Greater | Grand Sudbury

ASSET MANAGEMENT PLAN

WATER AND WASTEWATER

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CITY OF GREATER SUDBURY

FINAL

PROJECT NO.: 121-23026-00
DATE: JUNE 2018

WSP

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EXECUTIVE SUMMARY

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WSP was retained to undertake the development of a Water and Wastewater Asset Management Plan (AMP) that the City of Greater Sudbury (City, CGS) can utilize to assist with decisions regarding the building, operating, maintaining, renewing, replacing, disposing and funding of their water and wastewater infrastructure assets.

This Asset Management Plan was prepared in accordance with the Ontario Ministry of Infrastructure's "Guide for Municipal Asset Management Plans" and has been structured based on the following sections as outlined for a detailed Asset Management Plan.

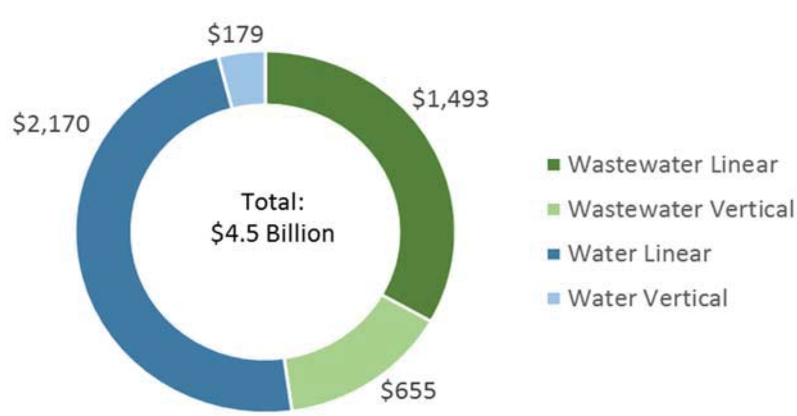
0. Executive Summary
1. Introduction
2. State of Infrastructure
3. Levels of Service
4. Asset Management Strategy
5. Financing Strategy
6. Next steps

The scope of this project encompasses the water and wastewater infrastructure owned and operated by the City of Greater Sudbury. The Plan also integrates the on-going Water and Wastewater Master Plan recommendations, adding additional asset management costs to those projects and building a consolidated capital expenditure forecast and strategic plan for the City's water and wastewater infrastructure.

ES 1. STATE OF INFRASTRUCTURE

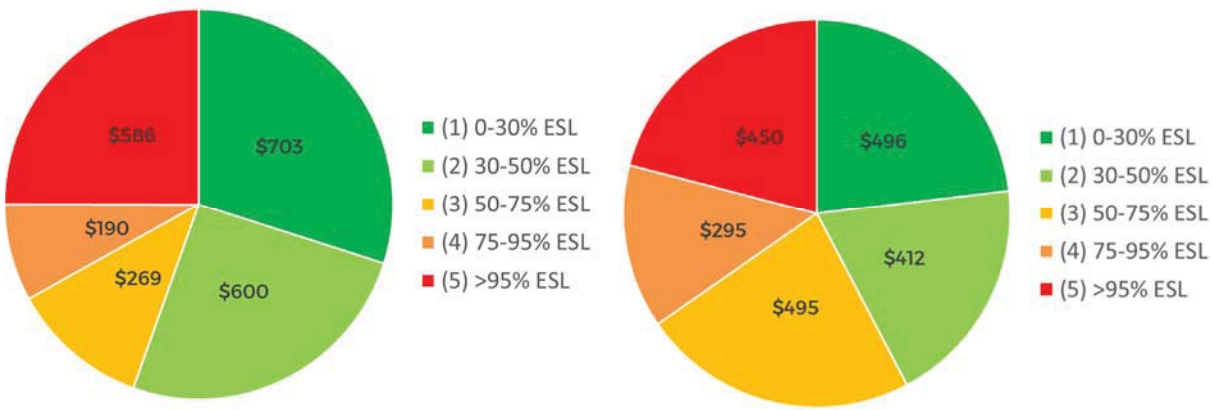
The City's water and wastewater infrastructure consists of approximately 997 km of watermains, 791 km of wastewater mains, appurtenances, and 143 Water and Wastewater facilities, with a total replacement cost of approximately 4.5 billion dollars (2017 CAD). These figures do not include infrastructure that is privately owned and maintained.

Figure ES 0-1 Cost Distribution of Water Wastewater Infrastructure



Various data sources were integrated for this study, including the City's GIS, the City's Tangible Capital Asset Inventory, and available hydraulic models. The condition of the City's infrastructure was estimated using the best available information; expected service lives were estimated for each asset type using industry accepted standards and local experience by the City staff, and an estimated replacement value and year of installation was associated with each asset. A considerable portion of the infrastructure, up to 25% of the water and up to 50% of the wastewater infrastructure, by value, was found to have reached or exceeded its estimated service life (Figure ES 0-2). This group of assets is typically in very poor condition, heavily affecting O&M costs and capital investment needs.

Figure ES 0-2 Percent Expended Service Life of Water (Left) and Wastewater (Right) Infrastructure, by total Replacement Cost (2017 CAD, $M)



A risk framework was developed, and each individual asset was assigned a risk score based on a calculated Consequence and Probability of Failure.

The Consequence of Failure was estimated based on asset-specific engineering principles, customer impacts, and environmental impacts. These were gathered from the City's GIS as well as water and wastewater models, applying customized tools, and manually identifying high-risk portions of the network.

The Probability of Failure for the linear assets was determined utilizing customized deterioration models derived using the City's failure data. The Probability of Failure for facilities has been determined according to asset lifecycle categories / discipline groups (e.g., structural, architectural, electrical, site works, etc.) within the facility. The Probability of Failure for each category was taken as proportional to the age versus its estimated service life, utilizing an age-based deterioration model.

A comprehensive asset-level inventory is provided with the digital media accompanying this report, along with a corresponding GIS data set, documenting the estimated value, condition, age and risk for the City's water and wastewater assets.

ES 2. LEVELS OF SERVICE

Levels of service provide the means to measure customers' needs and expectations of the City and the services provided, and offers a mechanism for communicating costs of services. The level of service metrics selected are driven by the City's Vision, Mission and Values and are therefore focused on the impact to citizens, communities and the natural environment. This section outlines an initial set of levels of service targets for CGS's water and wastewater systems.

MISSION, VISION AND VALUES	OBJECTIVE	IMPLICATION TO ASSET MANAGEMENT PLAN
To support a growing community with quality municipal services	To ensure that all growth is well managed, well designed and sustainable.	New/upgraded infrastructure projects are focused in designated areas as outlined in the City's strategic planning documents. The recommendations from the Water and Wastewater Master Plan have been explicitly integrated into the Asset Management Plan's financial strategy.
To demonstrate innovative leadership amongst northern communities	Embrace infrastructure asset management as a best practice throughout the organization and become an Asset Management leader amongst Northern Ontario Municipalities	This first edition of the Asset Management Plan aims to move beyond basic asset management practices. Its development has included updates to the asset registry through data scrubbing efforts, identification of initial Levels of Service aligned with the City's core objectives, a detailed Risk analysis considering actual infrastructure failure records and advanced deterioration modeling, and a corridor-based Long-Term Financial Plan integrated with the City's Water and Wastewater Master Plan that will support future efforts to provide sustainable services to the community.
Acting today in the interests of tomorrow	Develop a strategic Asset Management Plan that relies upon social, environmental and financial risk as a means to prioritize infrastructure investment decisions	A risk-based prioritization framework has been introduced in this AMP to facilitate strategic infrastructure decision-making. Further, integration of the Water and Wastewater Master Plan recommendations provides an overall Plan that considers not only the ongoing management of existing infrastructure but also development to meet future needs.

A customer satisfaction survey or measure of willingness to pay, was not undertaken as part of this iteration of the City's Asset Management Plan. Future asset management initiatives and updates to the Asset Management Plan should focus on stakeholder and community engagement in developing Levels of Service.

Some of the City's stakeholders include:

- Regulatory bodies
- City of Greater Sudbury community, visitors
- Local industry
- City Council
- City Departments

ES 3. ASSET MANAGEMENT STRATEGY

Recommended works were classified based on four (4) lifecycle strategies (operations & maintenance strategies, renewal / rehabilitation strategies, capital replacement strategies, and disposal strategies), expansion strategies and non-infrastructure strategies. Following the identification of investments expected over the full asset lifecycles, the projected reinvestment needs were compared to the current annual capital budget to determine the adequacy of the funding for the sustainability of the infrastructure.

The importance of prioritizing the implementation of these strategies based on a risk-driven framework has been emphasized. A set of maps and prioritized lists have been developed to this end: A summary of the vertical inventory and detailed risk maps for the linear network are attached as Appendices A and B to this report respectively. The digital media accompanying this report includes asset-level risk rates, and also digital versions of prioritized lists of projects for (1) Facilities Renewal Projects (2) Watermains Projects (3) Sanitary Sewer Projects and (4) Water system valves. These are projects that have been identified as critical and aging infrastructure, and should be monitored and inspected to ensure acceptable levels of risk.

Additional work was completed to assess the watermains. Historic break data has been geocoded, and capital projects have been prioritized based on this failure data and the AMP's criticality framework; a prioritized list is attached as Appendix C to this report. Combined, the age-based approach and the failure driven approach serve as a first step towards a risk-driven asset renewal framework; further development of this framework into comprehensive physical and economic lifecycle models will enable optimized asset renewal decision making.

ES 4. FINANCIAL STRATEGY

To answer the question "What is the right level of capital investment necessary to achieve long-term sustainability?" a decision support framework was developed specifically for the CGS inventory, to simulate the long-term impact of varying funding scenarios over the entire asset portfolio.

Applying the risk framework and deterioration models, different funding scenarios were simulated and the impacts to the overall system risk and level of service were assessed. Optimal expenditure forecasts were identified to determine the annual investment required for infrastructure sustainability, and these projected infrastructure investment needs were compared to the City's historical expenditures to identify potential funding gaps. A long term annual capital expenditure of $50M was identified as being a sustainable investment for asset renewal strategies on the existing system; integrating the Master Plan recommendations along with additional costs that have been associated with these projects from an asset management perspective, require an average annual capital expenditure of $100M until at least 2036. Recommended Capital expenditures are presented in the following table for five 5-year horizons:

Horizon	Annual Capital Budget (Million $)	Annual Capital Budget (Million $) – Including Master Plan Recommendations
2018-2021	50	110
2022- 2026	50	90
2027-2031	50	110
2032-2036	50	90
2037-2041	50	50

ES 5. NEXT STEPS

Next steps have been provided at the end of each section of this Plan to identify how the City can continue to develop and update this Asset Management Plan in the future. A summary of these next steps is provided in the following table.

