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City of Sault Ste. Marie Asset Management Plan Wastewater

August 15th, 2022

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AECOM: 2015-04-13

Quality information

Prepared by

Mohammad Amini, MASc.
Asset Management
Consultant

Checked by	Checked by	Verified by	Approved by
			
Donghui Lu, Ph.D., Asset Management Consultant	Khalid Kaddoura, Ph.D, P.Eng, PMP, Senior Asset Management Engineer	Jeff Atherton, AVP, Project Advisor	Chris Lombard, MBA P.Eng., Asset Management Leader, Americas Water

Revision History

Revision	Revision date	Details	Authorized	Name	Position
Draft V0	June 10th, 2022	Draft Report – Wastewater AM Plan		Chris Lombard	Project Manager
Final	August 15th , 2022	Final Report – Wastewater AM Plan		Chris Lombard	Project Manager

Distribution List

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0	1	Catherine Taddo, P.Eng., Manager, Development and Environmental Engineering, Public Works and Engineering Services, City of Sault Ste. Marie

Prepared for:

Catherine Taddo, P. Eng.
Manager, Development and Environmental Engineering
Public Works and Engineering Services

City of Sault Ste. Marie
99 Foster Drive, Sault Ste. Marie, ON P6A 5X6

Prepared by:

AECOM, 523 Wellington Street East
Sault Ste. Marie, Ontario Canada P6A 2M4

T 705.942.2612 F 705.942.3642

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List of Abbreviations

Abbreviation	Description
AM	Asset Management
AMP	Asset Management Plan
ARC	Arc Chambers
CCTV	Closed Circuit Television
CIBI	Canadian Infrastructure Benchmarking Initiative
CMMS	Computerized Maintenance Management System
Conveyance-FM	Conveyance – Force Mains
Conveyance-GRAV	Conveyance – Gravity Mains
Conveyance-MH & CHAM	Conveyance – Manholes and Chambers
Conveyance-SC	Conveyance – Service Connections
ESL	Expected Service Life
FIPPA	Freedom of Information and Protection of Privacy Act
FLSH	Flushing
GIS	Geographic Information System
I&I	Inflow & infiltration
LoS	Level of Service
MFIPPA	Municipal Freedom of Information and Protection of Privacy Act
O&M	Operations and Maintenance
O. Reg.	Ontario Regulation
PUC	Public Utilities Commission
RSL	Remaining Service Life
SCADA	Supervisory Control and Data Acquisition
WWTP-EE	Wastewater Treatment Plant East End
WWTP-WE	Wastewater Treatment Plant West End

1 Introduction

AECOM Canada Ltd. (AECOM) was retained by The City of Sault Ste. Marie (the "City") to develop an asset management plan to comply with the first phase of the Ontario Regulation 588/17 (O. Reg. 588/17) requirements in respect to its core municipal infrastructure assets. The scope of work for this investigation is outlined in AECOM's proposal dated June 9th, 2021, and subsequent project correspondence.

1.1 Background

Sault Ste. Marie is a city located on the St. Mary's River, North of the United States of America, bordering on two of the Great Lakes with an estimated population of 73,368 (2016). The City provides a wide range of public services to their constituents with the expectation from the public that these services are expected to function efficiently at a certain level. The provision of these services requires the management of the physical assets to meet desired service levels, manage risks, and to provide long term financial sustainability. These assets include, but are not limited to roads, bridges, sidewalks, wastewater assets, stormwater management assets, landfill, fleets, buildings, and parks.

In accordance with the terms of reference for this assignment, it is understood that the City is proceeding with an asset management plan to comply with the first phase of the regulatory requirements in respect to its core municipal infrastructure assets, in accordance with O. Reg. 588/17, by July 1, 2022. The core assets to be included in the scope, as defined by the regulation, include the City's wastewater assets, stormwater management assets, roads, and bridges and culverts.

1.2 Scope and Objectives

In 2015, the City's first Asset Management Plan (AMP) was published. In 2019, by the City Council approval, the Strategic Asset Management (AM) Policy for the City came into effect.

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.

The objective of this AMP is to capture the core infrastructure assets and deliver a financial and technical roadmap for the management of the City's roads, bridges and culverts, wastewater assets, and stormwater assets. The intent of this plan is to provide the means for the City to maximize value from its assets, at the lowest overall expense while, at the same time, enhance service levels for its residents. Furthermore, the objective of this AMP is to align with the guidelines laid out in the City's Strategic AM Policy and Section 5 of O. Reg. 588/17.

As management of each core asset is not a consistent process due to maintenance and construction requirements, we have grouped the core assets as follows:

1. Roads, and Bridges and Culverts.
2. Stormwater Management Assets.
3. Wastewater Assets.

This AMP has been developed for the City's Wastewater management system, as shown in **Table 1-1**. Stormwater, and Road and Bridges & Culverts AMPs are presented under separate reports.

Table 1-1: In-Scope Wastewater Assets

Asset Category	Sub-Assets
Wastewater Treatment Plants	East End Wastewater Treatment Plant (WWTP-EE) and West End Wastewater Treatment Plant (WWTP-WE) including Structural, Process Mechanical, Building Mechanical, Electrical, and Instrumentation & Control Assets.

Asset Category	Sub-Assets
Pump Stations	Structural, Process Mechanical, Building Mechanical, Electrical, and Instrumentation & Control Assets.
Wastewater Conveyance System	Wastewater gravity mains, force mains, manholes, chambers, and service connections.

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

- Asset hierarchy, 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 data gaps analysis (**Sections 2**).
- The City's level of service objectives, stakeholder identification, current levels of service (LoS) determined in accordance with the qualitative descriptions and technical metrics outlined in O. Reg 588/17, and future demand drivers (**Section 3**).
- Asset lifecycle management strategies and funding needs to maintain current LoS, minimize associated asset risks, and to optimize costs over the whole lifecycle of the asset (**Section 4** and **Section 5**)

1.3 Asset Management 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 1-2: 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, roads, and bridges & culverts).
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 level of service that the municipality proposes to provide, the activities required to meet those level of service, and a strategy to fund activities.

2 State of Infrastructure

The City's wastewater conveyance system is a combination of linear sewer mains and force mains that is connected to the City's 25 sanitary pumping stations. Wastewater generated by the City flows through over 664 kilometers of service connections, gravity, and force mains before it eventually reaches the City's two wastewater treatment plants, namely the East End Wastewater Treatment Plant (WWTP-EE) and West End Wastewater Treatment Plant (WWTP-WE).

WWTP-EE is located at 2221 Queen Street East. The plant was constructed in two stages in 1959 and 1972, respectively, providing primary treatment only. In 1987, a sludge dewatering facility was added, and the plant was upgraded in 2006 to a biological nutrient removal (BNR) plant with ultraviolet (UV) disinfection. The design flow for this treatment plant is 36,000 m^3/day.

Originally constructed in approximately 1984 and located at 55 Allens Side Road, WWTP-WE provides conventional activated sludge treatment for a design capacity of 20 MLD. A detailed facility condition assessment was completed for WWTP-WE in 2014. The City is currently completing a phase one upgrade with subsequent upgrades to follow in the future phases.

The wastewater conveyance system, including small pump stations, is managed by City Staff, while the ongoing operations of the City's large wastewater infrastructure, including wastewater treatment plants and the large pump stations, are contracted out to the Public Utilities Commission (PUC).

2.1 Asset Hierarchy

To fulfill the requirements of O. Reg 588/17 and to pave the way for robust long range asset management planning, the City requires a logically segmented asset break down structure (hierarchy) under the scope of this AMP. To do so, the core wastewater conveyance system must become sufficiently granular to recognize which individual assets are due for renewal. However, it is important to balance the fine trade-off between adequate granularity to provide essential information with too much granularity that the data collection and management effort eclipses the usefulness of the data itself.

The City has a wide range of wastewater assets organized hierarchically, as presented in **Figure 2-1**. This breakdown of the infrastructure is derived from the way that assets are presented within the data sources, which indicates program area's responsibilities and parent-child relationships within each asset type.

Figure 2-1 shows the two plants WWTP-EE and WWTP-WE, and each of which includes sub-categories: structural, process mechanical, building mechanical, electrical, and instrumentation & control.

Pump Stations are also segmented to 25 sub-sections, named PS 1 to PS 25, including further sub-categories. Moreover, conveyance system encompasses three main asset categories, which are sewers, service connections, and manholes & chambers.

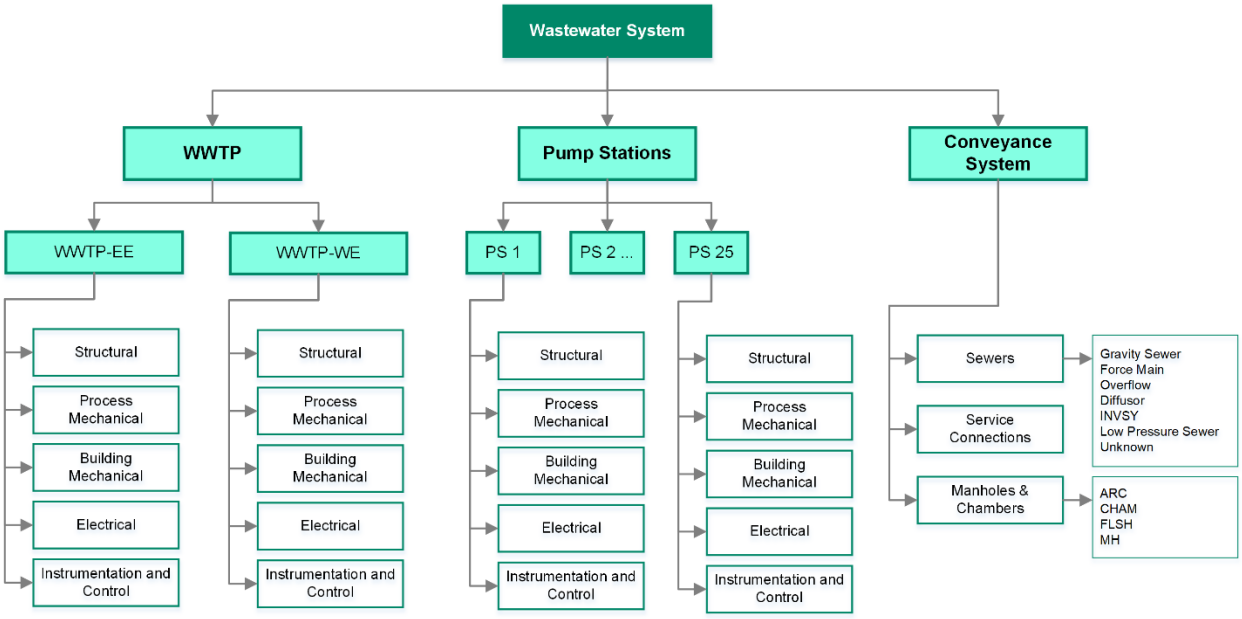

Figure 2-1: City of Sault Ste. Marie Wastewater Asset Hierarchy

2.2 Current State of the Assets

2.2.1 Asset Inventory

Table 2-1 provides a summary of the wastewater inventory for each asset category within City's wastewater conveyance system.

Table 2-1: Wastewater Asset Inventory Summary

Asset Group	Asset Category	Asset Sub-Category	Sub-Category Quantity	Unit	Count of Inventory Records
Wastewater System	Wastewater Treatment Plants	WWTP-EE	1	Ea.	373
		WWTP-WE	1	Ea.	639
	Pump Stations	Pump Stations	25	Ea.	497
	Conveyance	Force Mains	14	km	192
		Gravity Mains	380	km	5,672
		Manholes and Chambers	5,057	Ea.	5,057
		Service Connections	270	km	26,295
Total					**38,725**

2.2.2 Current Asset Replacement Value

The City's wastewater system is valued at approximately $1.78 Billion. **Table 2-2** presents the current replacement value of each asset category. The gravity mains account for the highest replacement value, which is approximately $940 Million, followed by service connections, contributing to over $486 Million. WWTP-EE and WWTP-WE are valued at approximately $127 Million and $70 Million, respectively. Pump stations constitute approximately $26 Million. It should be noted that 45% was considered as a markup rate, including removing existing infrastructure, engineering (Design and Contract administration), contingencies, and mobility.

