assets are either in Very Good or Poor conditions without any Passenger Vehicles being in Good condition (fewer assets are in Fair condition).

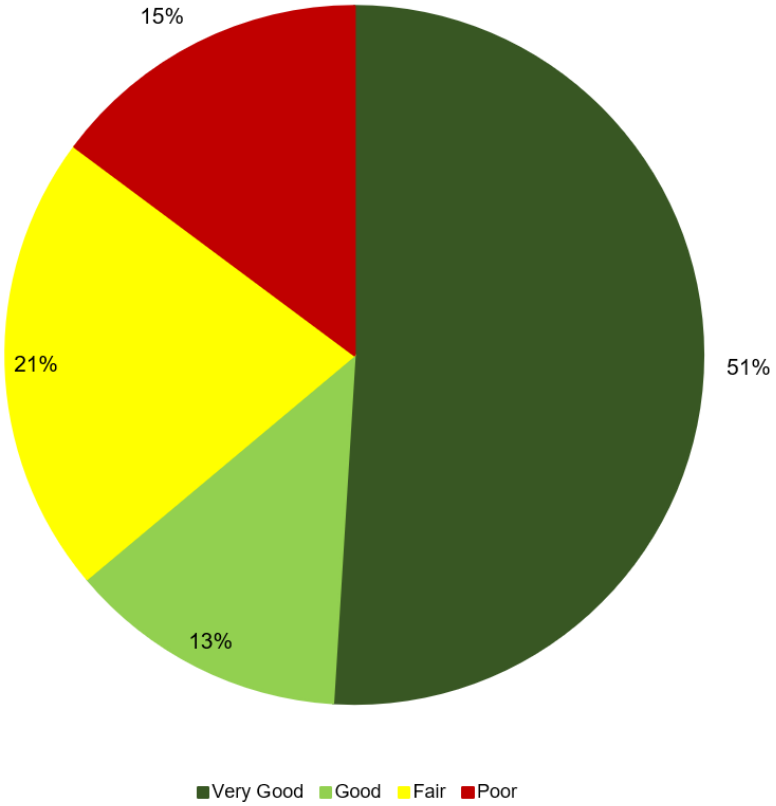

Figure 2-2: Fire & Rescue Asset Condition Summary

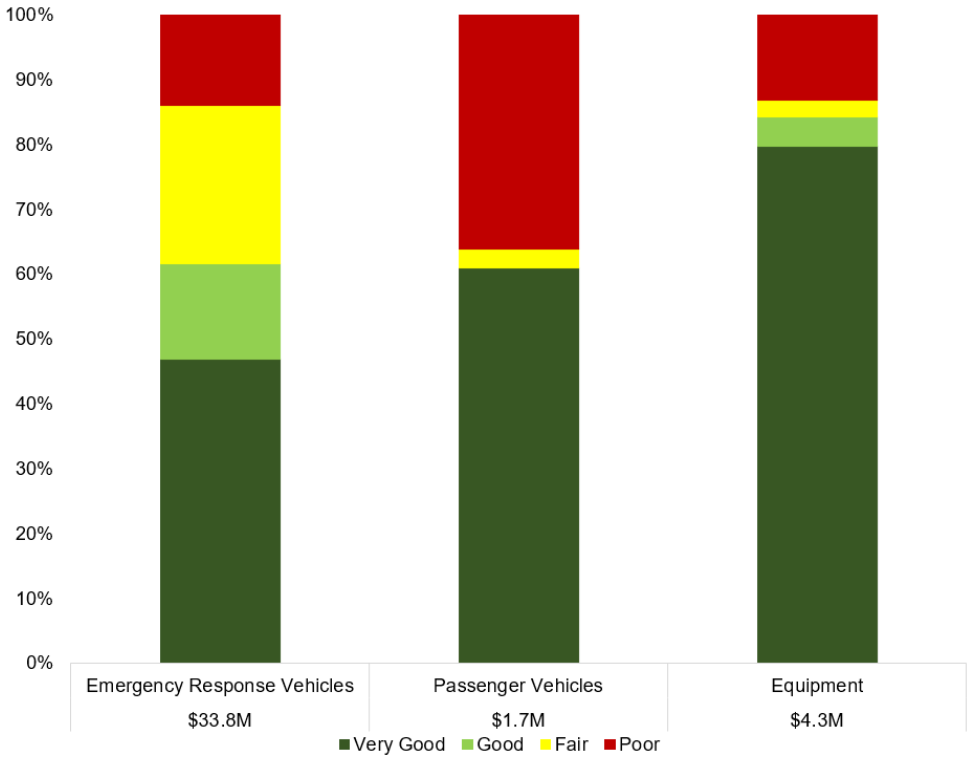

Figure 2-3: Distribution of Fire & Rescue Asset Condition

3. Levels of Service

3.1 Purpose

LoS supports every aspect of the overall AM System as shown in 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.