SECTION	CATEGORY	RECOMMENDATIONS
2 - State of Infrastructure	General	• Implement comprehensive asset identification standards • Refine and improve risk framework introduced in this AMP
	Linear Infrastructure	• Define clear relationship and editing procedures between the hydraulic model and the GIS; minimize double efforts and provide one source of data • Capture installation dates from all relevant sources • Accurately link pipe failure and condition data to allow for seamless computation. Implement mobile solutions for on-site capturing of high resolution data. • Implement corridor based strategic planning
	Vertical Infrastructure	• Enhance vertical infrastructure asset inventory granularity, accuracy, and completeness
3 - Levels of Service	Community and Technical Levels of Service	• Collect and document Performance Measures • Identify customer expectations and willingness to pay through a Public Consultation Process
4 - Asset Management Strategy	Lifecycle Interventions	• Review and refine strategies
	Risk-based prioritization	• Refinement of the deterioration model for gravity mains, sanitary sewer mains and watermains • Develop and refine practices for documenting and maintaining critical customers and assets • Develop physical and economic failure models • Develop risk ratings for each W&WW facility • Undertake detailed condition assessments for each facility
5 - Financial Strategy	Funding Sources	• Determine the appropriate strategies to fund the identified investment needs and recommendations.

The key challenges and next steps identified in this AMP for the management of the City of Greater Sudbury's water and wastewater systems are (1) Securing a sustainable budget as identified in this AMP for both the Master Plan recommendations and the ongoing asset renewal needs (2) Updating the Levels of Service framework with input from a public consultation process (3) Implementing a risk driven infrastructure management framework (4) Implementing a corridor based planning approach that takes into consideration needs of other infrastructure disciplines, mainly roads (5) Continuous improvement of data collection and management practices.

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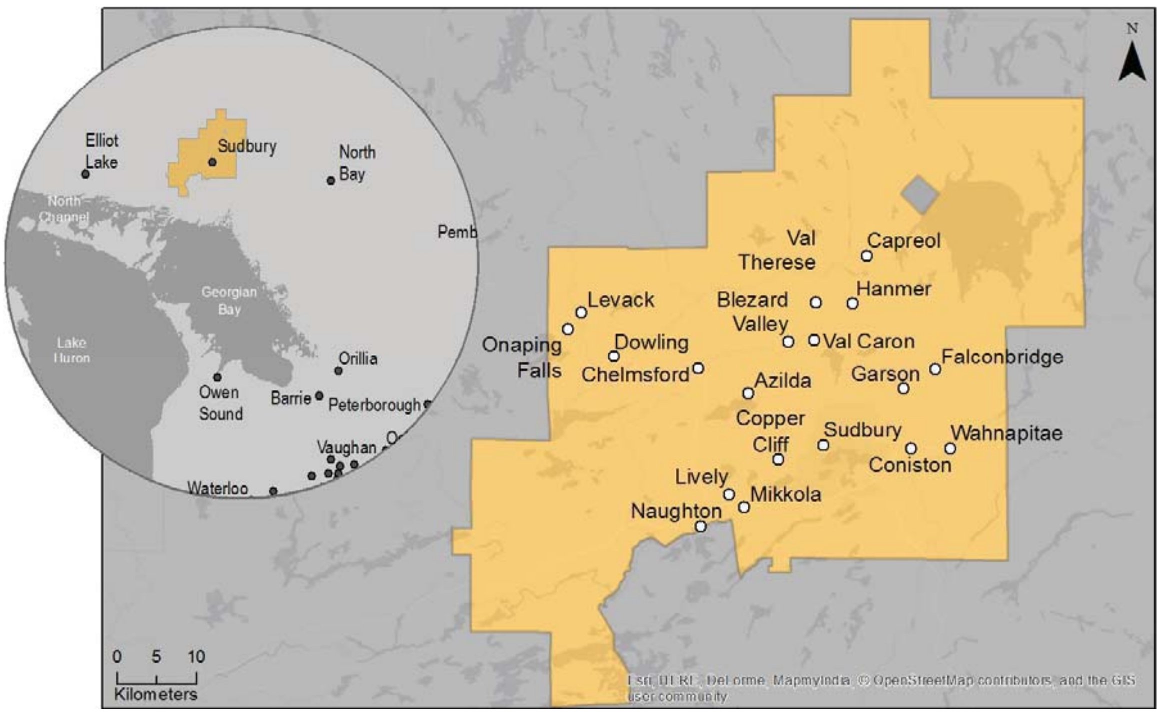
INTRODUCTION

1 INTRODUCTION

1.1 CITY OF GREATER SUDBURY

The City of Greater Sudbury (City, CGS) is located in Northeastern Ontario at the convergence of Trans-Canada Highway and Highway 69 south (Map 1-1). Formed on January 1st, 2001, the City is geographically the largest municipality in Ontario and serves as the regional capital of Northeastern Ontario

Map 1-1 City of Greater Sudbury



1.2 BACKGROUND & CONTEXT OF THE ORGANIZATION

1.2.1 INTERNAL CONTEXT

The City has established the following vision, mission, and values:

VISION - A growing community, recognized for innovation, leadership, resourcefulness and a great northern lifestyle.

MISSION - Providing quality municipal services and leadership in the social, environmental and economic development of the City of Greater Sudbury.

VALUES - As stewards of the City of Greater Sudbury, we believe in recognizing the specific needs of all our citizens in urban, rural and suburban areas, and are guided by our belief in:

- Acting today in the interests of tomorrow
- Providing quality service with a citizen focus
- Embodying openness and transparency
- Communicating honestly and effectively
- Creating a climate of trust and a collegial working environment to manage our resources efficiently, responsibly and effectively
- Encouraging innovation, continuous improvement and creativity
- Fostering a culture of collaboration
- Ensuring an inclusive, accessible community for all
- Respecting our people and our places.

As part of the City's "open doors" theme of Open Government, strategic planning in the City of Greater Sudbury is a valuable tool for performance measurement with a focus on who the municipality serves, what the municipality does and why, in both the immediate and long-term. Strategic planning can help define where the City is going and evaluate outcomes for success. This strategic planning is used to set priorities, focus energy and resources, strengthen operations, establish common goals for employees and elected officials, achieve agreement on intended outcomes, and assess and adjust operations in response to a changing environment.

This Asset Management Plan supports the City's internal objectives by linking planned asset strategies with the City's mission of providing quality municipal services in a transparent, open manner.

1.2.2 EXTERNAL CONTEXT

The Ontario Ministry of Infrastructure's "Building Together Guide" (June 2011), indicates that any municipality seeking provincial infrastructure funding must demonstrate how its proposed project fits within a detailed Asset Management Plan. This helps to ensure that limited resources are directed to the most critical needs.

Ontario Bill 6, Infrastructure for Jobs and Prosperity Act, received Royal Assent on June 4, 2015. The purpose of the Act was to establish mechanisms to encourage principled, evidence-based and strategic long-term infrastructure planning. Clause 6 of the Bill states that every broader public sector entity must prepare infrastructure Asset Management Plans. Proposed projects are anticipated to be evaluated, in part, on whether or not they were contemplated by the established Plans.

WSP was retained to undertake the development of a comprehensive Water and Wastewater Asset Management Plan (AMP, Plan) that the City of Greater Sudbury can utilize to assist with decisions regarding the building, operating, maintaining, renewing, replacing, disposing and funding of their water and wastewater infrastructure assets. This Plan has been developed in compliance with the *Building Together* Guide, Ontario Bill 6, and in general conformance with the requirements of ISO 55001. In accordance with the Ontario Ministry of Infrastructure's "Guide for Municipal Asset Management Plans," the Plan has been structured based on the following sections.

0. Executive Summary
1. Introduction
2. State of Infrastructure
3. Levels of Service
4. Asset Management Strategy
5. Financing Strategy
6. Next steps

1.3 PURPOSE

The objective of this Water and Wastewater Asset Management Plan is to provide a strategic document that will guide decisions related to how the City's water and wastewater infrastructure will be managed to most efficiently and effectively allocate resources in a manner that will meet the City stakeholders desired levels of service for the lowest overall lifecycle costs.

The purpose of developing this Asset Management Plan for the City is to identify the costs and benefits of infrastructure investment decisions across the organization's water and wastewater asset portfolio. Over-investment in one area can lead to an under-investment in another. To demonstrate the impact of investment decisions, target Levels of Services were set so that performance against these targets could be measured. A Financial Plan is included in the Financial Strategy section of this document which shows how current levels of investment are measuring up against the investments needs. This Plan will help to demonstrate the impacts of investment decisions across the organization.

1.3.1 RELATIONSHIP TO OTHER PLANNING DOCUMENTS

This Asset Management Plan does not stand apart, or alone in assisting the City in the sustainable planning of infrastructure investment. Reliance upon other targeted planning documents is how the overall asset strategy will be formulated. This document has already drawn upon the valuable work completed under other planning documents such as the

- City of Greater Sudbury Water and Wastewater Master Plan, WSP (on-going)
- City of Greater Sudbury Transportation Master Plan, WSP|MMM (on-going)
- Inventory and Valuation of Tangible Capital Assets Report, RV Anderson (2009)
- Condition Assessment of Lift Stations, Associated Engineering (2016)
- Condition Assessment and Capital Needs Plan – Valley East WWTP, AECOM (2016)
- Other internally developed planning resources

1.4 SCOPE OF THE ASSET MANAGEMENT PLAN

This Asset Management Plan only documents the asset management strategy for the City's Water and Wastewater systems, and does not include infrastructure that is privately owned and maintained. It is to be noted here, that the AMP did not include other infrastructure in the same corridor of the water/ wastewater infrastructure, such as roadways, sidewalks etc. The City of Greater Sudbury has an enormous Water & Wastewater System servicing various communities. It contains six distinct water systems and 13 independent wastewater systems. The linear infrastructure consists of approximately:

Water

- 997 km of watermains;
- 533 km of service connections;
- 5,699 hydrants;
- 8,950 system valves;
- 90 control valves;

Wastewater

- 769 km of gravity mains;
- 22.2 km of rock tunnel;
- 9.3 km of pressurized sanitary sewer mains;
- 381 km of lateral service connections;
- 11,726 maintenance holes;

- 2,792 valve chambers;
- 47,940 water meters;
- 6 water meter stations.
- 21 drop shafts;
- 70 control valves.