Table 2-2: Wastewater Current Replacement Value

Asset Group	Asset Category	Asset Sub-Category	Unit Replacement Cost ($ / Unit)	Total Replacement Value (2022)
Wastewater System	Wastewater Treatment Plants	WWTP-EE	$1000 - $250000 / Ea. (Per component)	$126,926,000
		WWTP-WE	$1000 - $250000 / Ea. (Per component)	$69,878,000
	Pump Stations	Pump Stations	$1,000 - $ 250,000 / Ea. (Per component)	$26,537,000
	Conveyance	Force Mains	$500 - $9,000 / m	$40,017,000
		Gravity Mains	$500 - $9,000 / m	$939,724,000
		Manholes and	$10,000 - $35,000 / Ea.	$87,519,000
		Service Connections	$500 - $2,300 / m	$486,331,000
			WWTP	**$196,804,000**
			Pump Stations	**$26,537,000**
			Conveyance	**$1,553,591,000**
			Total	**$1,776,932,000**

2.2.3 Age and Remaining Service Life

In practice, various assets will deteriorate at different rates and not necessarily linearly over time. However, it is pivotal to keep in mind the level of effort required to predict failure compared with the asset value. More sophisticated deterioration modelling may be warranted for very high value assets, whilst the cost of deterioration modeling for low-value assets may very well exceed the replacement cost of the asset. The actual service life can vary significantly from the estimated service life (ESL). The latter is defined as the period over which an asset is available for use and able to provide the required LoS at an acceptable risk and serviceability (i.e., without unforeseen costs of disruption for maintenance and repair). 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 are being operated at a lower demand than their designed 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 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 cost to maintain the asset, its energy efficiency, and the cost to upgrade to an updated technology that would result in cost savings are likely to render this approach uneconomical.

Initially, the average age was calculated based on the purchased and installation year of each individual asset. Then, based on the age of the asset and the ESL (collected from a State of Infrastructure Workshop with the City, and additional information provided by the City), the remining service life (RSL) was calculated. It should be noted that in the case that age was higher compared to ESL, RSL was considered as zero.

Table 2-3 and **Figure 2-2** present the weighted average age, weighted average ESL, and remaining service life for various asset sub-categories within the City’s wastewater system. The average age of the assets ranges from 21 to 51 years with average ESLs that vary from 59 to 80 years. It should be noted that service connections, gravity mains, and manholes & chambers are the oldest in comparison with other assets. The minimum weighted average is WWTP-WE,

21 years, which is the average of all components. The minimum RSL is related to force mains, 29 years, compared to WWTP-WE that has an average RSL of 42 years.

Table 2-3: Wastewater Average Age, ESL, and Remaining Service Life

Asset Group	Asset Sub-Category	Weighted Average Age	Weighted Average ESL	Remaining Service Life
Wastewater System	WWTP-EE	25	59	34
	WWTP-WE	21	63	42
	Pump Stations	25	60	35
	Conveyance-FM*	46	75	29
	Conveyance-GRAV*	47	78	31
	Conveyance-MH & CHAM*	44	80	36
	Conveyance-SC*	51	80	29

* FM = Force Main, GRAV = Gravity Main, MH & CHAM = Manhole and Chamber, SC = Service Connections

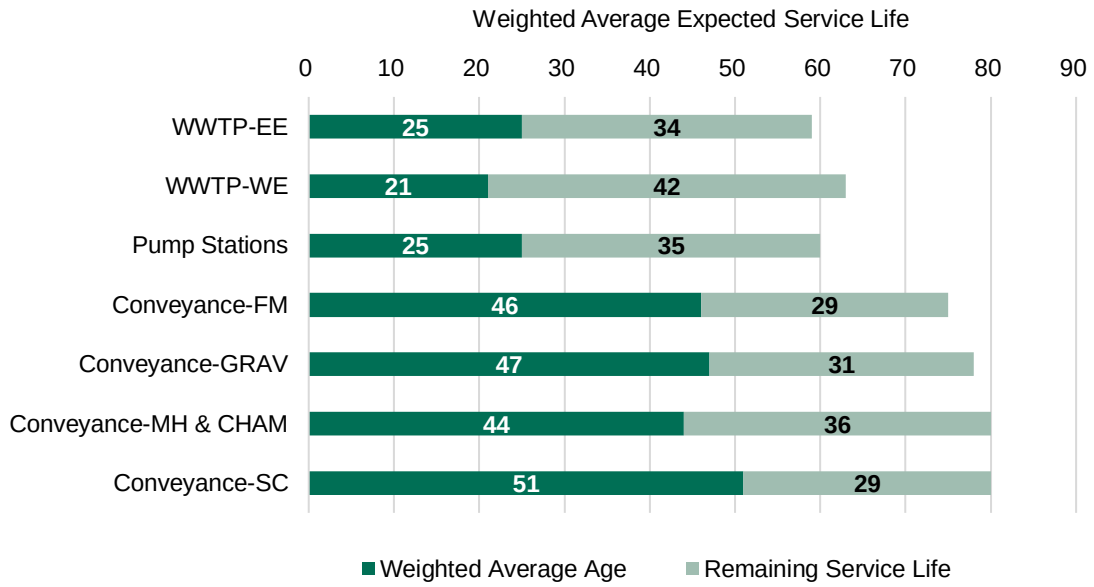

Figure 2-2: Wastewater System Weighted Average Age and Remaining Service Life

Figure 2-3 shows the installation profile of the City's wastewater system according to asset sub-categories. It should be noted that a significant proportion of gravity sewers and service connections was installed before 1965, contributing to the highest replacement values for these two categories. In addition, WWTP-WE components were installed from 1981 to 1985 as the first phase, and from 2016 to date as another phase. WWTP-EE, however, was initialized from 1986 to 1990 in the first step and developed from 2006 to 2010.

Figure 2-4, on the other hand, illustrates the linear assets profile based on 10-year periods to better understand how much gravity mains, force mains, and service connections are contributing to replacement values.

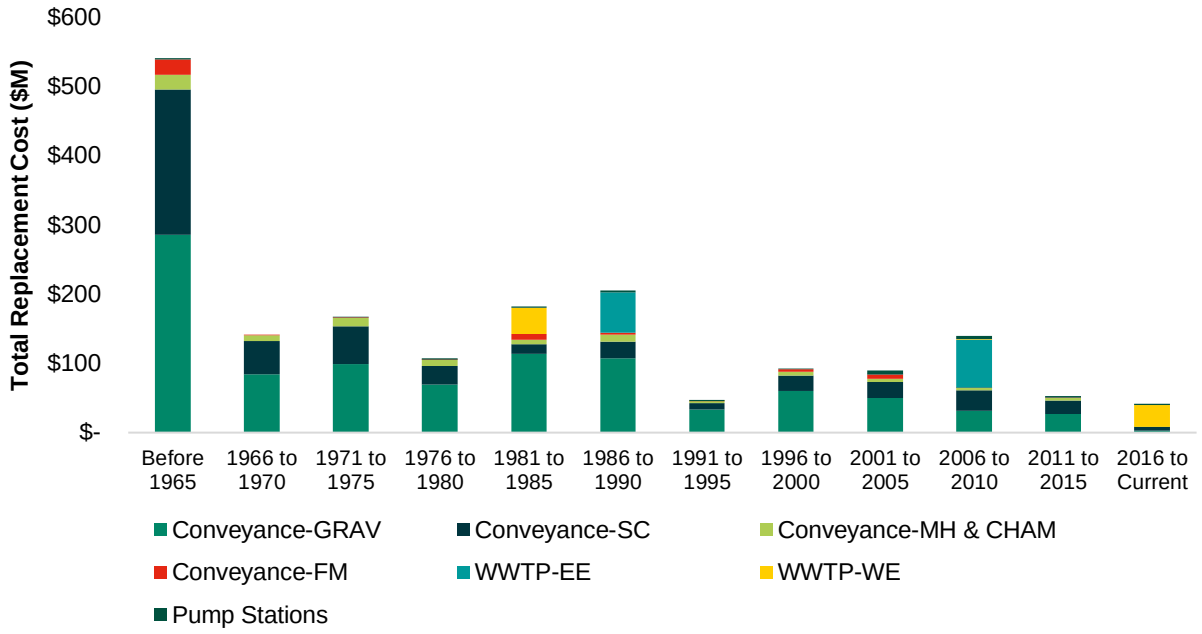

Figure 2-3: Wastewater Installation Profile

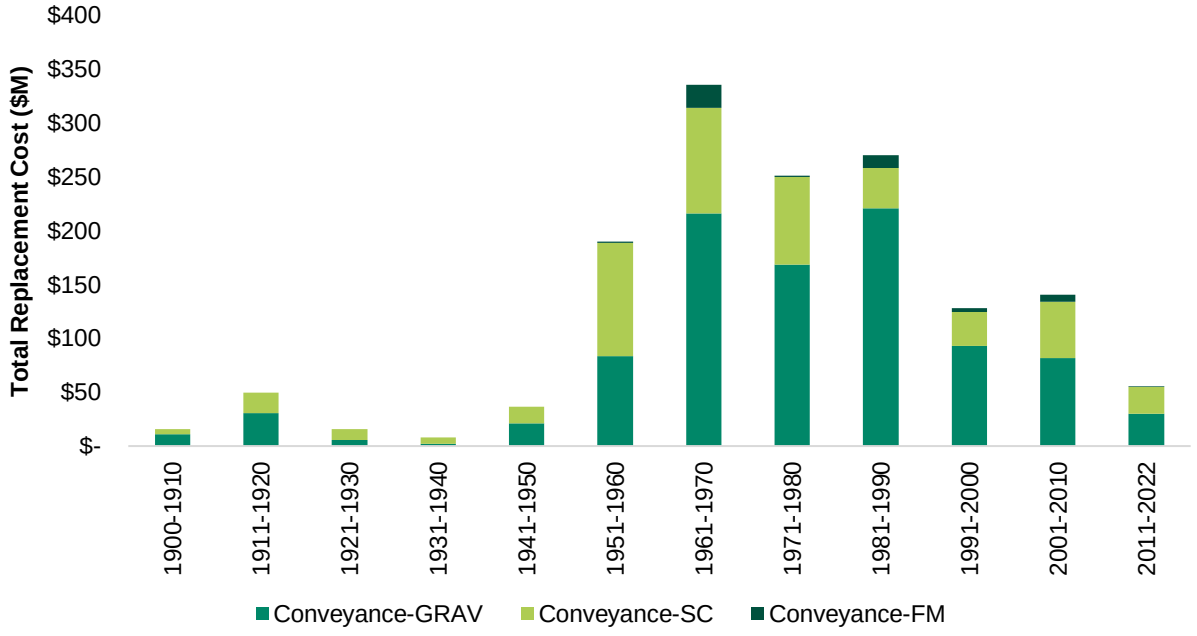

Figure 2-4: Installation Profile of Wastewater Mains and Service Connections

2.2.3.1 Type of Pipe Materials

Table 2-4 provides information about different pipes materials employed within each sub-category. For instance, there are 158 km of asbestos cement pipes, which is the highest contribution to gravity mains, followed by PVC and vitrified clay, with approximately 97 and 72 km, respectively. For service connections, however, almost 154 km of materials are unknown, which represents approximately 50% of all service connections. PVC and asbestos cement with about 65 and 48 km are other materials utilized for service connections. **Figure 2-5**, **Figure 2-6**, and **Figure 2-7** show the percentage of each material type by length for gravity mains, force mains, and service connections, respectively.