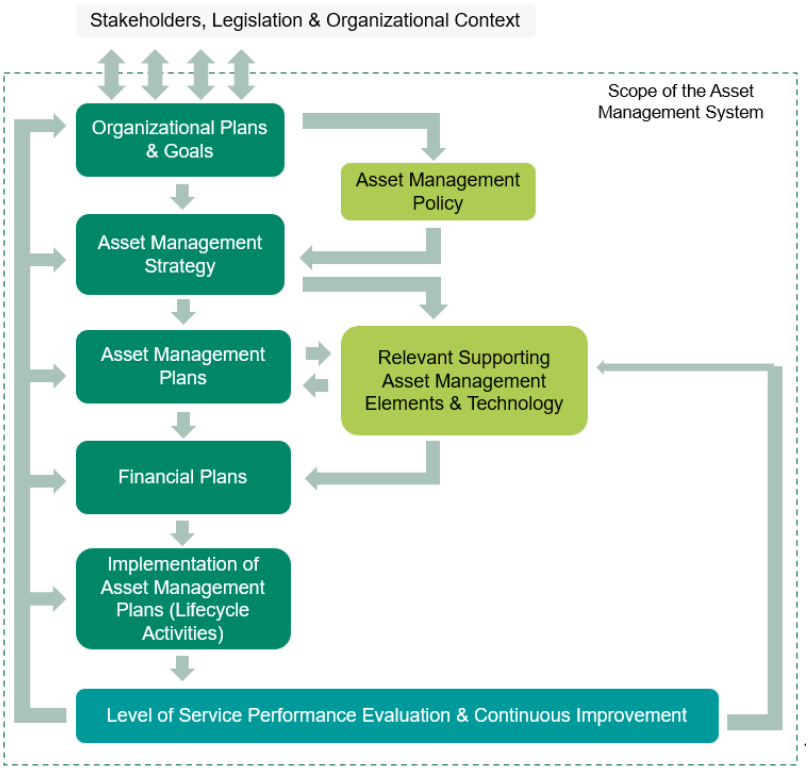

Figure 3-1: LoS within the AM System

In AECOM'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**).

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 & 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 & Capacity	Customers can easily access the service with minimal inconvenience.
Health & 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 & 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 Levels of Service 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 oppose 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.

Measured in the most recent Citizen Satisfaction Survey conducted by Ipsos, the percentage of respondents satisfied with Fire Services was 100%. Additionally, the VFRS (Vaughan Fire & Rescue Services) Response Area Map is illustrated in **Figure 3-2**