The City is also responsible for the operating and maintenance of approximately 143 water and wastewater facilities. There are 60 water facilities including 12 booster stations, 13 small water systems, 1 raw water pump station, 1 pressure control building, 9 water storage facilities, 2 water treatment plants, 2 small treatment facilities, as well as 20 water well houses. Additionally, there are 83 wastewater facilities including 69 lift stations, 4 wastewater lagoons, as well as 10 wastewater treatment plants.

This Plan has been developed considering a twenty-five year planning horizon, from 2017 to 2041. Readers should keep in mind that forecasts towards the end of the planning horizon are intrinsically less reliable than those that can be associated with recent condition assessments. As such, it is anticipated that this Plan will be treated as a living document to be updated as contexts change and at no less frequent a rate than once every five years.

1.5 ASSET MANAGEMENT OBJECTIVES

The objectives of this AMP are:

- To identify the current state of the City's water and wastewater infrastructure from the perspective of condition, performance, and risk;
- To establish an initial Level of Service for the City's water and wastewater infrastructure that enables measurement of initiatives associated with "providing quality municipal services;"
- To forecast water and wastewater infrastructure needs, aligned with corporate objectives, over a twenty-five year planning horizon; and
- To identify opportunities for improvement to the City's asset management system, in support of the City's vision of innovation.

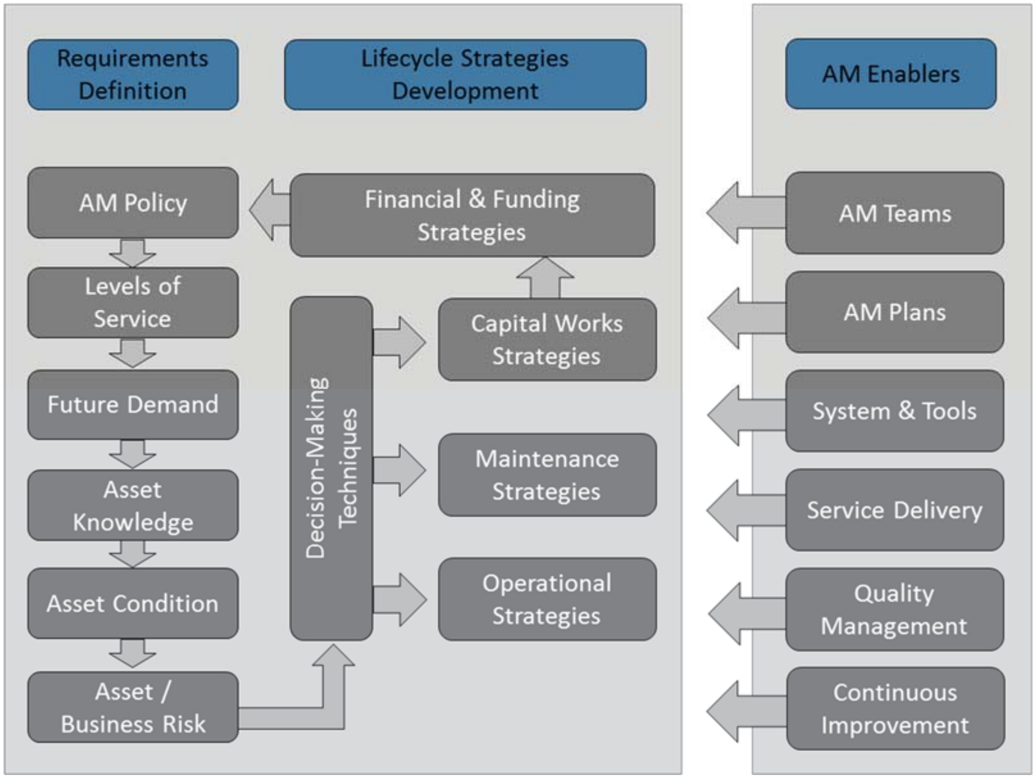
1.6 DEVELOPMENT OF THE ASSET MANAGEMENT PLAN

Future government funding of infrastructure projects will be contingent on an Asset Management Plan and therefore these asset categories were selected as a starting point for Asset Management within the City of Greater Sudbury to match with potential future funding programs.

This document should be re-evaluated on a five year basis. This Asset Management Plan has been developed so that regular updates can be made to reflect the changing needs and funding levels of the City's infrastructure.

The management framework presented in the International Infrastructure Management Manual (Figure 1-1) outlines the relationship between the processes and procedures being presented in this Plan.

Figure 1-1 Typical Asset Management Framework



An asset management strategy as presented in this document is a way of managing assets with the intention of delivering the City's services at the lowest lifecycle cost. This Plan is a framework that presents a strategy for best management of the City's infrastructure on an annual basis. Although certain principles of asset management such as Condition Assessment, Levels of Service and Capital Planning are addressed within this document, these are high level approaches and assessments that are to be refined as the City's asset management strategies grow. This Asset Management Plan will require on-going and continual work to ensure its success.

1.7 ASSET MANAGEMENT PLAN NEXT STEPS

This Plan is recommended to be re-evaluated on a five year basis. The timeline for the revision is as follows:

Year 1 - 2018: Validate asset inventory, track and develop reporting practices and procedures

Year 2 - 2019: Update inventory, collect condition and performance information

Year 3 - 2020: Audit results from previous AMP, collect condition and performance information

Year 4 - 2021: AMP development to begin

Year 5 - 2022: Publish revised AMP

Revision of this subject area AMP will be led by Water/Wastewater services, but coordinated with Infrastructure Capital Planning to ensure continuity between divisional Plans.

STATE OF INFRASTRUCTURE

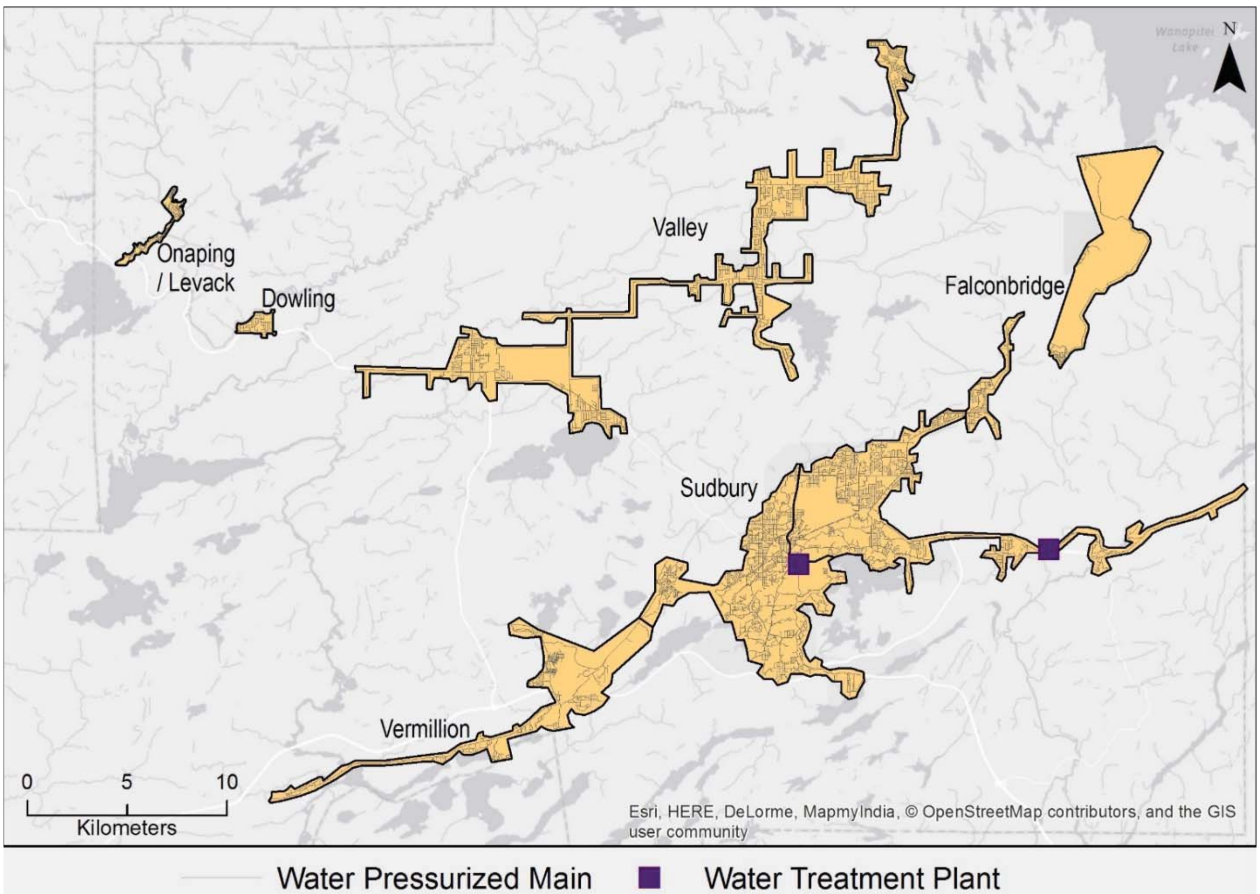
2 STATE OF INFRASTRUCTURE

2.1 SYSTEM OVERVIEW

The City of Greater Sudbury owns and operates six (6) municipal water supply systems (Map 2-1) and thirteen (13) independent wastewater systems (Map 2-2) that service the various communities in the City.

Key asset inventory information including location, size, length, material, year of installation and other attribute information is included in the digital asset inventory provided with this AMP.