Table 2-4: Sewers and Service Connections by Materials Type

Type of Main	Material	Total Length (km)
Gravity Mains	Asbestos Cement	158.22
	Concrete	29.39
	Other	9.58
	PVC	97.04
	Unknown	24.15
	Vitrified Clay	72.45
Force Mains	Cast Iron	1.46
	Concrete	3.53
	Concrete Pressure Pipe	1.21
	Ductile Iron	2.37
	HDPE	2.08
	Polyethylene	4.24
	PVC	2.02
	Unknown	0.26
Service Connections	Asbestos Cement	48.58
	Other	2.26
	PVC	65.47
	Unknown	154.06

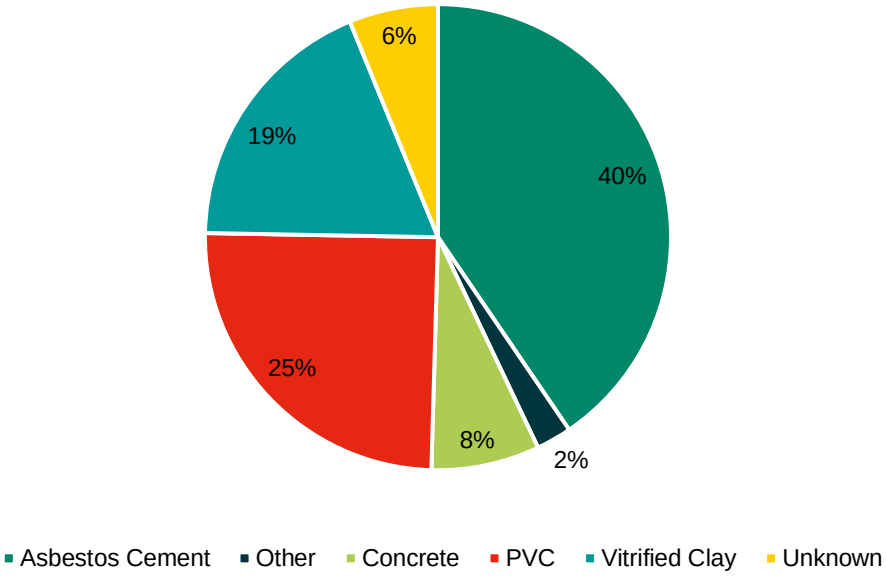

Figure 2-5: Gravity Mains Materials

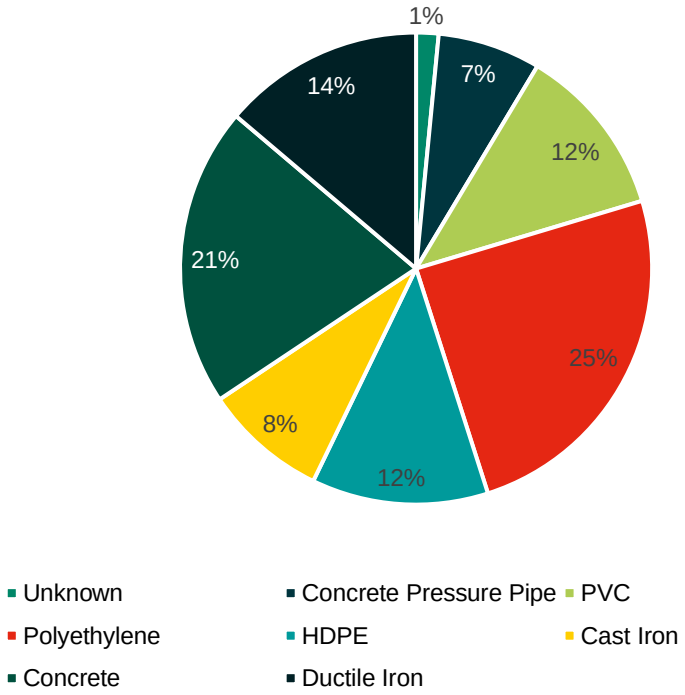

Figure 2-6: Force Mains Materials

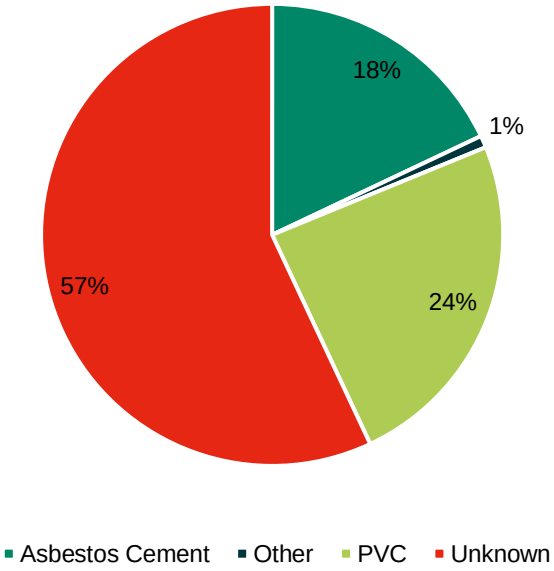

Figure 2-7: Service Connection Materials

2.2.4 Asset Condition

All assets are expected to deteriorate over their lifetime, and their assigned condition reflects the physical state of the asset. The City conducted wastewater facility condition assessment for the WWTP-WE in 2012, which would be insufficiently reliable enough for scoring the current condition for this AMP as the condition results were 10 years old. The condition assessments for forcemains located in River Road and Queen Street (2014) were incorporated in this AMP as they provided in-depth condition assessment analysis and also remaining service lives of the forcemains. It is worth mentioning that CCTV inspections are more accurate than age-based calculations, and that the City has conducted CCTV inspections of its gravity sewer assets in the past. However, no CCTV data was available in digital format and was therefore not considered in this assessment. It should be noted that no on-site condition assessments were carried out for this project. Hence, age-based approach has been applied to assess the condition of wastewater assets that has no consumable condition data. Accordingly, a two-parameter Weibull distribution function was used to assess the current condition of the wastewater assets. The Weibull distribution has been used extensively in reliability studies and lifetime prediction models in industries ranging from automotive to the oil & gas and provides a suitable distribution for this type of analysis.

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 ESL. To perform a high order network-level analysis, it was assumed that assets would fail (and require replacement) within a deterioration envelope / curve approximated by a Weibull probability distribution. The two-parameter Weibull cumulative distribution has two parameters for scale and shape, as set out in Equation [1]:

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

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

A set of Weibull cumulative distribution functions were leveraged to simulate a set of deterioration curves for assets with different ESLs as shown in **Figure 2-8**.

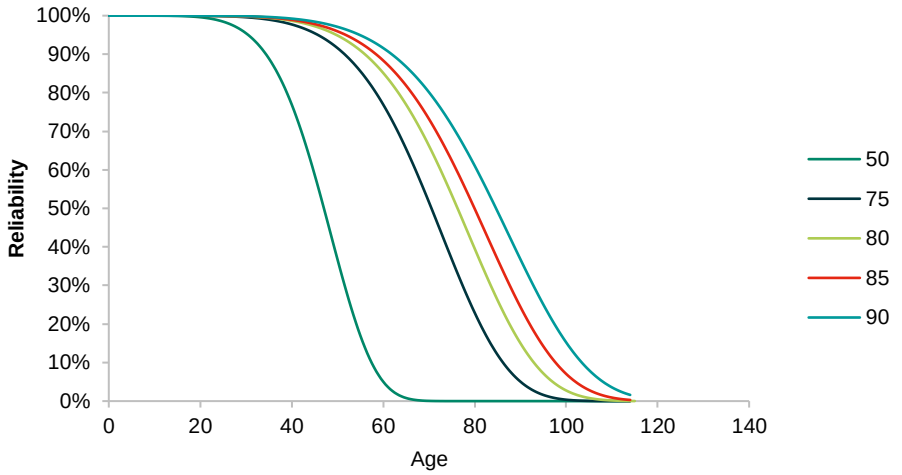

Figure 2-8: Asset Deterioration Curve Samples

Table 2-5 summarizes the condition grade of the City's wastewater infrastructure with associated replacement values. Just under 70% of the assets are in the very good condition, with total replacement value of approximately $1.23 Billion, and only 77% of the infrastructure is in the very poor condition with total replacement value of almost $137 Million. Good condition accounts for 16.7% of the existing infrastructure, having a replacement value of around $297 Million. Fair and poor condition assets make up 2.5% and 3.5%, respectively.

Table 2-5: Wastewater Condition Summary

Rank	Condition Rating	Replacement Value	% of Replacement Value
1	Very Good	$1,236,713,000	69.6%
2	Good	$297,100,000	16.7%
3	Fair	$43,601,000	2.5%
4	Poor	$62,009,000	3.5%
5	Very Poor	$137,511,000	7.7%

Additionally, **Figure 2-9** and **Table 2-6** granulate the condition of the assets based on different asset sub-categories and their corresponding replacement values. As mentioned before, 7.7% of the assets contribute to very poor condition with total replacement value of approximately $137 Million, among which gravity mains account for the highest value with almost $76 Million, followed by service connections, making up $43 Million. Considering the age-based calculations, sewer mains and service connections are expected to predominate the capital investment due to value of assets in very poor conditions.

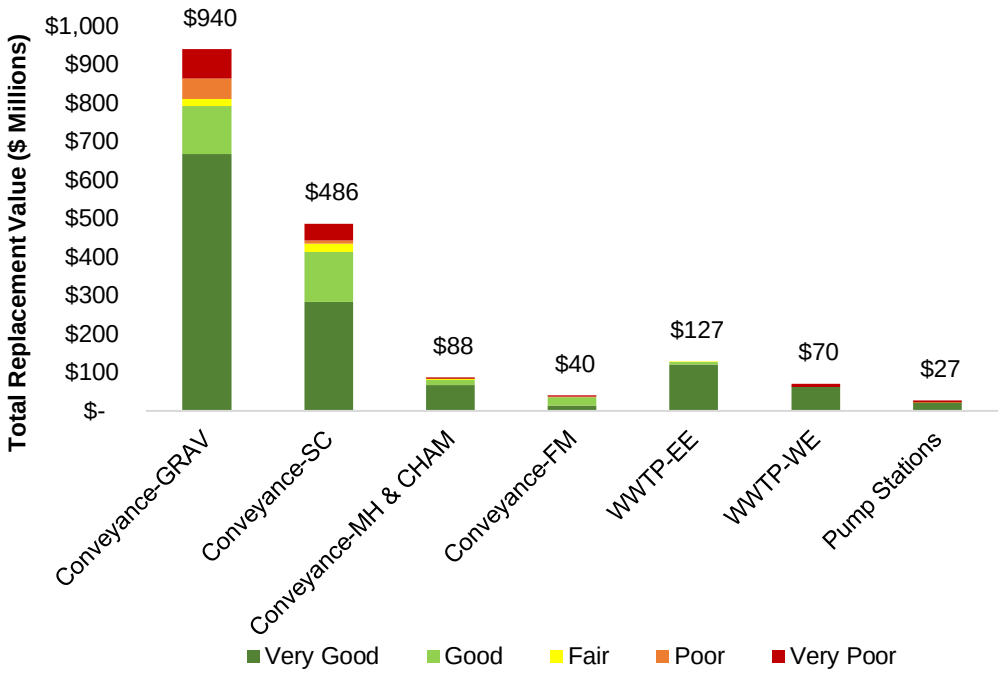

Figure 2-9: Wastewater Condition Summary for Asset Categories

* FM = Force Main, GRAV = Gravity Main, MH & CHAM = Manhole and Chamber, SC = Service Connections

Table 2-6: Distribution of Condition for Wastewater Asset Categories

Condition Rating	Gravity Mains	Service Connections	Manholes and Chambers	Force Mains	WWTP-EE	WWTP-WE	Pump Stations	Total Condition Summary
Very Good	71%	58%	78%	34%	95%	90%	81%	**70%**
Good	13%	27%	15%	55%	5%	0%	3%	**17%**
Fair	2%	4%	2%	0%	0%	0%	1%	**2%**
Poor	6%	2%	1%	3%	0%	0%	1%	**3%**
Very Poor	8%	9%	4%	7%	0%	10%	15%	**8%**
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

2.2.4.1 Gravity Sewers

Table 2-7 and **Figure 2-10** compare gravity sewers' conditions in terms of their diameters categorized into four groups: <450mm, 450 to 1,500 mm, >= 1,500 mm, and Unknown. As shown, pipes with size of less than 450 mm contribute to the highest replacement values, accounting for the highest proportion of poor (approximately $48.5 Million) and very poor condition (approximately $69 Million). The total replacement value for gravity sewers smaller than 450 mm is estimated to be around $670 Million, with 7% and 10% pertaining to poor and very poor condition, respectively.