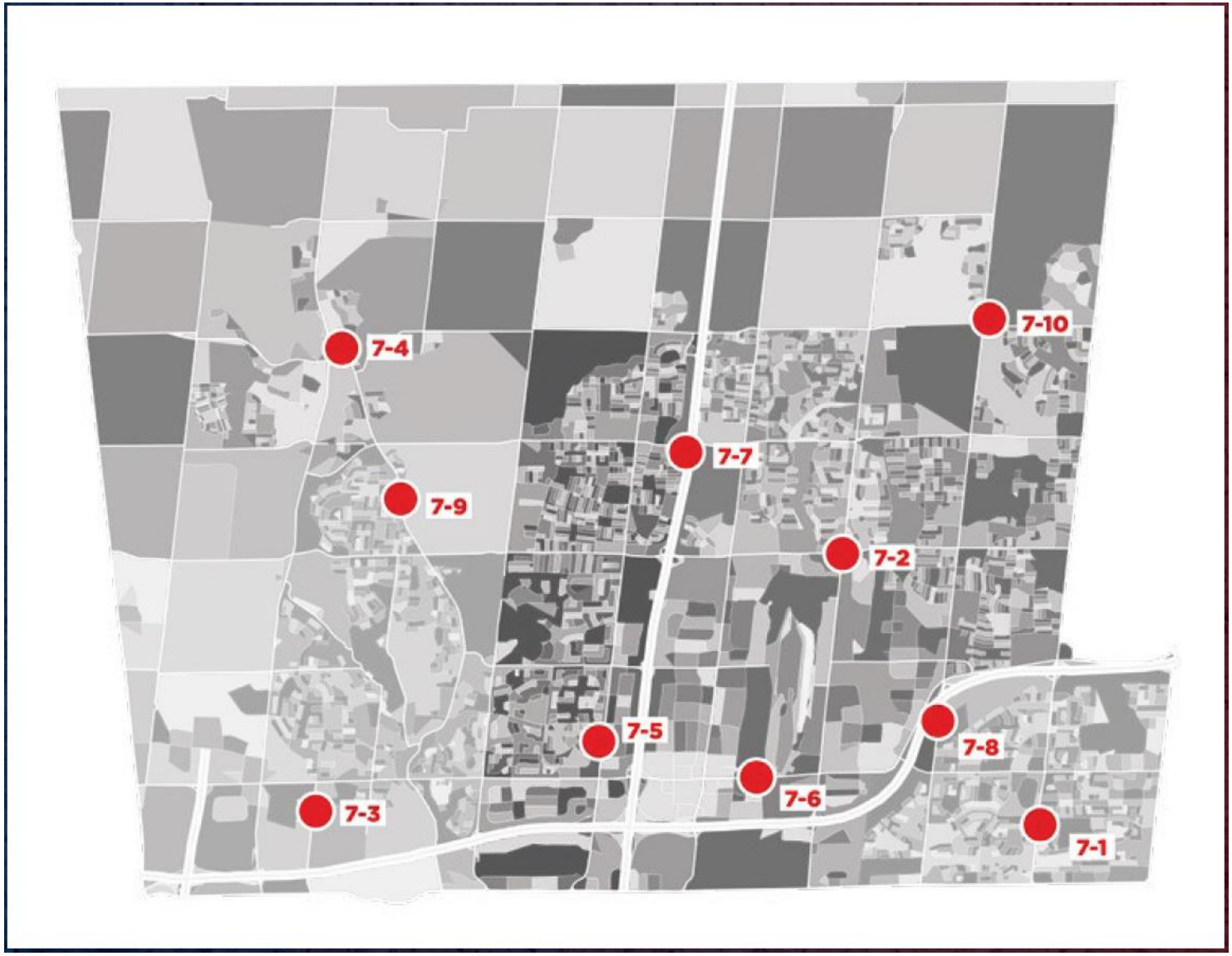

Figure 3-2: VFRS Response Area Map

4. Asset Lifecycle Strategies

Asset lifecycle management focuses on the specific activities we must undertake during all phases of the asset lifecycle. Considering entire asset lifecycles can ensure we make sound decisions that consider present and future service delivery needs.

The overarching goal of life cycle management is to maximize the long-term benefits and services 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.

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.