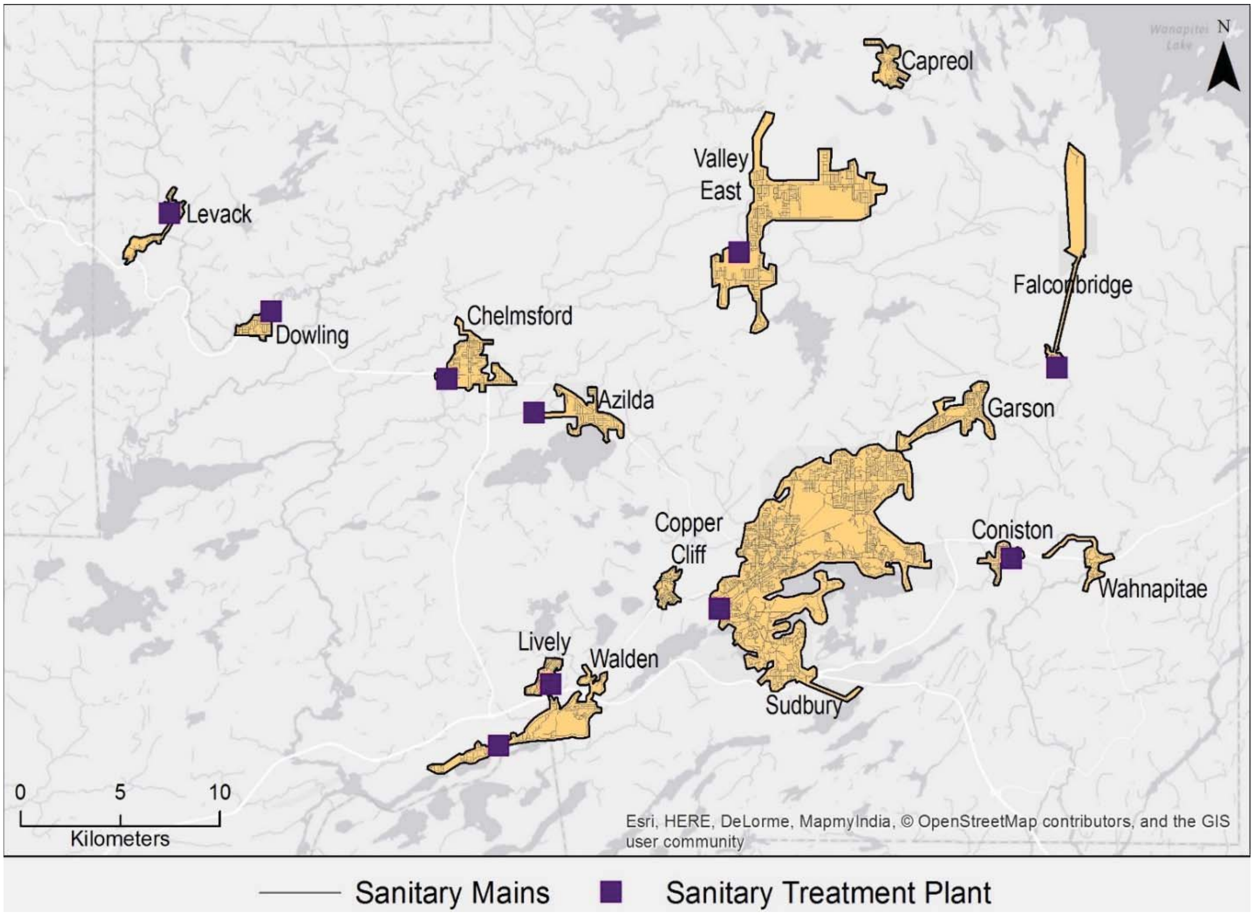
Map 2-1 Greater Sudbury Water System Map



The City of Greater Sudbury's Water System consists of:

- Valley Water System
- Onaping - Levack Water System
- Dowling Water System
- Vermilion Water System
- Sudbury Water System
- Falconbridge Water System

Map 2-2 Greater Sudbury Wastewater System Map



The City of Greater Sudbury's Wastewater System consists of:

- Onaping - Levack Wastewater System
- Dowling Wastewater System
- Chelmsford Wastewater System
- Valley Wastewater System
- Azilda Wastewater System
- Copper Cliff Wastewater System
- Lively / Walden Wastewater System
- Sudbury Wastewater System
- Coniston Wastewater System
- Wahnapitae Wastewater System
- Garson Wastewater System
- Falconbridge Wastewater System
- Capreol Wastewater System

2.2 DATA SOURCES

The foundational information used for the development of the state of vertical infrastructure in this Asset Management Plan is based on the 2015 City's Water and Wastewater Tangible Capital Asset Inventory. This information was augmented by the 2016 City of Greater Sudbury Water and Wastewater infrastructure Geographic Information System (GIS) data as well as the Water and Wastewater Master

Plan hydraulic model. Where more recent data meeting the requirements of this Plan was available, best efforts were made to incorporate the newer data.

The main data source for the linear inventory is the CGS 2016 GIS database. Where available, data from the hydraulic models of the W&WW Master Plan were used to supplement missing data, mainly for missing diameters, materials and installation years.

The following sections describe the City of Greater Sudbury's Water and Wastewater asset portfolio in terms of (1) quantity, (2) replacement value, (3) age, (4) condition, and (5) risk. A detailed asset-level inventory is attached as digital media to this report. In addition, a summarized Facility Inventory is provided as Appendix A to this report; and a complete set of Linear Risk Map is provided as Appendix B. These lists and summaries provide an overview of the City's water and wastewater portfolio based on desktop estimations for the different aspects of the existing infrastructure. These estimations will then serve as the basis for forecasting the expenditure needs in the following sections.

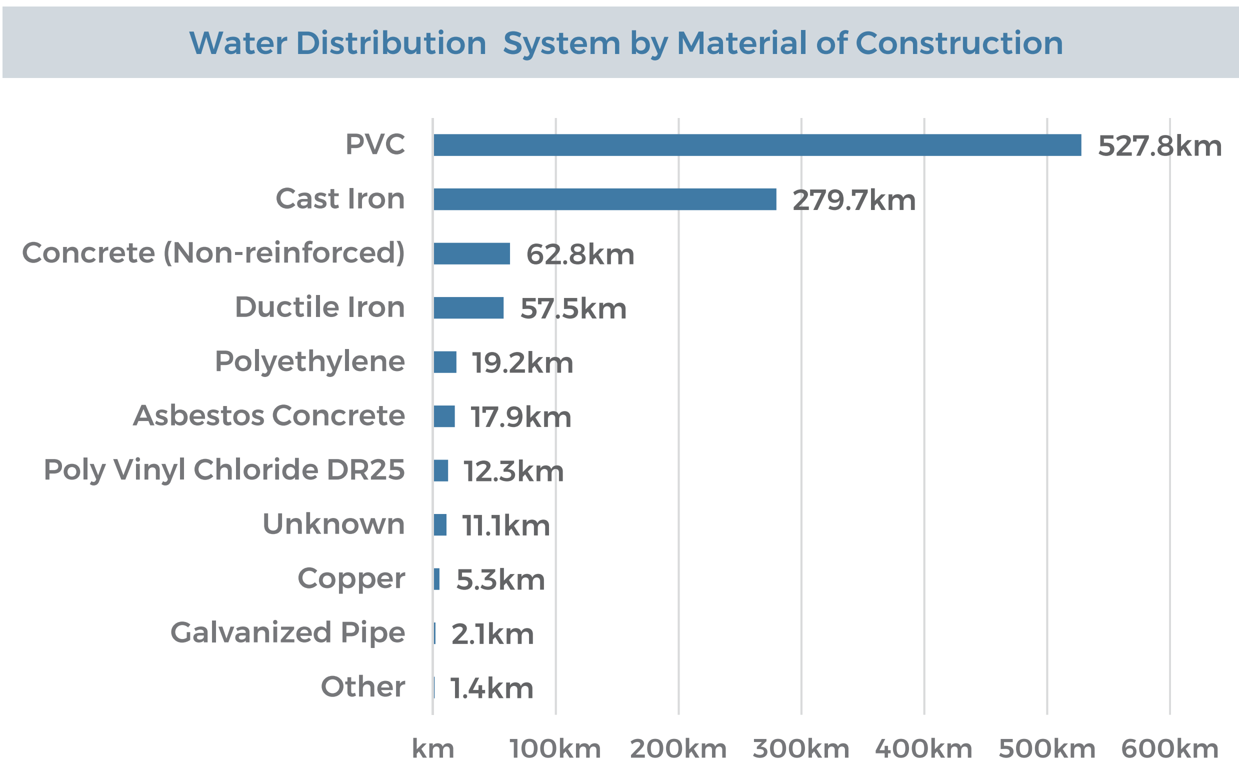
2.3 ASSET PORTFOLIO SUMMARY

2.3.1 PORTFOLIO BY QUANTITY

WATER SYSTEM

The City of Greater Sudbury is responsible for the operation and maintenance of approximately 997 km of watermains (Figure 2-1), 5,699 fire hydrants, 8,950 valves, 2792 valve chambers, 533 km of service connections, 90 control valves, 47,940 water meters, and 6 water meter stations. Within the City of Greater Sudbury, the Sudbury municipal water system includes 553 km of watermains, making it the largest independent water distribution system. The second largest water distribution system is the Valley Water System (281 km of watermains). Both systems contribute approximately 84% to the total length of the watermains in the City.

Figure 2-1 Watermains Length by Material

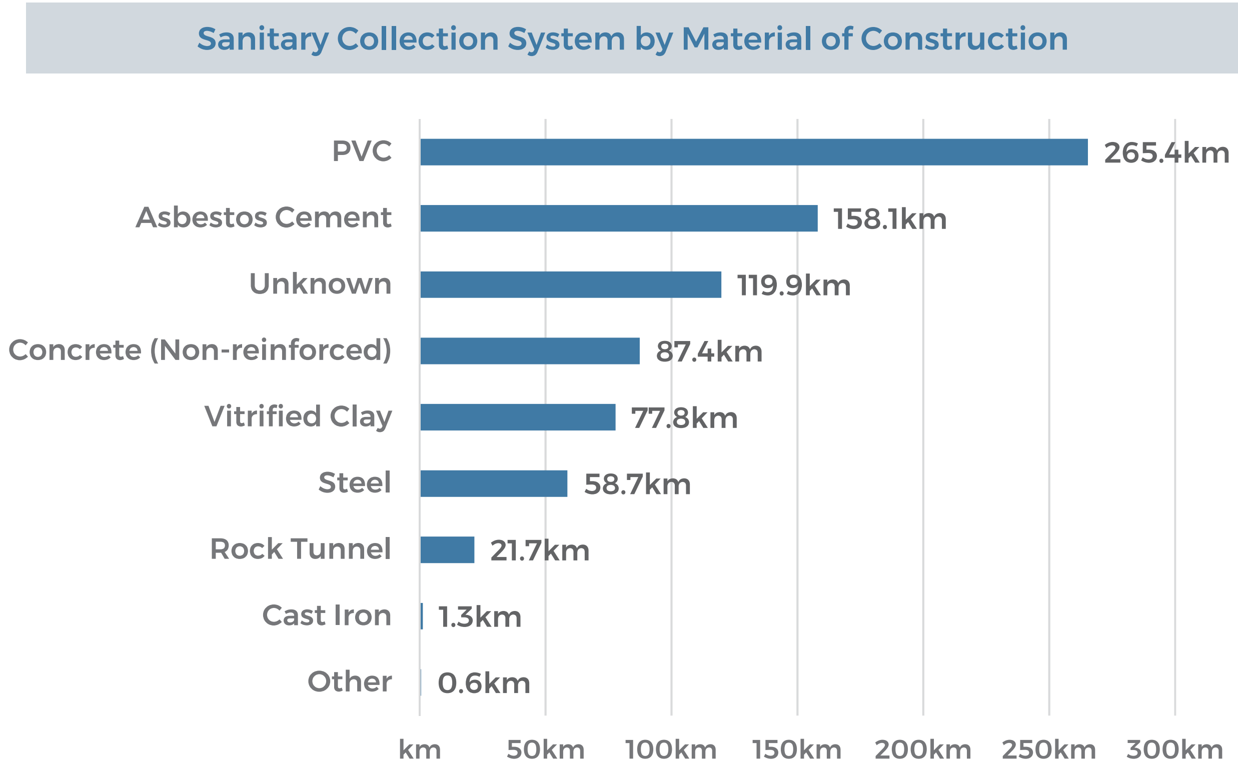


The City is also responsible for the operation and maintenance of approximately 60 water facilities, including 12 booster stations, 13 small water systems, 1 raw water pump station, 1 pressure control building, 9 water storage facilities, 2 water treatment plants, 2 small treatment facilities, and 20 water well houses. As is common with asset inventories, some discrepancies have been noted in datasets utilized in preparing this AMP. Best practice recommends continual verification and validation of asset data through future works. It is recommended that the Valley Water System dataset be given priority for verification, because of known or suspected discrepancies in the record data.