Table 2-7: Gravity Sewers Condition by Diameter

Condition Rating	< 450Ø	450Ø - 1,500Ø	≥ 1,500Ø	Unknown
Very Good	$455,133,000	$158,393,000	$47,828,000	$5,515,000
Good	$81,304,000	$42,943,000	$0	$464,000
Fair	$16,640,000	$3,059,000	$0	$0

Condition Rating	< 450Ø	450Ø - 1,500Ø	≥ 1,500Ø	Unknown
Poor	$48,541,000	$3,353,000	$0	$169,000
Very Poor	$68,886,000	$7,029,000	$0	$465,000
Total	**$670,504,000**	**$214,777,000**	**$47,828,000**	**$6,613,000**

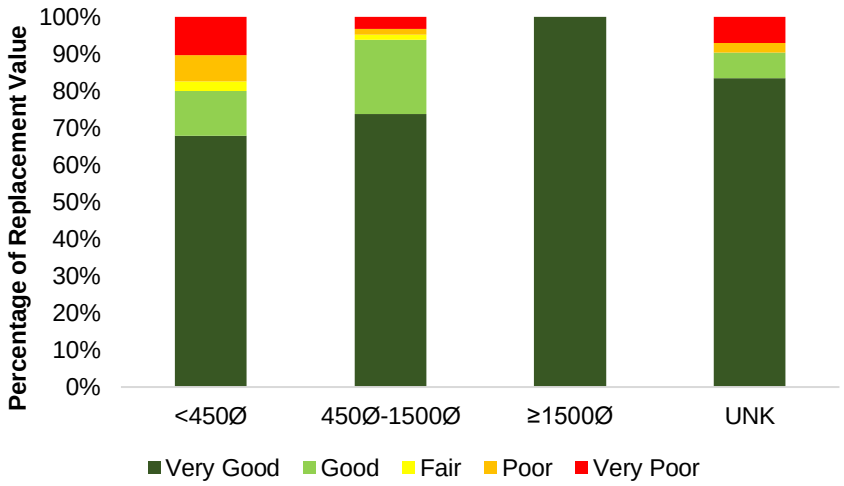

Figure 2-10: Gravity Sewers Condition Distribution by Diameter

2.2.4.2 Force Mains

Table 2-8 compares force mains in terms of their conditions, based upon their diameter: <450 mm, 450 to 1,500mm, and Unknown. As seen, force mains with sizes smaller than 450 mm contribute to almost $13.4 Million, among which approximately 54% pertains to very good condition (**Figure 2-11**). Moreover, size 450mm to 1,500 mm also makes up the highest replacement values, $26.5 Million. Around 76% of this range of diameters are in a good condition (**Table 2-8** and **Figure 2-11**) - see note under **Table 2-8**. Unknown pipes, although with a negligible contribution, are in a very good condition.

Table 2-8: Force Mains Condition by Diameter

Condition Rating	< 450Ø	450Ø - 1,500Ø *	Unknown
Very Good	$7,252,000	$6,341,000	$36,000
Good	$1,990,000	$20,203,000	$0
Fair	$0	$0	$0
Poor	$1,320,000	$0	$0
Very Poor	$2,875,000	$0	$0
Total	**$13,437,000**	**$26,544,000**	**$36,000**

* NOTE: The largest diameter for Force Mains is 1,400 mm, however, the range of numbers created to make the table consistent with the Gravity Sewers' table

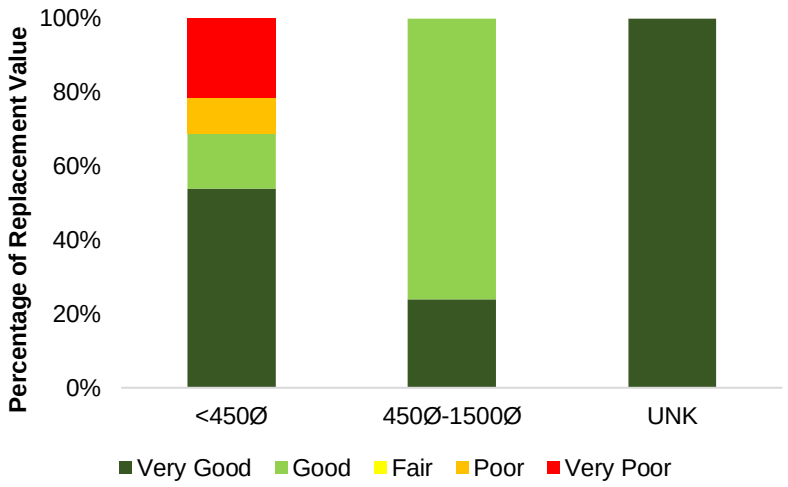

Figure 2-11: Force Mains Condition by Diameter

2.3 Asset Data Gap Analysis

2.3.1 Data Gap Observations

Table 2-9 provides a summary of observed data gaps in the compiled wastewater asset inventory across key data attributes that help to make informed decisions over the asset lifecycle for this AMP.

Table 2-9: Observations on Asset Data Completeness

Asset Group	Inventory Completeness (%)						
	Asset ID	Name / Location	Install Date	Inspection Date	Condition	Expected Service Life	Replacement Cost
Wastewater	99.5%	100%	90%	0%*	0%*	0%**	0%**

* The City's recent CCTV inspection records is not linked to the asset IDs in the GIS inventory.
** The gap is filled during the development of this AM plan.

2.3.2 Data Confidence

The quality of asset data is critical to effective AM, accurate financial forecasts, and informed decision-making. For this reason, it is important to know what the reliability of the information is for the State of Infrastructure analysis of the wastewater assets. **Table 2-10** provides a description for the data confidence grades used to classify the reliability of the asset data used in this data gap analysis. Through consultation with City staff during a State of Infrastructure Workshop, the asset attribute data for the in-scope wastewater assets were assigned the grades outlined in **Table 2-11**.

Table 2-10: Data Confidence Grading Scale

Confidence Grades	Description
A - Highly reliable	Data is based on sound records, procedures, investigations and analysis, documented properly and agreed as the best method of assessment. Dataset is complete and estimated to be accurate ± 2%
B - Reliable	Data is based on sound records, procedures, investigations and analysis, documented properly but has minor shortcomings, for example some of the data is old, some documentation is missing and/or reliance is placed on unconfirmed reports or some extrapolation. Dataset is complete and estimated to be accurate ± 10%

Confidence Grades	Description
C - Uncertain	Data is based on sound records, procedures, investigations and analysis which is incomplete or unsupported, or extrapolated from a limited sample for which grade A or B data are available. Dataset is substantially complete but up to 50% is extrapolated data and accuracy is estimated ± 25%
D - Very Uncertain	Data is based on unconfirmed verbal reports and/or cursory inspections and analysis. Dataset may not be fully complete, and most data is estimated or extrapolated. Accuracy ± 40%
E - Unknown	None or very little data held.

Table 2-11: High-Level Asset Data Confidence Grades

Asset Category	Data Confidence Average Grade		
	Inventory	Age	Condition
Wastewater	B	B	C

2.3.3 Data Management Practice

The asset data lifecycle is a sequence of stages that data goes through from its initial creation (i.e., data capture and entry) to its eventual archival and/or deletion at the end of its useful life[1]. A clear definition and understanding of the organization's process for acquiring, storing, utilizing, assessing, improving, archiving, and deleting data (see **Figure 2-12**) will ensure good data management practices and help to sustain levels of data quality required to support AM activities.

Figure 2-12: Asset Information Lifecycle

The seven key stages of the asset data lifecycle are described in more detail below:

1. **Acquiring New Data**: The majority of new asset data arises from asset creation, refurbishment and overhaul activities. New data may also come by way of inheritance or transfers from other business units, organizations, or third parties. As such, it is important to have clearly defined processes in place not only to add or update asset data, but to migrate and merge data from other sources.

2. **Storing Data**: The way asset data is stored is an important consideration for overall data quality. Having a planned approach to data storage will inevitably reduce the likelihood of duplication and inconsistencies across datasets within the organization. Depending on the needs of the organization, this stage may involve procuring a new software to adequately house the data, along with a data backup and recovery plan to ensure that the necessary data protection and privacy standards are met.

3. **Utilizing / Analysing Data**: This aspect of the asset information lifecycle is where users encounter the data to support data-driven activities within the organization. Data can be viewed, processed, edited, and published to

[1] TechTarget Network, Definition: Data Life Cycle, 2020.

allow users to access the data outside the organization. Critical data that has been modified should be fully traceable to maintain the integrity of the data. As such, it is important to communicate to the users why asset data is so important, and how it is used to inform decisions within the organization.

4. **Assessing Data**: Assessing the data quality helps to determine the level of confidence in the information and ensures that decision-makers are making informed decisions based on the quality of data available to them. Moreover, it is important to fully understand the availability and quality of the asset data before issuing information publicly. Some of the results of data degradation, due to improper or lack of assessment, may include:
    - Poor asset performance due to lack of information and understanding of asset behaviour.
    - Non-compliance with statutory regulations or safety requirements.
    - Safety incidents due to risks not being identified or reported.
    - Asset failure due to gaps in maintenance planning.
5. **Improving Data**: Improving data quality involves establishing clear targets which are intended to be communicated widely across the organization. It is imperative that the organization understands the costs, benefits, and risks associated with any data improvements since the cost of the improvement may outweigh the overall benefit. It is also important to note that *more* data does not necessarily mean *better* data. It is very possible to collect data that does not add value to the organization. As such, it is critical that the organization aligns its data improvement targets with its AM objectives and considers the data-driven decisions staff need to make at the operational and strategic level, to ensure that the *right* data is being improved upon.
6. **Archiving Data**: Archiving data is the process of storing data that is no longer active or required but is able to be retrieved in case it is needed again. Data that is archived is stored in a location where no usage or maintenance occurs. It is recommended that a data archive strategy exists within an organization in order to lay out the data archival requirements, which considers the following:
    - What data should be archived and why?
    - Are there any legal obligations for retaining data records?
    - How long should data records be retained?
    - What is the risk associated with not being able to retrieve data records?
    - Who should be able to access archived data records?
    - What is the expected timeframe to retrieve archived data records?

    Clearly communicating these requirements across the organization is key to ensuring staff are educated on why records are being archived, how they can access archived data records, and for how long archived data records can still be accessed.
7. **Deleting Data**: The deletion of data is the final component of the asset information lifecycle. Typically, within organizations there is a resistance to permanently delete data, otherwise known as data “squirrelling”, due to the overall capacity of storing data increasing and the cost decreasing. However, within the organization’s data archive strategy, a retention period should be specified to indicate when data should be deleted, along with any processes to follow, such as obtaining prior missing period.

2.3.3.1 Current Data Management State

The City’s Public Works and Engineering Services Department staff are involved in wastewater data management. The City’s wastewater data is currently stored in GIS, Excel spreadsheets, reports, and as-built drawings. Currently, the City updates assets in the GIS post-construction, and there may be a lag in obtaining as-builts and adding/updating data.

The City is following the mandate in records retention procedures for municipalities as per Freedom of Information and Protection of Privacy Act (FIPPA) and the Municipal Freedom of Information and Protection of Privacy Act (MFIPPA).