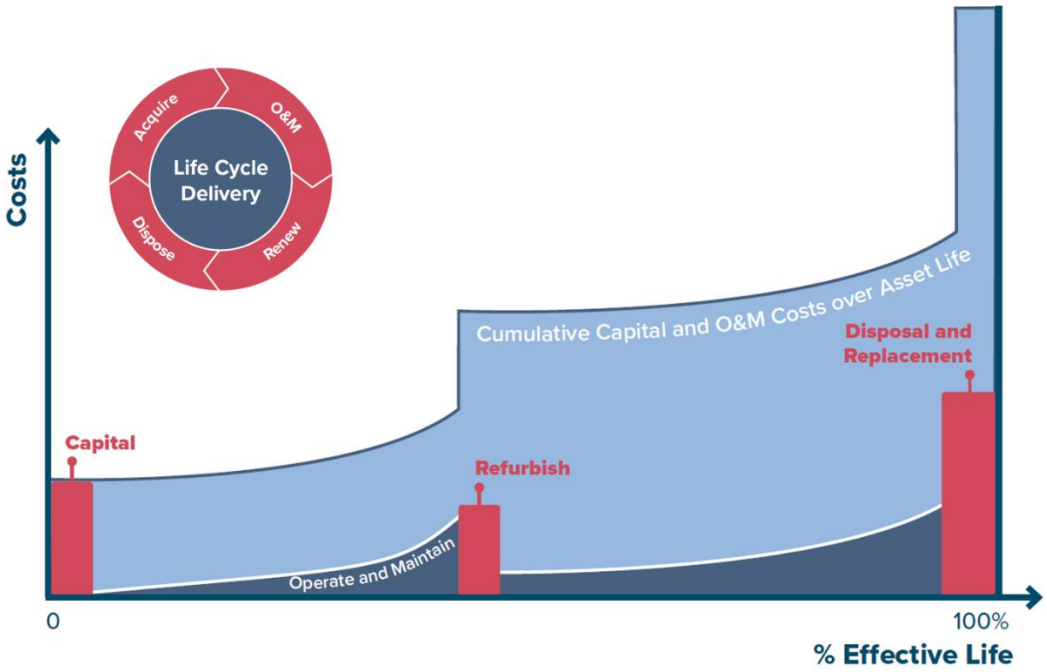

Figure 4-1: Life Cycle Cost Accumulation Over Asset Life

4.1 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.
- Availability and management of spares.
- Staff skill and availability to manage the asset.
- The manner of the asset's eventual disposal.

4.2 Operations and Maintenance Strategies

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. Maintenance expenses include periodic preventive and reactive 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 number 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.

4.3 Renewal and Replacement Strategies

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. 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.

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.

4.4 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.

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 & Rescue asset. The asset reinvestment forecasts prepared for this assessment are estimates of what it will cost over the next 20 and 50 years.

The annual reinvestment need for the Fire & Rescue assets were based on age & ESL in years (i.e., replacing assets that has exceeded their ESL) in inflated dollar values.

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 & Rescue assets is $3.3M over the next 20 years in inflated dollar values. This is equivalent to a total of approximately $66M over the next 20-year period, as presented in **Figure 5-1**.