WASTEWATER SYSTEM

The City of Greater Sudbury is responsible for the operation and maintenance of approximately 791 km of sanitary sewers including 21.7 km of rock tunnel (Figure 2-2) , with 381 km of service connections, 9.7 km of sanitary pressurized sewers, 11,726 maintenance holes, 70 control valves and 21 drop shafts.

Figure 2-2 Sanitary Sewers Length by Material



The City is also responsible for the operation and maintenance of approximately 83 wastewater facilities, including 69 lift stations, 4 wastewater lagoons, and 10 wastewater treatment facilities.

2.3.2 PORTFOLIO BY REPLACEMENT VALUE

A 2017 estimated replacement value for each asset was developed for all assets in the water and wastewater portfolio. The assumed vertical infrastructure replacement values used in this Plan are based on the replacement costs assigned to each facility under the 2015 Tangible Capital Asset reporting update and escalated forward to 2017 at a rate of 2% per year to determine the 2017 replacement cost. The linear infrastructure replacement costs used in this Plan are based on the Linear Water Infrastructure Cost Estimation parameters, developed for the Master Plan. Summaries for the water linear, water vertical, wastewater linear and wastewater vertical infrastructure are provided in the following pages; total replacement for the entire inventory is estimated at $4.5 Billion.

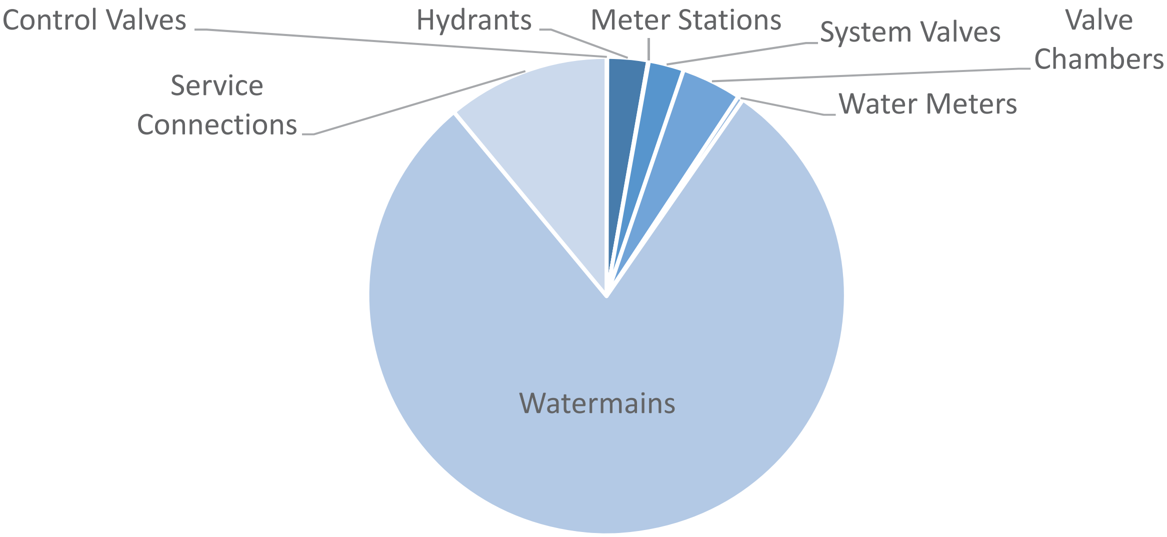
Water Linear Infrastructure Replacement Value:

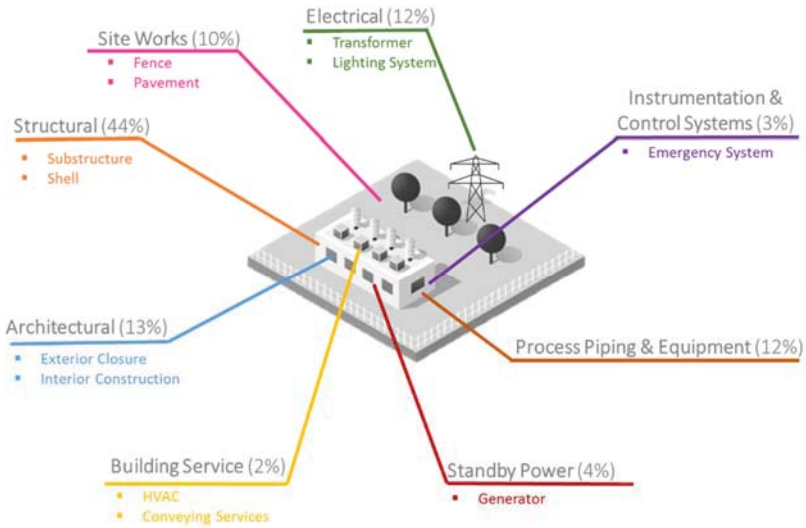
$2,170M

Table 2-1 Water Linear Infrastructure Replacement Value by Asset Type

ASSET TYPE	QUANTITY	REPLACEMENT VALUE (MILLION)
Watermains (km)	997	$1,720.9
Service Connections (km)	533	$239.2
System Valves	8950	$51.8
Control Valves	90	$0.8
Hydrants	5699	$59.6
Meter Stations	6	$1.2
Valve Chambers	2792	$87.9
Water Meters	47940	$8.23

Figure 2-3 Water Linear Infrastructure Replacement Value by Asset Type





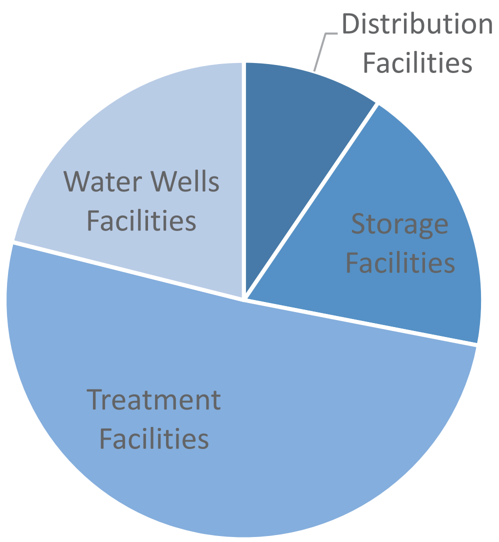
Water Vertical Facilities Replacement Value:

$179M

Table 2-2 Water Vertical Facilities Replacement Value by Facility Type

FACILITY TYPE	QUANTITY	REPLACEMENT VALUE (MILLION)
Distribution Facilities	26	$17.0
Storage Facilities	9	$33.3
Treatment Facilities	2	$91.2
Water Wells Facilities	20	$37.8

Figure 2-4 Water Vertical Facilities Replacement Value by Facility Type



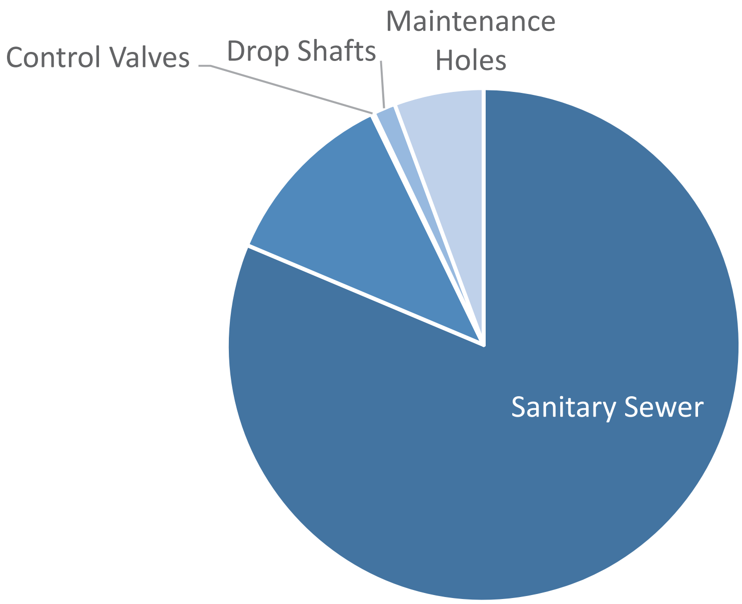
Wastewater Linear Infrastructure Replacement Value:

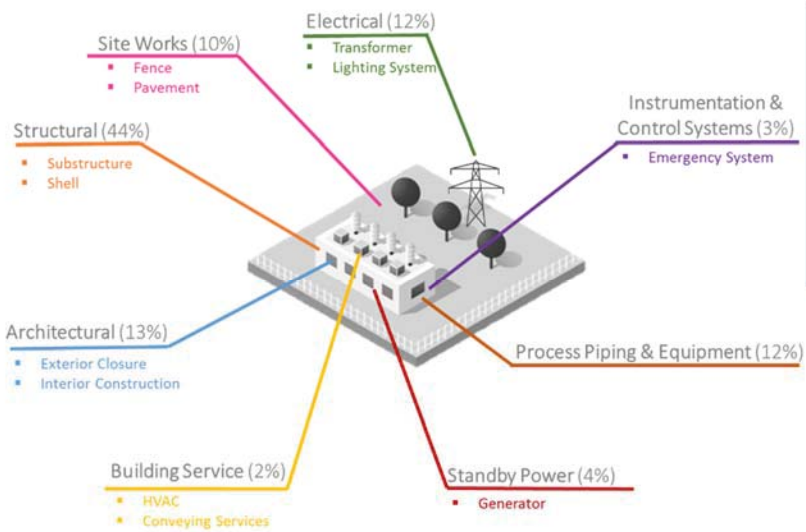
$1,493M

Table 2-3 Wastewater Linear Infrastructure Replacement Value by Asset Type

ASSET TYPE	QUANTITY	REPLACEMENT VALUE (MILLION)
Sanitary Sewer (km)	791 km	$1,215
Lateral Connections (km)	381 km	$171
Control Valves	70	$2.4
Drop Shafts	21	$21
Maintenance Holes	11,726	$84