2.3.3.2 Future Data Management State

The City will develop and implement a software strategy that helps streamline data management following this AMP. Eventually, the City plans to have a clear and efficient data management process and comprehensive and robust asset inventory to support their AM decision making. The implementation plan for data improvement is presented in **Section 6**.

3 Level of Service

3.1 Purpose

Level of Service (LoS) supports every aspect of the overall AM system. The objective of establishing clearly defined service levels is to help the City meet stakeholder values, achieve its strategic goals, make informed decisions, and implement effective asset lifecycle activities.

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 the current LoS being provided, determined in accordance with the qualitative descriptions and technical metrics provided (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. The City’s corporate objective is to lift up the community and build pride, and attract people (visitors, employers and employees).

The City’s Comprehensive Background Report[2] (2021) for the New Official Plan outlined the overarching themes that reflect the City’s value, as shown in **Table 3-1**. Each overarching theme is also assigned a corporate service objective.

The development of level of service targets should be aligned with these corporate objectives which will be addressed in the next iteration of the AMP.

[2] City of Sault Ste Marie. 2021. Comprehensive Background Report.

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

Overarching Themes	LoS Objective
Healthy Community	Supports healthy living, active transportation, access to passive and active recreation, social interaction and the creation of spaces that are comfortable, safe and accessible for all ages and abilities (the "8 to 80 Cities" concept).
Environmental Sustainability	Supports energy conservation and efficiency, improved air quality, reduced greenhouse gas emissions and climate change adaptation.
Integrated Mobility	Supports accessibility and choice of a diversity of transportation modes.
Sense of Place	Fosters a welcoming place for all that establishes connection and provides a memorable experience to visitors.
Sustainable Growth	Stimulates reinvigoration of neighbourhoods to provide a complete range of housing, services, employment and recreation.
Economic Resiliency	Supports the growth and diversification of the city's economy.
Social Equity	Contributes to creating a welcoming and inclusive community, focusing on the removal of systemic barriers so that everyone has access to an acceptable standard of living and can fully participate in all aspects of community life.
Cultural Vitality	Celebrates the Sault's history, diverse communities and natural and cultural heritage, with the Downtown as the Sault's core destination for arts and culture.

3.3 Stakeholders Identification

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. The organization typically engages with their stakeholders to:

- Establish which activities or services matter most.
- 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. The following groups were identified as key stakeholders for wastewater service at the LoS workshops. This is not intended to be an exhaustive list; however, the following groups provide a good starting point for the City to move forward to the next stage.

- Council.
- Residents.
- Industrial, Commercial, Institutional (ICI).
- Regulatory Agencies (i.e., Ministry of the Environment, Conservation and Parks [MECP], Fisheries and Oceans Canada [DFO]).
- Government Agencies (i.e., Environment and Climate Change Canada [ECCC] and Michigan Department of Environment, Great Lakes, and Energy [EGLE]).
- Neighbouring Municipalities or Downstream Municipalities (i.e., First Nations including Garden River First Nation, Batchewana First Nation, and Echo Bay, and municipalities from the US including Chippewa County, Michigan, and the City of Sault Ste Marie, Michigan).
- Environmental groups (i.e., Bi-National Public Advisory Council [BPAC] [US & Canada joint committee], Clean North, International Joint Commission, and Stream keepers).
- Developers.
- Other City Departments (e.g., Planning Department).
- Contractors and suppliers (e.g., EDS).

3.4 O. Reg. 588/17 Levels of Service Metrics

O. Reg. 588/17 requires legislated community levels of service for core assets. Community levels of service use qualitative descriptions to describe the scope or quality of service delivered by an asset category. O. Reg. 588/17 also requires legislated technical levels of service for core assets. Technical levels of service use metrics to measure the scope or quality of service being delivered by an asset category.

Table 3-2 presents a summary of the City's wastewater service level for O. Reg 588/17 Metrics. References are provided to show where O. Reg 588/17 requirement has been attained.

Table 3-2: O. Reg. 588/17 Levels of Service Metrics (Wastewater Services)

O. Reg 588/17 LoS Performance Measure	Unit	Community or Technical LoS	Current LoS Performance (2021)
Description, which may include maps, of the user groups or areas of the municipality that are connected to the municipal wastewater system.	Text / Map	Community	• Wastewater connectivity map (See **Figure** 3-1)
% of properties connected to the municipal wastewater system.	%	Technical	• 89% of the City's properties are connected to the municipal wastewater system.
Description of how combined sewers in the municipal wastewater system are designed with overflow structures in place which allow overflow during storm events to prevent backups into homes.	Text	Community	• The City is no longer serviced by combined sewers.
Description of the frequency and volume of overflows in combined sewers in the municipal wastewater system that occur in habitable areas or beaches.	Text	Community	• The City is no longer serviced by combined sewers.
# of events per year where combined sewer flow in the municipal wastewater system exceeds system capacity compared to the total number of properties connected to the municipal wastewater system.	#	Technical	• The City is no longer serviced by combined sewers.
Description of how stormwater can get into sanitary sewers in the municipal wastewater system, causing sewage to overflow into streets or backup into homes.	Text	Community	• Stormwater can get into the wastewater system through manhole covers, inflow and infiltration (I&I), as well as cross connections from residential properties.
Description of how sanitary sewers in the municipal wastewater system are designed to be resilient to avoid events described in previous paragraph.	Text	Community	• The sanitary system is designed with overflows; the sanitary sewers must be built to City's design standards and bylaws.
Description of the effluent that is discharged from sewage treatment plants in the municipal wastewater system.	Text	Community	• Effluent can be defined as water pollution, such as the outflow from a sewage treatment facility. The effluent from the East End and West End treatment facilities in Sault Ste Marie have documented compliance limits, and objectives in the recent Environmental Compliance Approvals (ECA) for the East End Plant and West End Plant. • The effluent criteria include effluent flow rates, and parameters for Carbonaceous Biochemical Oxygen Demand ($CBOD_5$), suspended solids, phosphorous,

O. Reg 588/17 LoS Performance Measure	Unit	Community or Technical LoS	Current LoS Performance (2021)
			ammonia, unionized *E. coli*, Ph, Residual Chlorine, and Phenol. • Refer to the Objective and Compliance Limits in ECA Report no. 5922-BZNHV3 and 3973-AFPTCN for West End and East End Wastewater Treatment Plan, respectively.
# of connection-days per year due to wastewater backups compared to the total number of properties connected to the municipal wastewater system.	#	Technical	• Nine instances of public / private basement flooding due to main blockages. 233 instances of sanitary/stormwater issues (rodding requests) compared to 26,384 connected properties in 2021.
# of effluent violations per year due to wastewater discharge compared to the total number of properties connected to the municipal wastewater system.	#	Technical	• Zero (violation of sewer use bylaw)

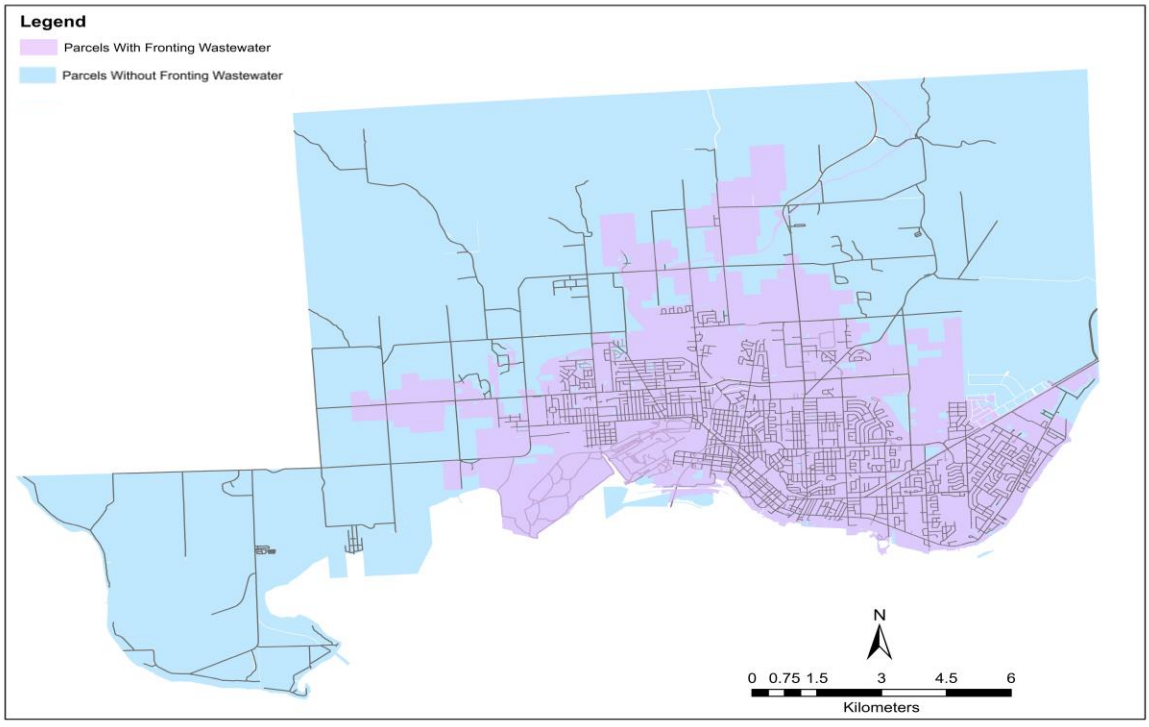

Figure 3-1: City of Sault Ste Marie Wastewater Service Connectivity Map

3.5 Levels of Service Performance Targets

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

One of the key challenges in setting targets in a municipal environment is that they can often become biased and/or politically motivated. Therefore, it is important to review LoS targets with internal and external stakeholders, especially the customers who will be impacted the most by changes in service delivery. An important aspect of evaluating LoS targets is determining how willing the user is to pay for the service. Regulatory requirements are an

exception; however, they only provide the minimum service standard. Cost is still an important parameter to consider when assessing the merits of service improvements. To deal with the financial realities, it is necessary to:

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

It is important that any targets set be realistic and achievable. Therefore, it is not advisable that the City sets any firm targets until their current performance has been fully assessed. O. Reg. 588/17 requires AMPs to include proposed levels of service and a formalized financial strategy by July 1, 2025.

3.6 Future Demand Drivers

Demand management is a critical component of managing the desired LoS in a sustainable manner, now and into the future. Understanding demand drivers enables the City to proactively develop effective, long-term strategies that are suitable for the City's unique political, environmental, social and technological landscape.

Factors identified during the LoS workshop that would impact wastewater service levels now and into the future include, but are not limited to, the following:

- Aging infrastructure (i.e., clay tile sewers and old concrete sewers, etc.).
- Regulatory changes.
- Staff availability (i.e., technical skill availability, skill gaps from changing technology, etc.).
- Succession management & skills transfer (i.e., succession plan to have licensed wastewater operators to operate the facilities, etc.).
- Funding (i.e., having proper AM plans to optimize service delivery with minimum rates).
- Contractor availability (i.e., contractors' availability for big projects, etc.).
- Climate change (i.e., higher I&I from precipitation, higher water level at Great Lakes, etc.).
- Supply Chain (i.e., material and equipment availability for capital projects, etc.).
- Fluctuations on contract pricings.
- Population growth.

On November 2, 2021, the City's Planning Division released the Comprehensive Background Report for updating the Official Plan[3]. The City's Official Plan guides the local decision-making on land use, development and public infrastructure over the next 20 years. The City's population is expected to reach approximately 80,000 people by 2031, and 83,300 people by 2036. Employment is projected to grow by about 6,000 jobs, from approximately 31,000 jobs in 2016 to 36,900 jobs in 2036.

When additional assets to accommodate this population and employment growth are introduced to the City's portfolio, additional human resources, training and funding are required to maintain and operate, and renew or replace those assets. O. Reg. 588/17 requires municipalities by July 1, 2025, to estimate capital expenditures and significant operating costs to achieve the proposed LoS and accommodate projected increases in demand caused by population and employment growth. This includes the estimated capital expenditures and significant operating costs related to new construction and / or to upgrade existing municipal infrastructure assets. The City will have to address these aspects during the later phases of the AM regulatory compliance and before the July 1, 2025 deadline.