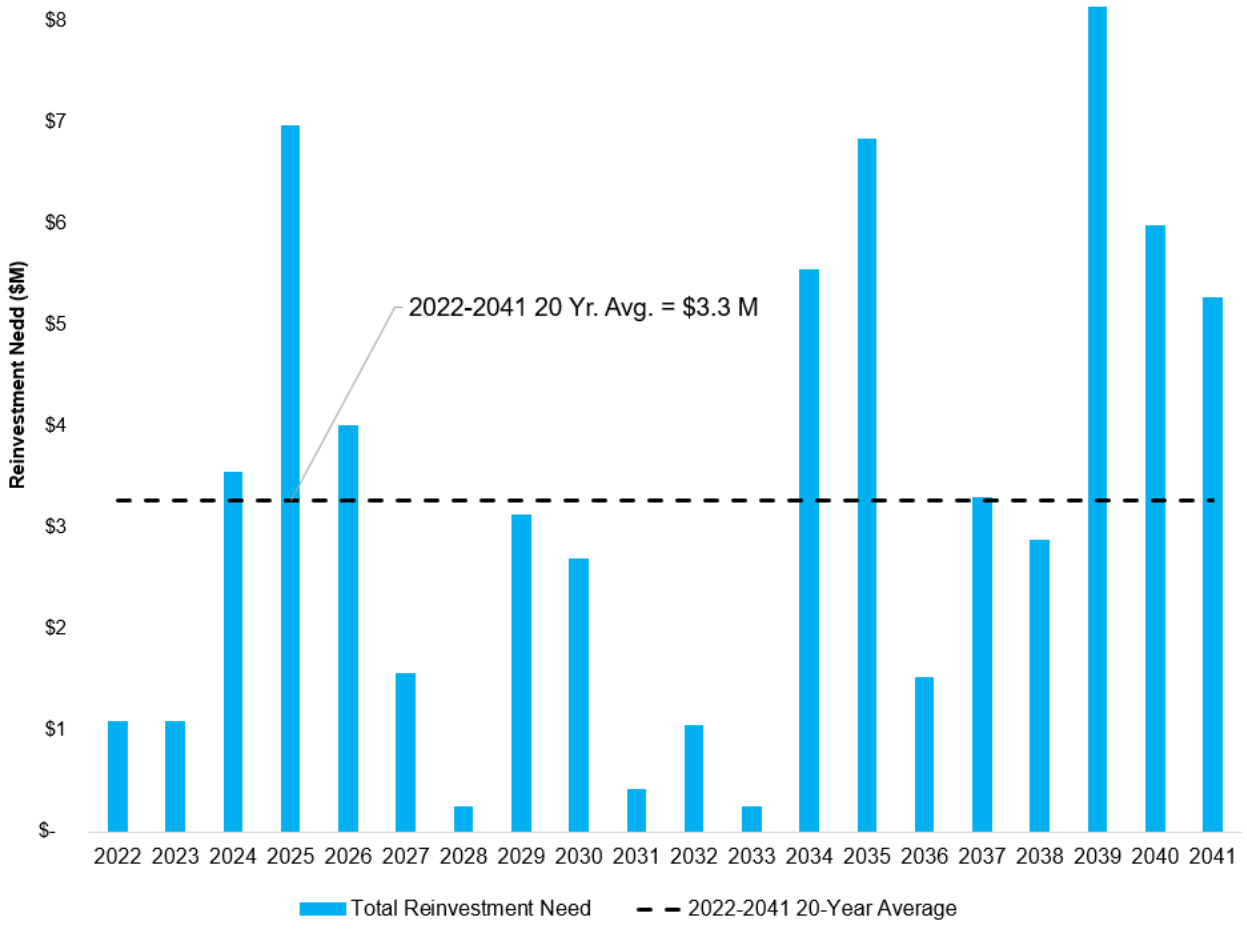

Figure 5-1: Fire & Rescue 20-Year Reinvestment Need

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 ESLs.

The detailed reinvestment needs for Emergency Response Vehicles, Passenger Vehicles, and Equipment assets are presented in **Table 5-1** in inflated dollar values.