Figure 2-5 Wastewater Linear Infrastructure Replacement Value by Asset Type





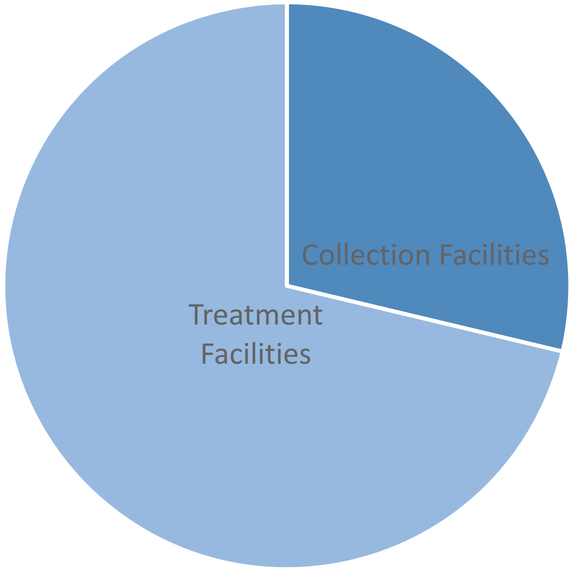
Wastewater Vertical Facilities Replacement Value:

$655M

Table 2-4 Wastewater Vertical Facilities Replacement Value by Facility Type

FACILITYFUNCTION	QUANTITY	REPLACEMENT VALUE (MILLION)
Collection Facility	69	$188.0
Treatment Facility	14	$466.5

Figure 2-6 Wastewater Vertical Facilities Replacement Value by Facility Type



2.3.3 PORTFOLIO BY ASSET AGE

EXPECTED SERVICE LIFE

Asset service life estimates (Table 2-5, Table 2-6, Table 2-7) were developed based on industrial accepted standards and local experience of City staff. In cases where material data was missing, this field was populated based on the material used in the hydraulic model, if available.

Table 2-5 Linear Asset Expected Service Life (Years) by Material

Material	Description	Water Mains	Sewers
AC	Asbestos Cement	55	55
CI	Cast iron	60	60
CIPP	Cured in place	80	-
COP	Copper	60	-
CP	Concrete (non-reinforced)	95	90
DI	Ductile iron	40	40
GP	Galvanized pipe	60	-
HDPE	High density polyethylene	80	80
PE	Polyethylene	55	55
PVC	Poly vinyl chloride	105	105
SP	Steel	60	60
UNK	Unknown	60	60
VC	Vitrified Clay	-	55

Table 2-6 Expected Service Life (Years) for Water Appurtenances

Description	Expected Service Life
Hydrants	60
System Valves	40
Control Valves (PRV, SRV, ARV)	30
Service Connections	60
Water Meters	20
Maintenance Holes and Chambers	70

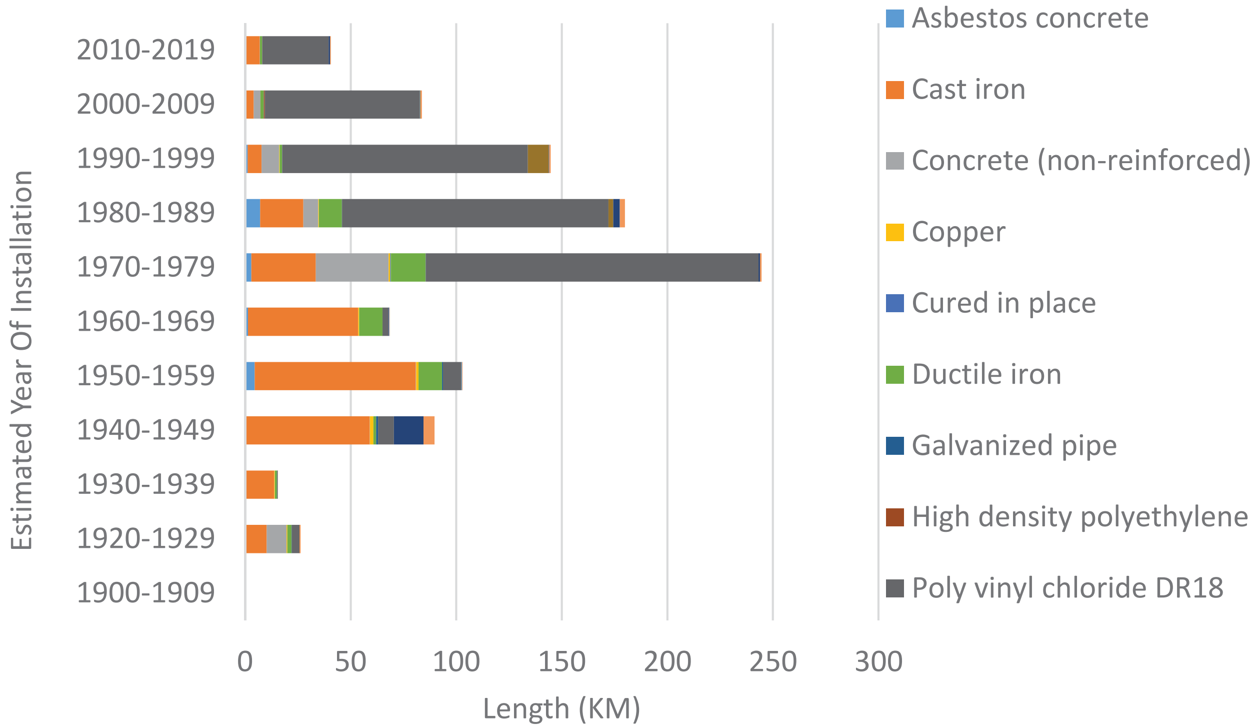
Table 2-7 Vertical Facility Assets Expected Service Life (Years)

Lifecycle Category	Water	Wastewater
Structural	80	80
Architectural	20	20
Building Services	20	20
Site Works	25	25
Process Piping & Equipment (PP&E)	30	25
Electrical	30	30
Instrumentation & Control Systems and Life Safety & Compliance Systems (I&CS)	15	15
Standby Power	25	25
Sanitary Forcemain	-	Varies by material per linear inventory

WATER SYSTEM

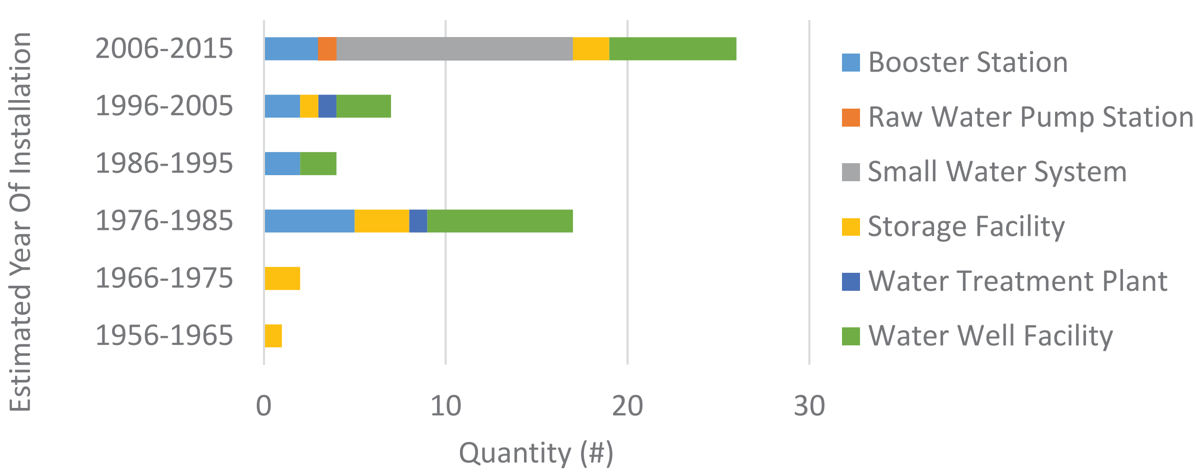
Installation dates for the linear water dataset were captured from both the City's GIS dataset and the hydraulic models; Considerable GIS analysis was applied to integrate those two data sets, and to estimate missing installation dates based on adjacent infrastructure. Examination of the age distribution of watermains in the City of Greater Sudbury (Figure 2-7) shows that the 1970's –1990's have witnessed a considerable construction phase, along with the wide spread implementation of PVC pipes.

Figure 2-7 Watermains Material Distribution by Year of Installation and Length[1]



The majority of the water facilities in the City of Greater Sudbury were constructed in the 2000s. The Falconbridge Tank is one of the oldest water facilities in the City. A summary of age distribution by facility type is shown in Figure 2-8.

Figure 2-8 Water Facilities Age Distribution by Facility Type

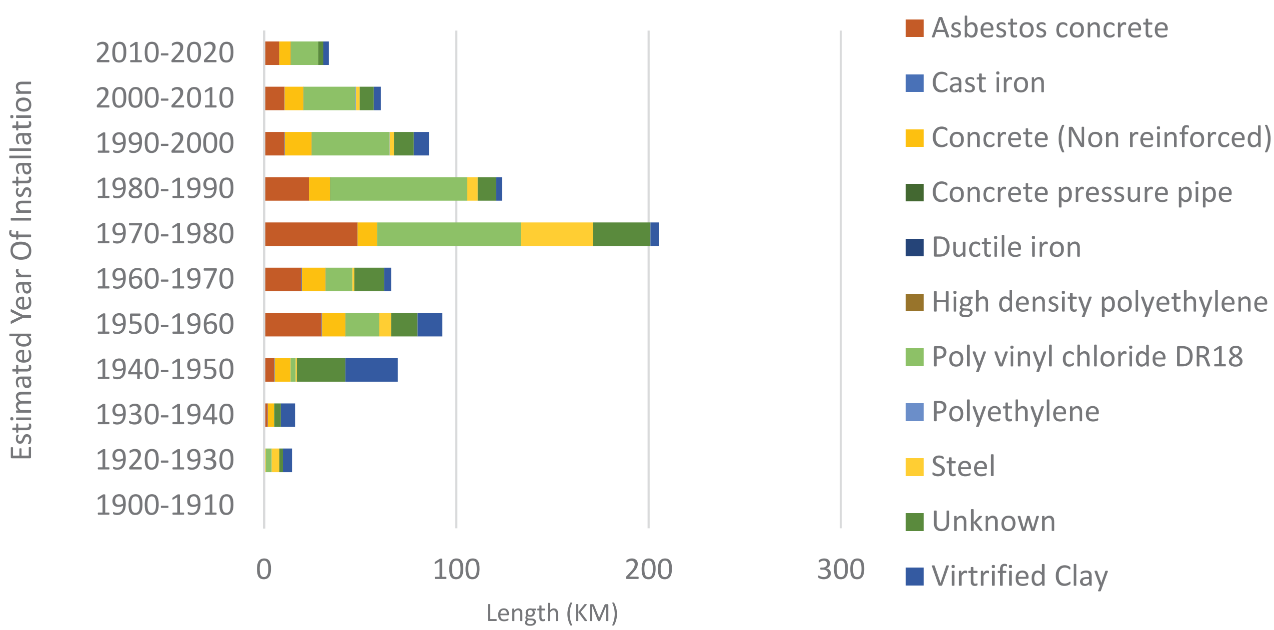


[1] In some cases, material documented for infrastructure that has been replaced\rehabilitated may still reflect the originally installed material.