[3] City of Sault Ste Marie. 1996. Official Plan

4 Asset Management Strategies

4.1 Asset Lifecycle Management Introduction

Asset lifecycle management focuses on the specific activities that should be undertaken 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 lifecycle 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 lifecycle cost, which is the total cost of all the activities undertaken throughout its service life. Part of the purpose of the asset management 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, renewal & replacement and disposal costs is many multiples of the initial acquisition costs. As such, it is important to fully understand the entire lifecycle costs across an asset's entire life before proceeding with asset acquisition.

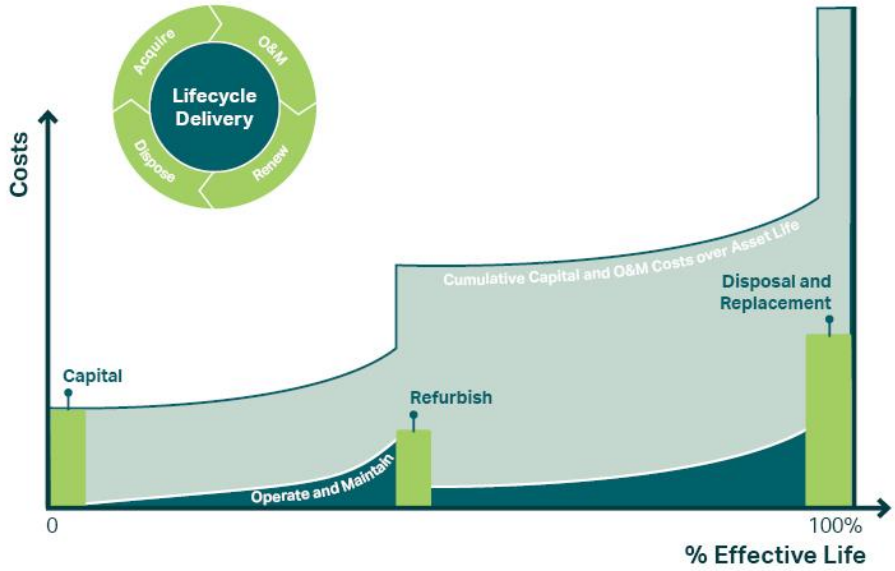

Figure 4-1: Lifecycle Cost Accumulation Over Asset Life

Asset lifecycle management strategies are typically organized into the following categories.

1. **Asset Acquisition / Procurement / Construction**: Acquisition includes expansion activities and upgrading activities to extend services to previously unserved areas or expand services to meet growth demands and to meet functional requirements. 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 lifecycle 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.

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

3. **Renewal and Replacement:** The third portion of full life cycle costing relates to the renewal and replacement of infrastructure that have deteriorated to the point where it no longer provides the required service. Renewal cost is sometimes incurred during the life of an asset where an investment is made to improve the condition and / or functionality of the asset e.g., re-lining of a pipe. Replacement activities that are expected to occur once an asset has reached the end of its useful life and rehabilitation is no longer an option.

4. **Decommissioning and Disposal:** There will inevitably come a point in time when an asset must be removed from service and, depending on the type of asset, there may be significant costs associated with its decommissioning and disposal. Factors that may influence the decision to remove an asset from service include changes to legislation that cause the asset to be in non-compliance, the inability of the asset to cope with increased service levels, technology advances that render the asset obsolete, the cost of retaining the asset is greater than the benefit gained, or the current risk associated with the asset's failure is not tolerable.

Normally, major costs that may be incurred during disposal and decommissioning derive from the environmental impact of the disposal and, if required, the rehabilitation and decontamination of land. In some cases, there will be residual liabilities and risks to consider if a decision is made to partially abandon the asset as opposed to fully disposing of its components (e.g., leaving a non-functioning pipe in the ground, or an inactive building standing). However, some cost savings may be achieved through the residual value of the asset or by exploring alternative uses for the asset. In all cases, it is important to consider disposal and decommissioning as the strategy employed has the potential to attract significant stakeholder attention. For that reason, the costs and risks associated with disposal and decommissioning should be equally considered in the City's capital investment decision-making process.

4.2 Wastewater Assets Management Strategies

The asset management strategies that are employed by the City to manage the wastewater system throughout their lifecycle is summarized in **Table 4-1**.

Table 4-1: Lifecycle Management Strategies for Wastewater Assets

Asset Group	Lifecycle Activity	Description of Activities Practiced by the City	Benefit or Risk Associated with the Activities
Wastewater	**Acquisition**	**All Wastewater Assets** • Assumption of subdivisions, commercial and industrial extensions, local improvements, etc. • Council approved specific initiatives. • Pipes that do not meet capacity requirements are upsized to increase capacity. • Undertake Environmental Compliance Approval (ECA). **Treatment Plants and Large Pump Stations** • Projects typically relate to process upgrades. The current upgrades on the East End WWTP are primarily focusing on improving the quality of wastewater treatment, while for the West End WWTP, the focus is on improving flow and replacing components.	• To extend services to previously unserved areas or expand services to accommodate asset enhancements. • Adequate planning and implementation of infrastructure projects help to manage existing and potential growth pressures and address other demand factors.
	Operations and Maintenance	**Sewers** • Flushing and cleaning. • Spot repairs. • Reactive CCTV Inspections of sewers. • Emergency blockage or failure responses. • Force mains valve exercising.	• Flushing and cleaning activities can remove debris to ensure desired capacity and help identify potential problems before they happen. • Spot repair will fix mains that have or may collapse and cause disruptions to service, backups and / or overflows. • Emergency blockage responses will remove partial or full blockages from mains that cause disruptions to service, backups and / or overflows and restore the main operational functions. • Valve exercising program ensure valves can be easily located and operated when and as needed.
		Manholes & Chambers • Routine inspections. • Performing maintenance as needed.	• Routine inspections for manholes & chambers to address the flow concerns or easement flooding issues.
		Service Connections • Clean-out installed. • Blockage removal. • Laterals unplug. • Relaying • Clay laterals replacement.	• Maintenance of service connections ensures assets are operating properly and reduce potential claims. • Replacement of clay and/or substandard laterals ensures that aged older pipe material are replaced to reduce failures.

Asset Group	Lifecycle Activity	Description of Activities Practiced by the City	Benefit or Risk Associated with the Activities
		Small Pump Stations • Routine inspection once a week. • Maintain the electronic components that monitor station security, controls, and diagnostics. • Clean the grease, debris and foam build-up from wet well. • Wash down and remove debris in the pump station chambers. • Annual oil change. • Emergency repairs.	• Regular inspections of facilities ensure wastewater facilities are operating properly and that potential maintenance issues are identified and prioritized for repair to avoid equipment failure. • Regular scheduled maintenance activities at wastewater facilities ensure that the facilities continue to operate properly. • SCADA upkeep to monitor and improve the efficiency and capacity of wastewater facilities and assets. • Facilities emergency repairs due to failure alarm or reported failure to reduce the possibility of a spill or other system failure.
		Wastewater Treatment Plants and Large Pump Stations • Regularly scheduled inspections and maintenance by the Public Utilities Commission (PUC). • PUC has a standard routine for maintaining the facilities. • Implement SCADA upkeep projects. • Emergency repairs.	
	Renewal and Replacement	**Sewers** • Sewer replacements are coordinated with road reconstructions. • The City prioritizes replacing clay sewers. • Redundancy for critical force mains is a concern the City aims to address.	• Coordination of sewer works together with road reconstruction. Allows the management of a range of assets within any road right-of-way to be optimally coordinated, leading to reduced cost and limited disruption to businesses and residents. • Replacing older pipe materials such as Clay sewers with Polyvinyl Chloride (PVC) pipes to reduce potential main failures. • Critical force main redundancy ensures wastewater network availability in case of a force main failure and unavailability.
		Manholes & Chambers • Replaced at the same time as the sewer mains. • Minor defects observed on site are addressed under the maintenance budget.	• Bundling similar works to manage related assets and reduce overall lifecycle cost.
		Service Connections • Replaced at the same time as the sewer mains. • Minor defects observed on site are addressed under the maintenance budget.	• Bundling similar works to manage related assets and reduce overall lifecycle cost.
		Small Pump Stations • The small pump stations are assessed annually in terms of priorities for renewal/replacement.	• Renewal or replacement of underperforming wastewater facility assets reduce potential loss of service caused by unplanned failure.

Asset Group	Lifecycle Activity	Description of Activities Practiced by the City	Benefit or Risk Associated with the Activities
		Wastewater Treatment Plants and Large Pump Stations • The City is looking to conduct detailed condition assessments for larger pump stations. • Large pump stations operated by PUC are renewed based on functional needs. • Wastewater treatment facilities assets are renewed / replaced based on facility inspection reports.	
	Disposal	• Current practice is removal of old assets and landfill disposal. • Equipment is disposed or inventoried as spare parts.	• Ensure assets are disposed in compliance with waste regulations in Ontario.
	Non-Infrastructure	• Sanitary flow monitoring project to monitor and track I&I. • Perform sewer capacity studies. • Plan formalized condition assessment programs. • Master Plans and Official Plan.	• Monitoring and tracking I&I will facilitate identification of future remedial actions as may be required. Reducing infiltration and inflow will mitigate overflows and by-passes during periods of intense rainfall. • Sewer capacity studies provide the ability to understand the need to upsize pipes to accommodate needs. • Condition assessment programs help to identify and record asset condition to inform decision-making for maintenance and capital programs. • Master Plans and Official Plan include strategic planning / budgeting and project prioritization enable to inform long-term decision making.

5 Funding Need Analysis

5.1 Reinvestment Forecast and Lifecycle Modeling

Table 5-1 shows the assumptions on the reinvestment rate forecast for each Wastewater asset type, the reinvestment targets, and the resulting 10-year annual average reinvestment rate for the period from 2023 to 2032. The lifecycle analysis also incorporated the upcoming WWTP-EE and WWTP-WE upgrade projects planned for 2024 to 2026 by including "WWTP-EE Near Future" and "WWTP-WE Near Future" in the annual reinvestment analysis.

In the future, when condition assessment programs are implemented, asset conditions will be used to update the renewal and replacement forecast to better inform asset reinvestment needs.

Table 5-1: Wastewater Reinvestment Assumptions

Asset	Measure	Target	Resulting 10-Yr. Annual Avg. Reinvestment Rate (2023- 2032)
Wastewater Gravity Mains	Percentage of gravity mains exceeding their expected service life, that are replaced in 2023 and thereafter	100%	0.8%
Wastewater Force Mains	Percentage of force mains exceeding their expected service life, that are replaced in 2023 and thereafter	100%	5.9%
Wastewater Service Connections	Percentage of required replacement of service connections when replacing gravity mains addressed	100%	1.3%
Wastewater Manholes & Chambers	Percentage of required replacement of manholes & chambers when replacing gravity mains addressed	100%	0.6%
Wastewater Pump Stations	Percentage of wastewater pump station assets exceeding their expected service life, that are replaced in 2023 and thereafter	100%	2.6%
Wastewater Treatment Plants – East End	Percentage of East End WWTP assets exceeding their expected service life, that are replaced in 2023 and thereafter	100%	1.7%
	WWTP-EE Near Future projects (2024 to 2026)	100%	
Wastewater Treatment Plants – West End	Percentage of west end wastewater treatment plant assets exceeding their expected service life, that are replaced in 2023 and thereafter	100%	4.9%
	WWTP-WE upgrade project phase two plan - WWTP-WE Near Future projects (2024 to 2026)	100%	

The lifecycle analysis was implemented within an MS Excel Wastewater Asset Lifecycle Model. The analysis involves integrating key asset attribute information including asset inventory, age, expected service lives, replacement values, and condition to create a theoretical asset replacement cycle for each asset. The other relevant renewal needs information (e.g., the City's current plan for WWTP-EE and WE upgrade) were also considered in the lifecycle model. A financial dashboard was developed to present the lifecycle modeling results.