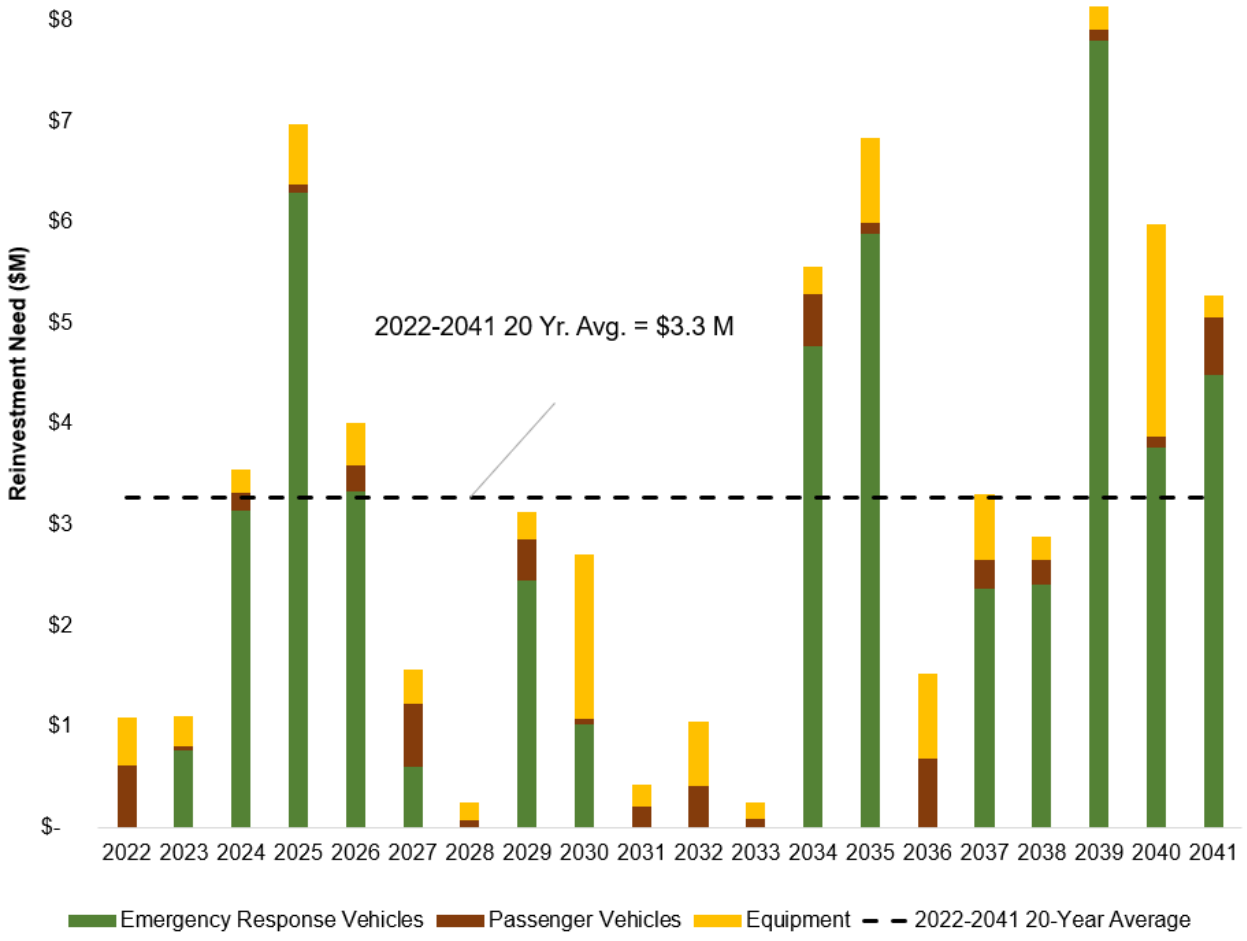

Figure 5-2: Fire & Rescue 20-Year Reinvestment Need Details

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

	Emergency Response Vehicles	Passenger Vehicles	Equipment	Total
Annual Average Need	$2,459,000	$286,000	$530,000	**$3,275,000**
20-Year Total	$49,180,000	$5,720,000	$10,600,000	**$65,500,000**

5.2 50-Year Fire & Rescue Assets Reinvestment Need

Looking ahead over the long term, the average annual reinvestment rate for the City's Fire & Rescue assets is $4.5M over the next 50 years in inflated dollar value, for a total of approximately $225M, as presented in **Figure 5-3**.

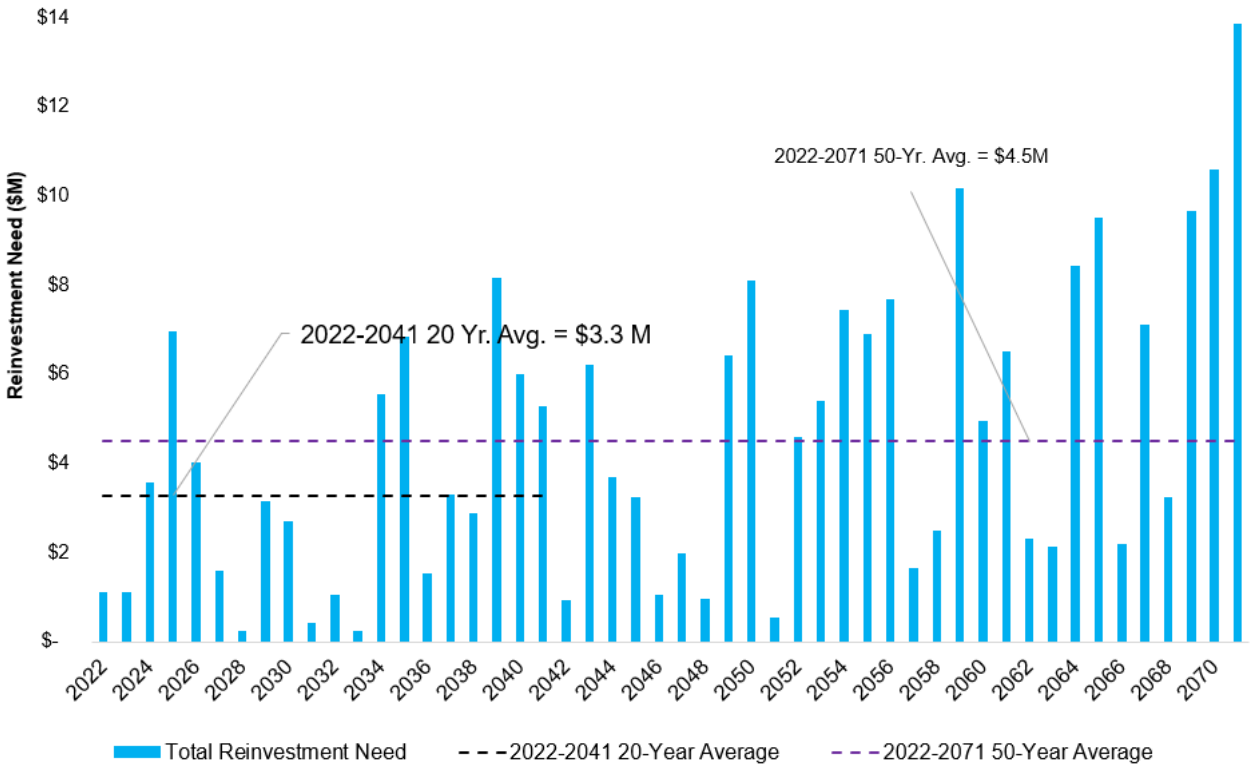

Figure 5-3: Fire & Rescue 50-Year Total Reinvestment Need (Inflated Dollar Value)