WASTEWATER SYSTEM

Installation dates for the sanitary sewers were not available and were estimated based on adjacent watermains. The ages of the sanitary sewers in the City of Greater Sudbury (Figure 2-9) is expected to follow a similar distribution as the water linear infrastructure, with considerable installations in the 1970's – 1990's.

Figure 2-9 Sanitary Sewer Age Distribution



The majority of the wastewater facilities in the City of Greater Sudbury were constructed before the 1980s. The St. Charles, Nickel, Lagace Lift Station and Lakeview Lift Station are among the oldest wastewater facilities in the City. They were originally constructed in 1946. A summary of age distribution of facilities is shown in Figure 2-10.

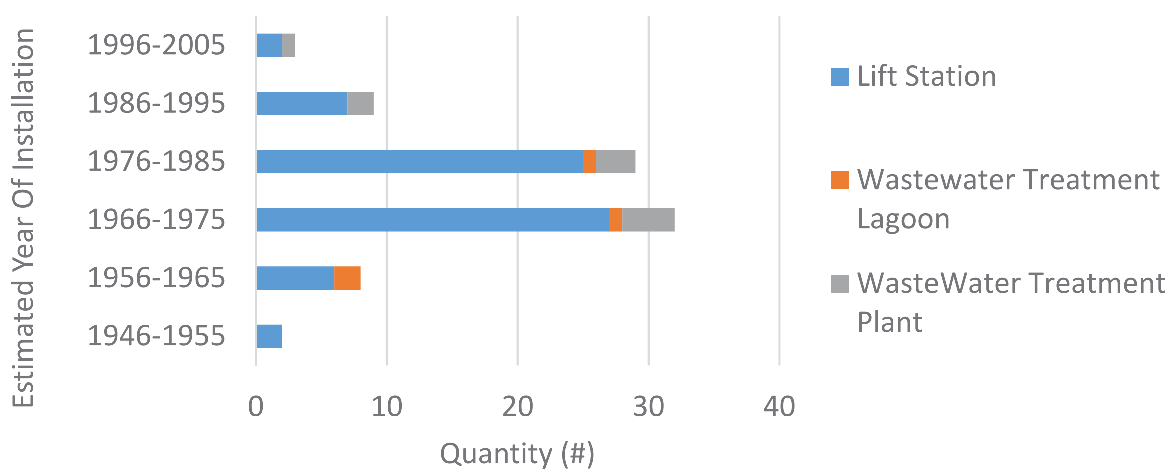


Figure 2-10 Wastewater Facilities Age Distribution

2.3.4 PORTFOLIO BY CONDITION

CONDITION RATING SCALE

Asset condition was assigned to the City's Water and Wastewater infrastructure based on asset life expectancy and asset age. Condition scores (Table 2-8) were assigned using a rating system of 1 (early stage of lifecycle) to 5 (reaching or beyond expected useful service life).

Table 2-8 Asset Condition Rating Scale

Rating	Grade	Definition	Description
1.0 – 1.3	A+	0-30% of Expected Service Life	Typically very good condition; perform normal maintenance
1.4 – 1.6	A		
1.7 – 1.9	A-		
2.0 – 2.3	B+	30-50% of Expected Service Life	Typically good condition; perform normal maintenance.
2.4 – 2.6	B		
2.7 – 2.9	B-		
3.0 – 3.3	C+	50-75% of Expected Service Life	Typically fair condition; significant maintenance, small dollar amount
3.4 – 3.6	C		
3.7 – 3.9	C-		
4.0 – 4.3	D+	75-95% of Expected Service Life	Typically poor condition; requires major rehabilitation, large dollar amount
4.4 – 4.6	D		
4.6 – 4.9	D-		
5.0	F	>95% of Expected Service Life	Typically very poor condition; requires asset replacement, replacement cost.

WATER SYSTEM

While the majority of linear assets in the City of Greater Sudbury's water portfolio, by length, are at their first half of expected service life and are therefore assumed to be in good condition (Figure 2-11), approx. 25% of the network is assumed to be in very poor condition, in many cases having significantly surpassed the infrastructure's useful lives. These portions of the network typically heavily affect O&M costs and capital investment needs; the financial impact of this group of assets is demonstrated in the financial strategy section of this report. The assumed condition of the watermains varies significantly by material (Table 2-9).

Figure 2-11 Watermains Expended Service Life by Length (km.)

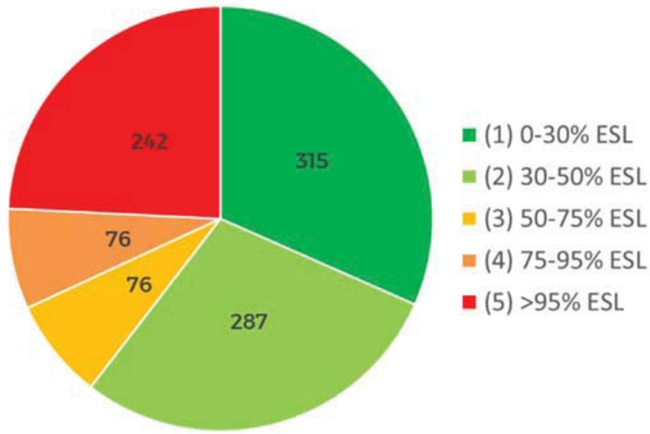


Table 2-9 Watermains Condition By Material

MATERIAL	AVERAGE AGE (YEARS)	EXPECTED SERVICE LIFE (YEARS)	AVERAGE CONDITION RATING	CONDITION GRADE
PVC	31	105	1.5	A
Concrete	47	95	2.3	B+
High Density Polyethylene	10	80	1.1	A+
Cured in place	38	80	2	B+
Steel	17	60	1.4	A
Galvanized pipe	66	60	4.7	D-
Copper	62	60	4.4	D
Cast iron	58	60	4.2	D+
Polyethylene	61	55	4.4	D
Asbestos Concrete	44	55	3.7	C
Ductile Iron	49	40	4.6	D

Most water facilities in the City due to their age, are expected to be in good condition (Figure 2-12, Table 2-10). Yet once again the dominant "Very Poor" group greatly affects the overall condition of the facilities and drives the maintenance and rehabilitation needs which will be discussed further.

Figure 2-12 Water Facilities Expended Service Life by Replacement Cost

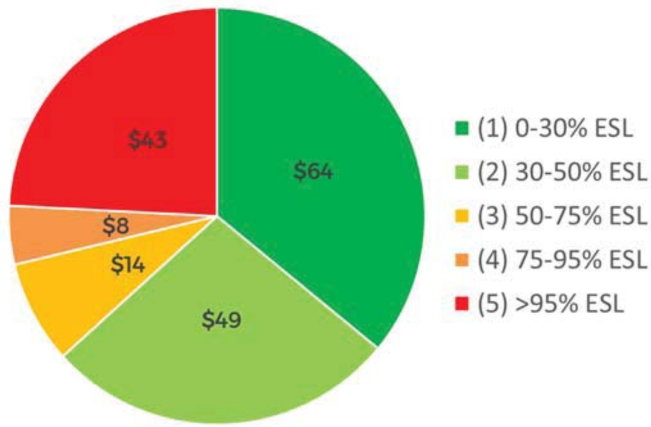


Table 2-10 City of Greater Sudbury Average Facility Condition by Facility Type

FACILITY TYPE	NUMBER OF FACILITIES	AVERAGE AGE	AVERAGE CONDITION	CONDITION GRADE
Water Well Facilities	20	22	2.6	B
Small Water Systems	13	10	1.4	A
Booster Stations	12	23	2.6	B
Storage Facilities	9	33	2.5	B
Water Treatment Plants	2	27	3.0	C+
Small Treatment Facilities	2	15	2.0	B+
Raw Water Pump Station	1	10	1.4	A
Pressure Control Building	1	7	1.1	A+

WASTEWATER SYSTEM

Based on the estimated age and expected service lives, over half of the City of Greater Sudbury's sanitary sewer network, by length, has surpassed 50% of the expected service life, and is assumed to be in fair condition; once again with a significant group of 23% of assets estimated to be in very poor condition (Figure 2-13). The assumed condition for individual sewer materials is displayed in Table 2-11.

Figure 2-13 Sanitary Sewer Expended Service Life by Length (km)

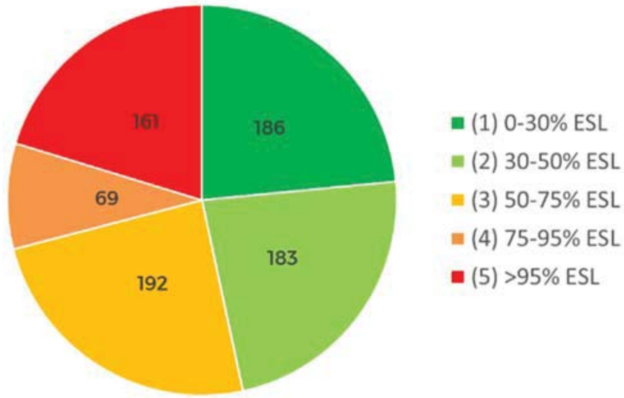


Table 2-11 City of Greater Sudbury Average Sanitary Sewer Condition by Material

MATERIAL	AVERAGE AGE (YEARS)	EXPECTED SERVICE LIFE (YEARS)	AVERAGE CONDITION RATING	CONDITION GRADE
PVC	35	105	1.7	A-
Concrete	41	90	2.3	B+
High density polyethylene	12	80	1	A+
Steel	47	60	3.3	C+
Cast Iron	58	60	3.7	C-
Polyethylene	16	55	1.2	A+
Asbestos Cement	43	55	3.5	C
Vitrified Clay	50	55	3.8	C-
Ductile Iron	17	40	1.5	A

Based on asset age and expected service life, the condition for facilities is generally poor (Figure 2-14, Table 2-12) as a result of a majority of facility assets having reached or approaching the end of their useful service life.