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. Project timing and cost should be further refined upon approach of the actual implementation date.

5.2 Capital Reinvestment Need Analysis

5.2.1 10-Year Reinvestment Need Analysis

The average annual reinvestment estimate for the City's wastewater system is $28 Million over the next 10 years in inflated dollar values. This is equivalent to a total of approximately $278.5 Million over the next 10-year period, as presented in **Figure 5-1**. The City should note that there are significant backlogs for reinvestment on the sewer gravity mains, force mains, and service connections which have already exceeded their ESLs. This expenditure spike is highlighted in the red outline presented in the year 2023 in **Figure 5-1**.

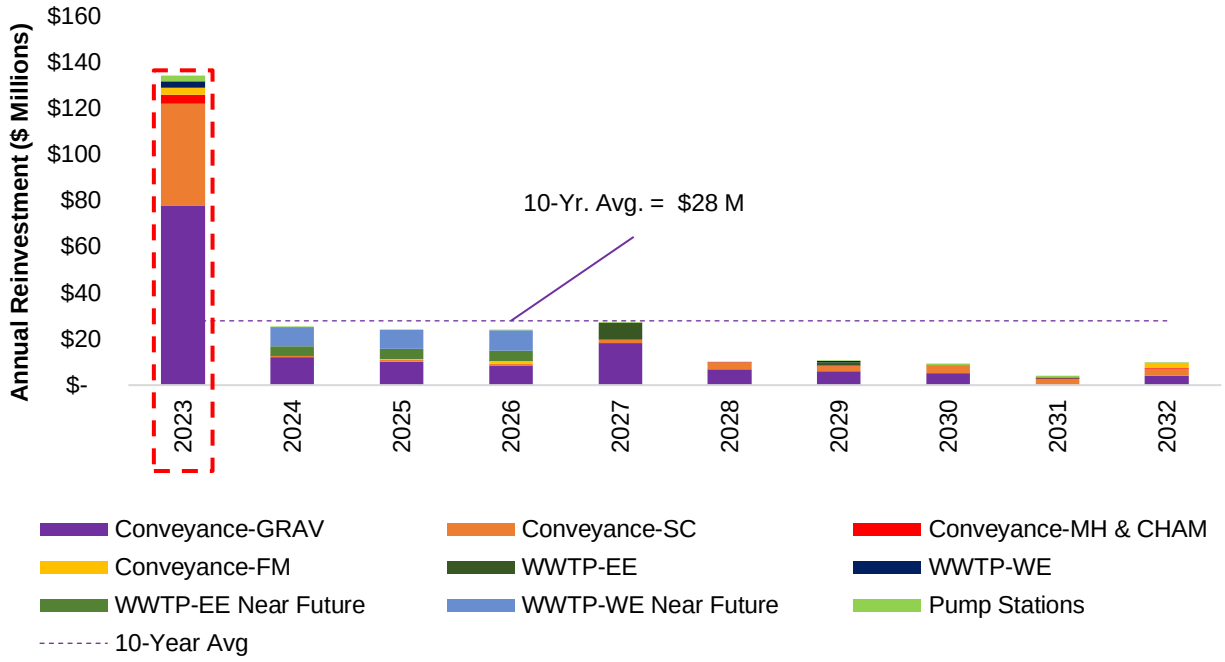

Figure 5-1: Wastewater 10-Year Capital Reinvestment Needs

The detailed 10-year reinvestment needs for gravity mains, force mains, service connections, manholes and chambers, pump stations, and WWTPs are presented in **Table 5-2** in inflated dollar values.

Table 5-2: Wastewater 10-Year Total and Annual Average Capital Reinvestment Need

Asset Type	Annual Average Need	10-Year Total
Wastewater Gravity Mains	$14,908,000	$149,080,000
Wastewater Force mains	$677,000	$6,770,000
Wastewater Service Connections	$6,165,000	$61,650,000
Wastewater Manholes & Chambers	$528,000	$5,280,000
Wastewater Pump Stations	$512,000	$5,120,000
Wastewater Treatment Plants – East End	$2,135,000	$21,350,000
Wastewater Treatment Plants – West End	$2,924,000	$29,240,000
Total	**$27,849,000**	**$278,490,000**

5.2.2 50-Year Reinvestment Need Analysis

Looking ahead over the long term, the average annual reinvestment estimate for the City's wastewater assets is $52M over the next 50 years in inflated dollar value, for a total of approximately $2.6 Billion, as presented in **Figure**

5-2. Considering the reinvestment needs starting from around 2042, a significant amount of the City's aged gravity mains will require renewal or replacement as they will approach and exceed their theoretical ESLs.

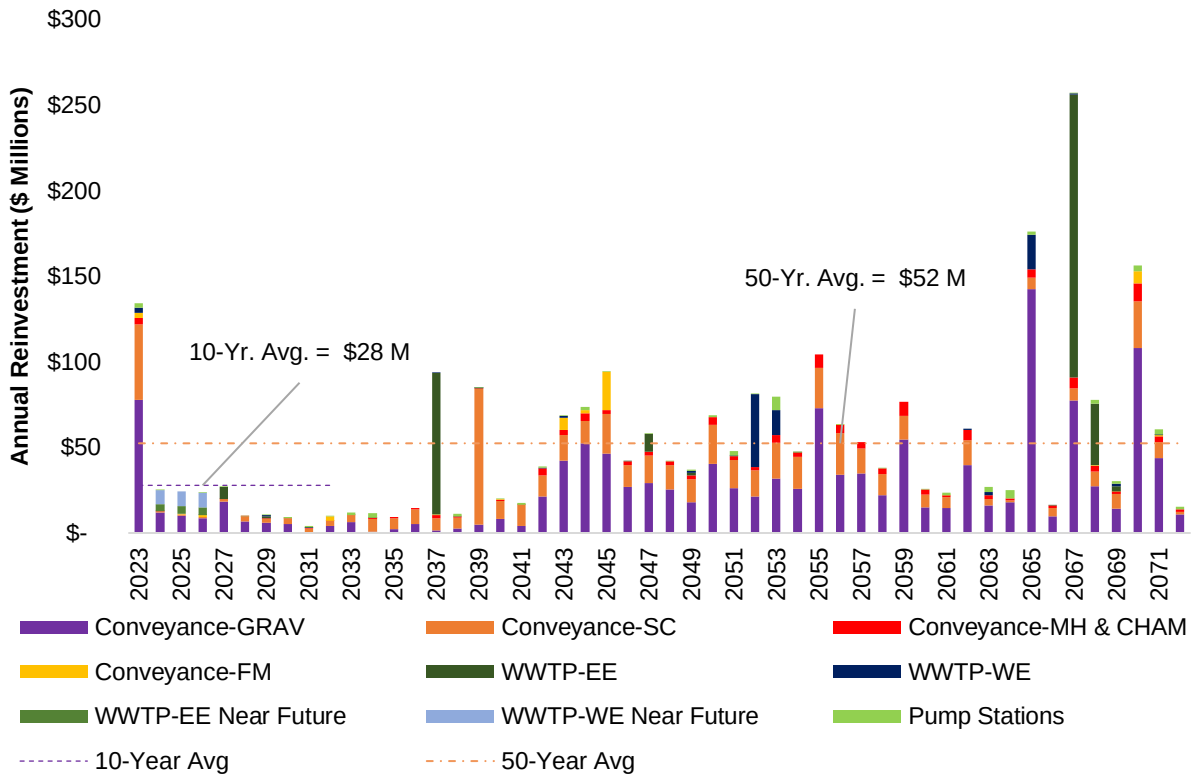

Figure 5-2: Wastewater 50-Year Reinvestment Needs

5.2.3 Benchmarking for Capital Reinvestment Needs

AECOM's Canadian Infrastructure Benchmarking Initiative (CIBI, see https://www.nationalbenchmarking.com/) is a partnership of over 50 Canadian municipalities, stretching from coast-to-coast, that annually collects and reports on water, wastewater, stormwater, and transportation LoS across operational, financial, environmental, and social "bottom lines". The findings from the CIBI serve as key inputs into establishing what constitutes industry best practice for asset management activities across Canadian municipalities. Capital reinvestment rate of wastewater conveyance system and wastewater treatment from CIBI were reviewed and analyzed to provide the City with context and useful comparable information to make informed decisions.

The City's current 10-year wastewater collection and treatment capital forecast and proposed capital reinvestment need from this AMP were benchmarked against the CIBI group median, the 25th percentile, and the 75th percentile. **Figure 5-3** presents the current 10-year annual average of City's wastewater capital reinvestment budget forecast and the associated average capital reinvestment rates. **Figure 5-3** shows the capital reinvestment rate benchmarking results.

The current forecasted capital reinvestment budget for wastewater conveyance system is below the 25th percentile, meaning there could be opportunities to increase the capital reinvestment to be on par with the Canadian benchmarking group. **Figure 5-3** shows that the proposed average capital reinvestment rates for wastewater collection (1.11%) is between the 25th percentile and 75th percentile, which means this proposed rate is in line with 50% of Canadian benchmarking municipalities' current practice.

It should be noted that the CIBI median values provide a good baseline regarding LoS across Canada. However, median values are not always appropriate for targets. In some cases, most Canadian municipalities are either behind or ahead of the curve due to alternate priorities.

The City's current capital budget forecast for its WWTPs is between the 25th percentile and 75th percentile indicating the capital reinvestment level is in line with 50% of Canadian benchmarking municipalities' current WWTP practice. It is noticeable that the proposed WWTP reinvestment rate (2.69%) is higher than the 75th percentile, as the City is prioritizing the WWTP upgrades in the near future. After including the "WWTP-EE Near Future" and "WWTP-WE Near Future" upgrade projects, an addition of approximately $4 Million, and $8 Million annually on average for the period from 2024 to 2026 for the East End and West End WWTPs, respectively, were added to the reinvestment need leading to an increase of reinvestment rate in the short term.

Table 5-3: City's Wastewater 2022 - 2031 Capital Reinvestment Budget Forecast Summary

Asset Category	Description	Current Capital Reinvestment Budget 2022-2031 10 Year Annual Average	City's Average Reinvestment Rate
Wastewater Conveyance	The capital reinvestment budget items for conveyance system include Infrastructure, Emergency Repairs, Pumping Stations, and Miscellaneous Projects.	$ 2,219,000	0.14%
Wastewater Treatment	The capital reinvestment budget items for wastewater treatment plants include Wastewater Treatment Plant Capital Maintenance and Repair, East End Plant, and SCADA.	$ 2,490,000	1.26%

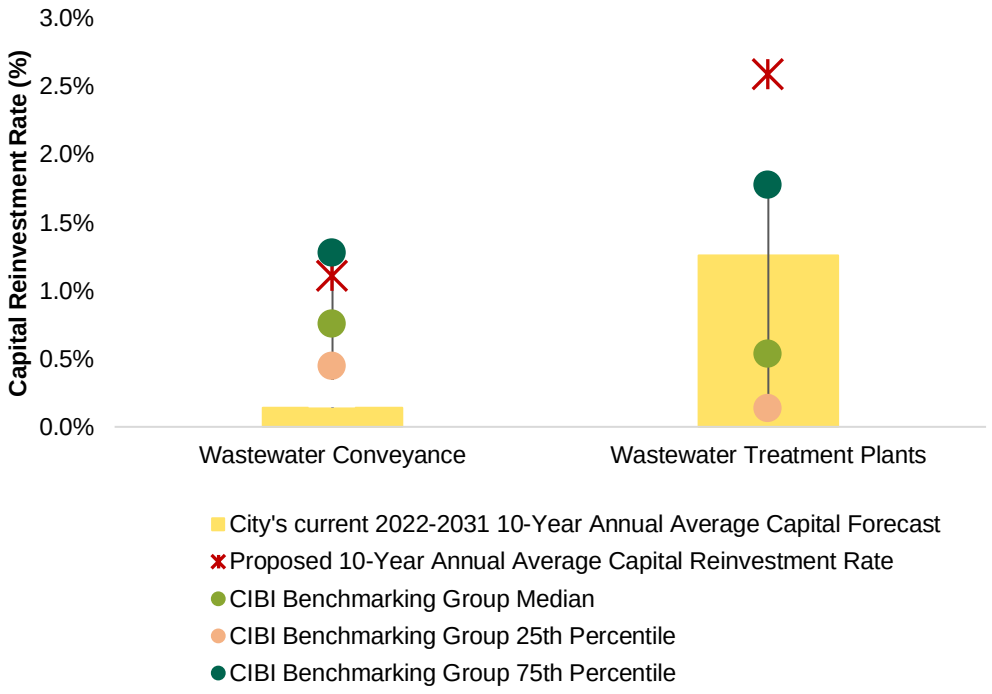

Figure 5-3: Capital Reinvestment Benchmarking

5.3 Full Funding Need Profile

Figure 5-4 shows a full picture of the City's wastewater funding need forecast over the next 10 years, which provides the City the full funding requirements in order to perform effective financial planning activities. The total annual reinvestment cost from **Figure 5-1** has been overlaid with the City's annual average wastewater O&M cost.