5.3 Full Funding Need Profile

Figure 5-4 shows a full picture of the City's Fire & 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 & Rescue O&M cost, and annual average Fire & Rescue growth-related development cost in inflated dollar values.

Fire & Rescue assets require approximately $62.7M annually over the next 20 years for O&M, equivalent to totally $1.25B in inflated dollar value. The Fire & Rescue growth-related cost or development cost (DC) requires approximately $22M over the next 20 years, equivalent to roughly $1.1M annually. As such, with the addition of O&M and DC, the total average annual funding need for the City's Fire & Rescue assets increases to approximately $67M annually, for a total of $1.34B 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 86% of the total O&M expenditure.

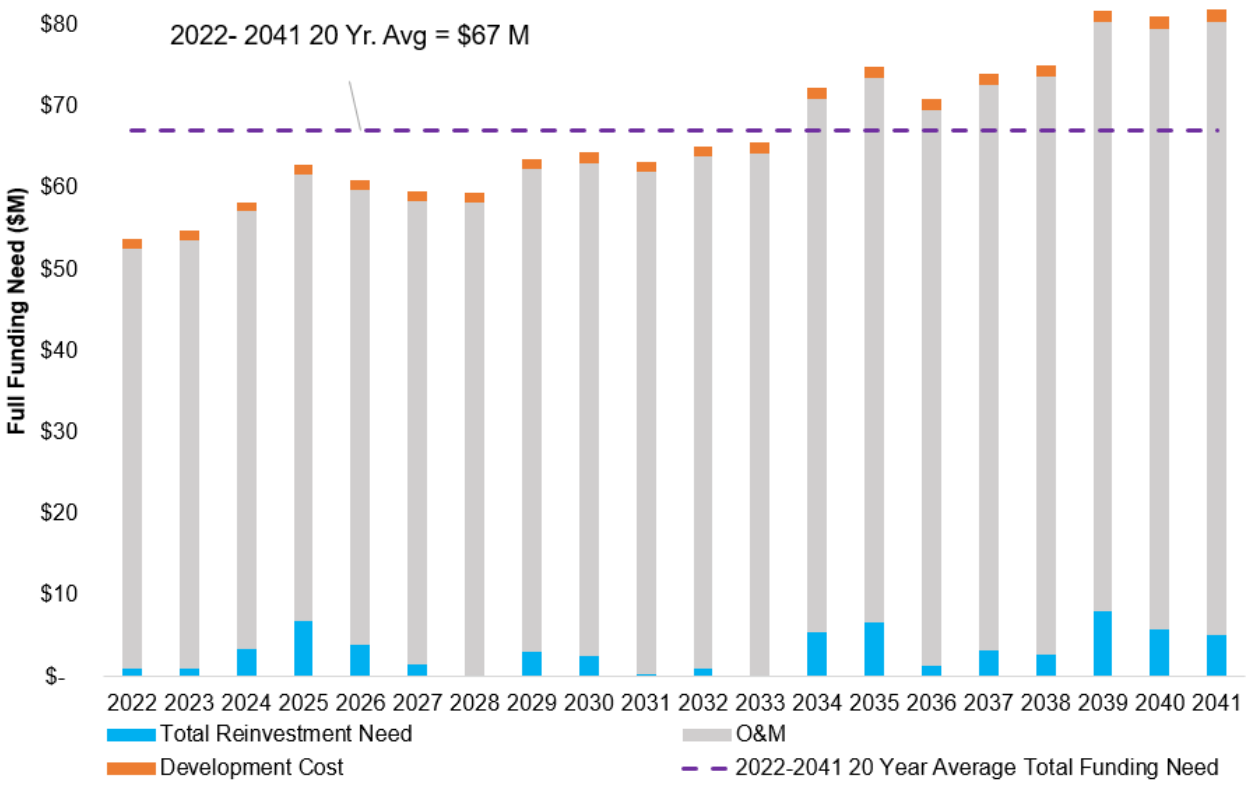

Figure 5-4: Fire & Rescue 20-Year Capital Investment and O&M Cost Forecast

6. Recommendations for Fire & Rescue AMP Continuous Improvement

Continuous improvement is an important component of any AM program and is achieved through the implementation of recommended improvement initiatives which support sustainable service delivery. AECOM has identified a set of activities that represents the next stage of AM planning and implementation within the City.