The City's wastewater full funding requirement increases to approximately $370 Million over the next 10 years with additional funding requirement, and O&M, equivalent to $37 Million per year in inflated dollar value.

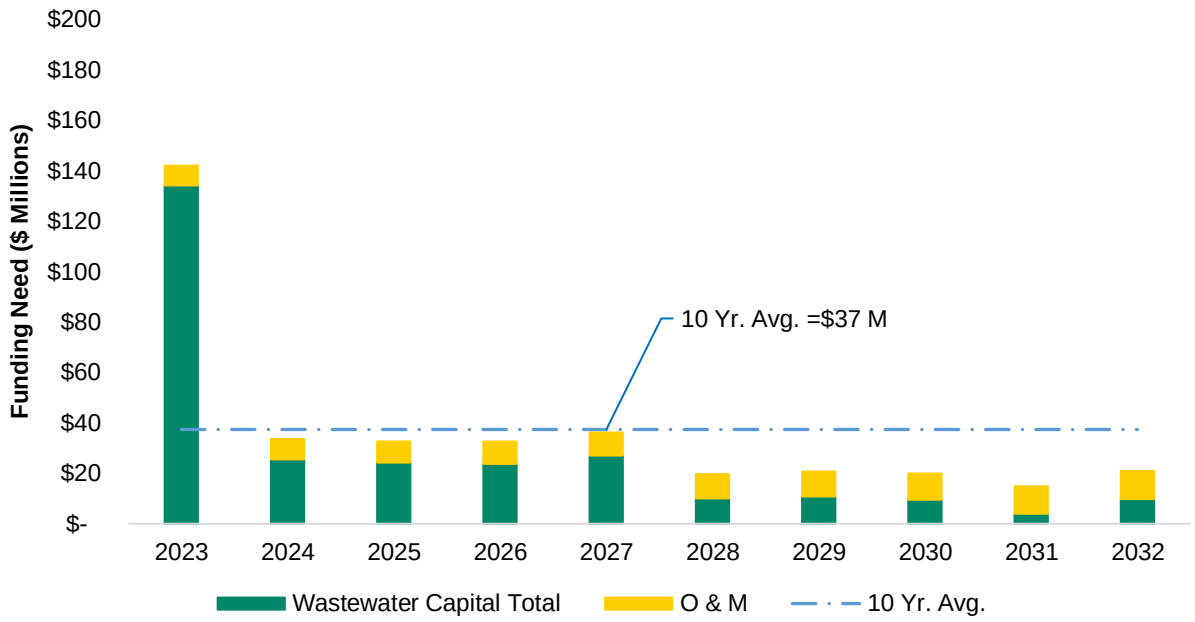

Figure 5-4: Wastewater Full Funding Need Profile

6 Implementation Plan and 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 wastewater assets are in a relatively good condition at the moment, there are future challenges that must be contended with considering the 50-year projection presented in **Figure 5-2**. It is important to address these challenges thoroughly and promptly to leave a positive legacy for future generations.

A suite of improvement initiatives has been identified for the next phase of AM planning for the City's wastewater assets, as outlined below:

- **Recommendation 1: Refine asset data and fill data gaps to make more informed and defensible decisions.**

  Continue to collect data and fill gaps in the GIS inventory to have a more accurate representation of the current state of wastewater infrastructure. The City has made great effort in ensuring that the GIS is the primary source of truth for its assets by capturing much of the inventory within the system. It is recommended that the City continue to merge asset data from various drawings, spreadsheets, and other databases through the process of digitizing, transforming, or georeferencing assets to capture the whole inventory. For example, in this assignment, AECOM has reviewed the 2013 condition assessment report inventory and any assets removed from the facility as part of the recent WWTP-WE Phase 1 Upgrades project were deleted. The WWTP-WE Phase 1 Upgrades contract drawings and the asset inventory were also reviewed and updated by including all major new structural, architectural, process mechanical, building mechanical, electrical and instrumentation assets. For existing buildings, the new assets for the renovated components were added. In addition, project cost values for each asset were provided based on the pre-tender cost estimate or on the payment certificate cost breakdown.

- **Recommendation 2: Develop a Data Governance Framework to provide a holistic and consistent approach to the City's wastewater data management practices**.

  A Data Governance Framework includes developing an Asset Information and Data Standards Strategy to clearly define what asset data exists, who is accountable for managing it, methods of data collection, and safeguarding data quality. The successful deployment of a Data Governance Framework aims to achieve the following benefits:

  - Enhanced data integrity to support reliable analysis.
  - Improved data management workflows and processes.
  - Improved AM reporting.
  - Clearly defined data management roles & responsibilities.

- **Recommendation 3: Review business process for asset acquisition and design workflow diagrams to formally document AM processes.**

  An opportunity exists for the City to continually reevaluate its business practices, including data management, to promote information sharing between roles, departments, and systems. The development of process maps is an excellent resource for visualizing the flow of information and formalizing procedures.

- **Recommendation 4: Develop a regular wastewater sewer condition assessment program**.

  Condition assessment is one of the primary steps utilized prior to performing maintenance, rehabilitation, or replacement activities. In sewers, the most commonly used inspection technique is CCTV for sewers up to 1,200 mm; larger sewers can be good candidates for multi-sensor inspection (MSI). For force mains, applicable pressure system condition assessment tools can be considered including leak detection. Wall thickness measurement can also be considered for ductile iron and cast-iron force mains. The results from this inspection

will be used to evaluate the internal condition of the pipeline to determine the structural and operational condition. A CCTV program will allow the City to:

- Better forecast infrastructure renewal and rehabilitation needs.
- Avoid infrastructure failures and the resulting economic, social, and environmental costs.
- Leverage cost-effective methods to extend the life of assets before the asset becomes too deteriorated and must be replaced.

- **Recommendation 5: Develop a regular wastewater facilities condition assessment program.**

  The last wastewater facilities condition assessment for the West End WWTP was performed in 2013. Condition assessment of the East End WWTP has not been completed since the 2000 upgrades. AECOM recommends that the City updates wastewater facility asset (treatment plants and the pump stations) condition at least every five years to inform maintenance, renewal, or replacement plans. A detailed condition assessment can include:

  - Inventory confirmations of key process equipment including process structural, process mechanical, process electrical and process instrumentation, building structures and systems, and site work.
  - Completion of all required asset class attributes (includes capturing manufacturer, model, serial number, and year installed).
  - Determining the current condition grade of each asset using a consistent condition rating scale.
  - Application of consequence of failure/criticality values based upon established criteria and information derived from discussion with plant staff.
  - Populating current asset replacement value based on local and recent cost data.
  - Developing a risk assessment and forecasting model.

- **Recommendation 6: Refine the Levels of Service Framework.**

  Considering the LoS deadline of July 1st, 2025, stipulated within the O. Reg. 588/17 regulations, the steps to refining the LoS framework and quantifying the gaps between existing and target service levels can include:

  - Collecting asset performance data for key performance indicators (KPIs) that are not currently being tracked, including associated costs.
  - Reviewing the LoS performance measures on an annual basis and updating asset performance data as required.
  - Analyzing and monitoring asset performance data to determine trends and to establish annual performance benchmarks.
  - Engaging 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.).
  - Developing 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 LoS.
  - Documenting information workflows, and clearly defining roles and responsibilities in the LoS continual improvement planning process. A component of collecting LoS performance data is ensuring that the right processes are in place to enable efficient LoS reporting. It is recommended that the City review its existing business process and identify opportunities to support cross-functional teamwork. This includes developing process maps and documenting clear roles and responsibilities so that key staff understand their role in data collection, recording, analysing, and monitoring

- **Recommendation 7: Develop a Risk Assessment Framework and use risk scores to drive financial needs forecasting.**

The use of a risk-based approach to inform financial needs provides a clear direction in maintenance, rehabilitation, and replacement work in terms of balancing priorities. It also provides transparency to the public and other stakeholders to demonstrate that decisions are made in an impartial and consistent manner, without unreasonable bias, and in accordance with agreed upon policy and priorities.

- **Recommendation 8: Implement a CMMS / Work Management System.**

  The City will conduct an AM Software Strategy following the completion of this AM plan to identify future system requirements that may include enhancing existing software, adding-on, or replacing.

- **Recommendation 9: Refine the Wastewater lifecycle model and update the model periodically as new information becomes available.**

  The wastewater funding model 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.

  - In light of the annual capital and O&M investments outlined in **Section 5**, the City should budget for wastewater expenditures on asset reinvestment and O&M to an average of $33 Million estimated per year over the next 10 years. However, when considering the longer-term needs, the City may want to consider establishing reserves to address future renewals and replacement beyond the 10-year horizon.
  - Review financial modeling assumptions on ESLs and replacement values and update the financial model with new information as it becomes available (e.g., when the results from the CCTV inspection program become available).

- **Recommendation 10: Continue to monitor growth needs and integrate growth related wastewater infrastructure funding needs into the financial forecast and update the Wastewater AM Plan as appropriate.**

  As referenced in **Section 3.6**, the City's wastewater system is expected to grow in line with an increase in the City's population. AECOM recommends that the City:

  - Includes growth-related capital needs as part of the capital budgeting.
  - Coordinates AM planning and development planning processes to ensure that the infrastructure systems that are built to serve new growth can be sustained over the long term.
  - Ensures that the wastewater asset inventory is always kept current as new assets are added and existing assets are refurbished or retired.

- **Recommendation 11: Continue to find ways to improve AM initiatives across the City by maintaining a high level of AM awareness through training, AM buy-in, communication, and knowledge sharing.**

  ISO 55010[4] identifies the that the financial and non-financial functions of AM within organizations are generally inadequately aligned. The lack of alignment between financial and non-financial functions can be attributed to silos in an organization, including reporting structures, functional / operational business processes, and related technical data. Financial and non-financial alignment needs to work both "vertically" and "horizontally", as follows:

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

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

- **Recommendation 12: Develop a Knowledge Retention Strategy to document staff AM knowledge and experience for succession planning purposes.**

  Communicate AM improvement initiatives and enhance AM awareness internally through internal communication.

- **Recommendation 13: Develop a Change Management & Communications Plan.**

  AM buy-in and support are needed from all levels of the City to ensure that AM standards, practices, and tools are properly adopted and incorporated into day-to-day work activities. A successful Change Management & Communications Plan will depend on the following factors:

  - AM buy-in from Council, senior management, staff, and departments.
  - AM objectives are realistic and achievable.
  - AM improvement initiatives are appropriately resourced.
  - A network of AM champions is developed and empowered across the City.

Appendix A - Wastewater Asset Inventory

The City's wastewater asset inventory is presented as a separate MS Excel file.

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