- **Continue to refine the asset inventory and close existing data gaps, so as to have a more accurate representation of the current state of the Fire & Rescue assets; and, ultimately, to make more informed and defensible decisions**.
  - AECOM recommends the City to continue maintaining the Fire & Rescue inventory, keep updating the inventory as assets are acquired or disposed.
  - AECOM recommends that the City to keep tracking mileage / hours for vehicles in Fire & Rescue asset inventory to better help inform the actual asset condition.
- **Develop a formalized with the Fire & Rescue condition assessment process and use condition grading schemes for Fire & Rescue assets.**
  - The grading system should contain a description of the condition, which is tied directly to each condition grade, and a description of the asset performance and level of corrective and preventive maintenance required for assets falling within a certain condition rating category. This process will allow the City to keep track of and better forecast Fire & Rescue asset renewal needs.
  - Perform condition assessments on the most critical assets first. This will ensure that the Fire & Rescue assets are assessed using the same methodology, and prioritized according to the asset's criticality, enabling a more defensible business case when raising issues of asset degradation to senior management and Council.
  - Maintaining a failure record would also be beneficial in the evaluation of the assets. This will aid in calculating mean time to failure, failure rate, etc. to support reliability assessment studies. It is recommended to develop detailed log of failure related information including failure type, failure data, time required to fix failure, and other supporting information. Each failure and repair should be assigned a unique identifier. Asset unique identifier should also be referenced per failure and repair.
- **Develop and Refine the LoS Framework.**
  - Collect current asset performance data for key performance indicators (KPIs) that are not currently being tracked, including associated costs.
  - Analyze asset performance data to determine trends and to establish annual performance benchmarks.
  - Engage in a discussion with key stakeholders to establish service level targets and identify associated costs to meet those targets.
  - Once LoS targets have been decided upon, the City should develop strategies on how to meet service level targets considering its existing operating environment (i.e., staff availability, current funding, resources, etc.).
  - Develop a Customer Consultation Plan to engage the public and other stakeholders on the LoS framework and to better understand customers' willingness to pay for enhanced service levels.
- **Incorporate risk assessment for future iterations of the AM plan and use the risk assessment results to drive future condition assessments and financial needs forecasting.**
  - Conduct a comprehensive criticality and risk assessment of Fire and Rescue assets to inform work prioritization.
  - Review risk attribute values periodically to ensure alignment with business objectives and appetite.

  - Overlay the risk model with the current state of the assets (i.e., condition), and the financial forecast. Using this approach, the City could focus its monitoring, maintenance, and renewal and replacement budget and activities on high-risk assets. Medium risk infrastructure could be addressed through the mitigation of failure through regular monitoring, and the low-risk assets could be accepted with caution.

- **Establish a sustainable Fire & Rescue funding model that fits the needs of the community.**
  - In light of the annual funding need outlined in **Figure 5-4**, the City should budget for a total of $67M per year, on average, for Fire & Rescue capital reinvestment, capital development, and O&M expenditures of over the next 20 years.
  - It is recommended the City to adjust the ESLs or RSLs for vehicles when the information on mileage / hours / failure records is available to better align with the actual asset condition, which will eventually impact the asset life cycle management decisions.
  - Review financial modeling assumptions on reinvestment rate and replacement values and update the financial model with new information as it becomes available. The financial model is based on a number of key assumptions that could have a significant impact on the outcomes of the model, such as the inflation rate.
- **Continue to find ways to improve AM initiatives across the City by maintaining a high level of AM awareness through training, communication, and knowledge sharing.**
  - Conduct an AM Software Assessment to identify future system requirements that may include enhancing existing software, adding-on, or replacing.
  - Develop a Knowledge Retention Strategy & Internal Communications Plan to document staff AM knowledge and experience for reporting and succession planning purposes. Communicate AM improvement initiatives and enhance AM awareness internally through internal communication.

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