Figure 2-14 Wastewater Facilities Expended Service Life by Facilities' Replacement Cost

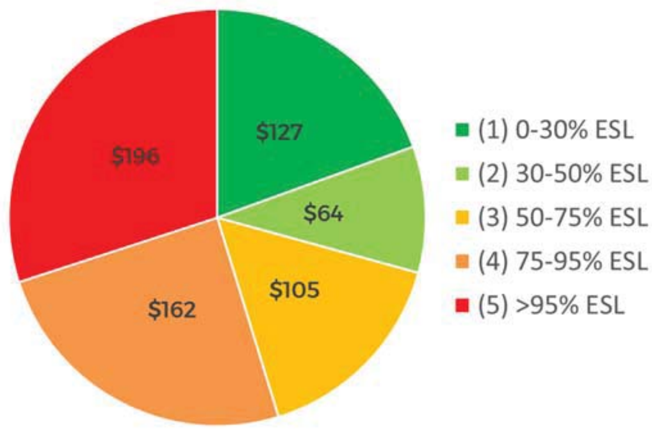


Table 2-12 City of Greater Sudbury Average Facility Condition by Facility Type

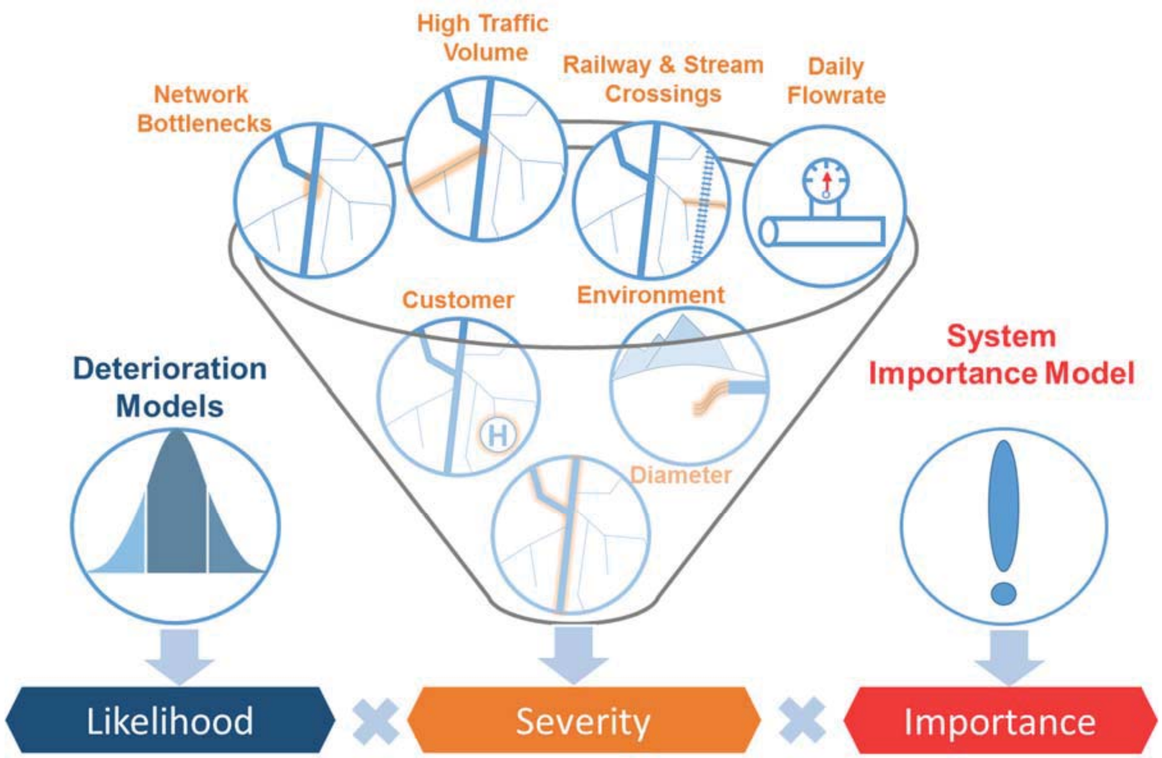
FACILITY TYPE	NUMBER OF FACILITIES	AVERAGE AGE (YEARS)	AVERAGE CONDITION	AVERAGE CONDITION DESCRIPTION	CONDITION GRADE
Lift Stations	69	42	3.3	Fair to Poor	C+
Wastewater Treatment Lagoons	4	46	4.8	Very Poor	D-
Wastewater Treatment Plants	10	36	3.9	Poor	C-

2.3.5 ASSET RISK

RISK ASSESSMENT METHODOLOGY OVERVIEW

Understanding risks is important for maintaining the functionality and safety of the City's infrastructure, and serves as a means for prioritizing the investment of available resources. A risk score was calculated system wide on all asset types individually expressed as the product of Likelihood of Failure, Severity of Failure, and Importance factor. These terms are illustrated in Figure 2-15 and are described below. In section 5 – Financing Strategy, the overall system average of these risk scores is then used as a bench mark for assessing the long term impact of varying investment scenarios.

Figure 2-15 Risk Methodology



PROBABILITY OF FAILURE (LIKELIHOOD)

Probability of Failure represents the chance that an asset will not be able to fulfill its intended purpose, expressed as a decimal between 0 and 1. A Probability of Failure of 0 implies that there is no chance that the asset will fail in a given year, whereas a probability of failure of 1 implies that the asset is statistically certain to fail in the given year. Both values are theoretical since at a given year the probability of failure will never be 0 or 1.

For linear infrastructure, material-specific deterioration models were developed utilizing watermain break data between the years 1990-2014. Where statistically significant, the models were utilized to determine the future behavior of watermain segments. If a material-specific model could not be applied due to limited failure records, a generic model for the deterioration of all materials was also derived. For linear appurtenances an age-based deterioration model was implemented that assessed an asset's risk relative to its age and expected service life.

Facilities were discretized into separate asset lifecycle categories / discipline groups (e.g., structural, architectural, electrical, site works, etc.). The Probability of Failure for each category was taken as proportional to the category age versus its estimated service life applying an age-based deterioration model.

CONSEQUENCE OF FAILURE (SEVERITY)

Consequence of failure represents the impact to stakeholders if an asset fails to fulfill its intended purpose, and is a relative representation of an asset within its discipline group. As an example, Consequence of Failure can be used to communicate the relative severity of one watermain failing compared to another watermain. The Consequence of Failure is determined for the different assets and asset types based on their geographic and engineering contexts. For this AMP, Consequence of Failure has been expressed as an integer between 1 and 5 (Table 2-13).

Table 2-13 Consequence of Failure Rating System

SEVERITY	DESCRIPTION	RATING
Insignificant	No disruption to normal operation, no environmental impact, no financial investment.	1
Minor	Some manageable operation disruption, minor environmental impact, small financial investment.	2
Moderate	Significant modification to normal operation but manageable, easy to mitigate environmental impact, moderate financial investment.	3
Major	Reduced production with inability to meet demand imminent, significant environmental impact, large financial investment.	4
Catastrophic	Inability to meet demand, potential injury, severe environmental impact, significant financial investment.	5

Separate factors were assessed within each asset category to determine the final Consequence of Failure rating. These factors or summarized by asset category in Table 2-14.

Table 2-14 Risk Factors by Asset Category

Asset Category	Risk Type	Parameter
Linear Assets	Technical	Capacity
		Network Bottlenecks (number of directly affected customers)
		Railway and River Crossings
		Road Hierarchy and Traffic Volume
	Community	Affected Critical Customers
	Environment	Nepahwin and Ramsey Lakes underwater mains
		Adjacent to major Water Bodies in natural environment
Lift Station	Wet Weather Flowrate_2 year Storm (m3/day)	
Water Storage Tank	Storage Capacity (mL: million Liter)	
Wastewater Treatment Facility & Lagoon	Wastewater Facility Rated Capacity(m3/day)	
Water Treatment Facility	Rated Capacity(m3/day)	
Booster Station	Pump Total Capacity (L/s)	

IMPORTANCE FACTOR

In order to compare risk across different asset groups and allow for computation of system wide risk rates, the above Probability and Consequence of Failure scores were translated into a universal value using an Importance Factor to rank and prioritize specific asset groups based on various considerations such as redundancy, ease of repair and backup measures/strategies should the asset fail. An Importance Factor table was developed using an Analytic Hierarchy Process to determine relative weightings between the importance of the various asset types across the water and wastewater portfolios.

APPLICATION OF RISK

A risk score was applied to each individual asset using the framework described in the previous section, gathering technical attributes and applying GIS tools to assess geospatial data contributing to the Consequence of Failure for linear assets.

CORRIDOR-BASED PROJECT LIMITS

To more realistically identify linear infrastructure projects, linear assets were grouped into corridor-based projects for analysis purposes. These projects address both water and sewer mains, as well as associated appurtenances, but at this iteration of the AMP are not associated with road corridors and infrastructure. These W&WW corridor-based projects were identified through geospatial automation, grouping adjacent linear mains and appurtenances roughly defined as junction-to-junction segments. It is important to keep in mind that these project limits are approximations; when the decision is made to rehabilitate or replace infrastructure, the linear assets to be included in the scope of work may vary and therefore the capital investment requirements should be reassessed at the project planning stage.

2.4 NEXT STEPS

The City of Greater Sudbury currently does not have a policy in place for the ongoing management of Asset Management Data. A suitable policy, including an associated data dictionary, should be established for future iterations of the AMP.

Greater Sudbury is part of a select group of municipalities to have committed to adopting the ambitious “open by default” standard. “Open Data by Default” is the first principle of the G8 Open Data Charter, which was adopted by Canada in 2013. Open by default means that data approvals should start from a position of data openness and that data should be released unless privacy, security, legal or other restrictions exist.

Dataset releases must follow the requirements of the Municipal Freedom of Information and Protection of Privacy Act, R.S.O. 1990, c. M.56 [MFIPPA], Personal Health Information Protection Act, 2004, S.O. 2004, c. 3, Sched. A, and all other applicable legislation. Datasets containing personally identifiable information or subject to any privacy, security, legal or other restrictions will not be released as open data. The City may also have contractual or other obligations, all of which may limit the data which can be published on the Open Data Portal. When a dataset cannot be released as-is due to any restrictions, staff will evaluate whether a modified version of the dataset can be released that would comply with such requirements.

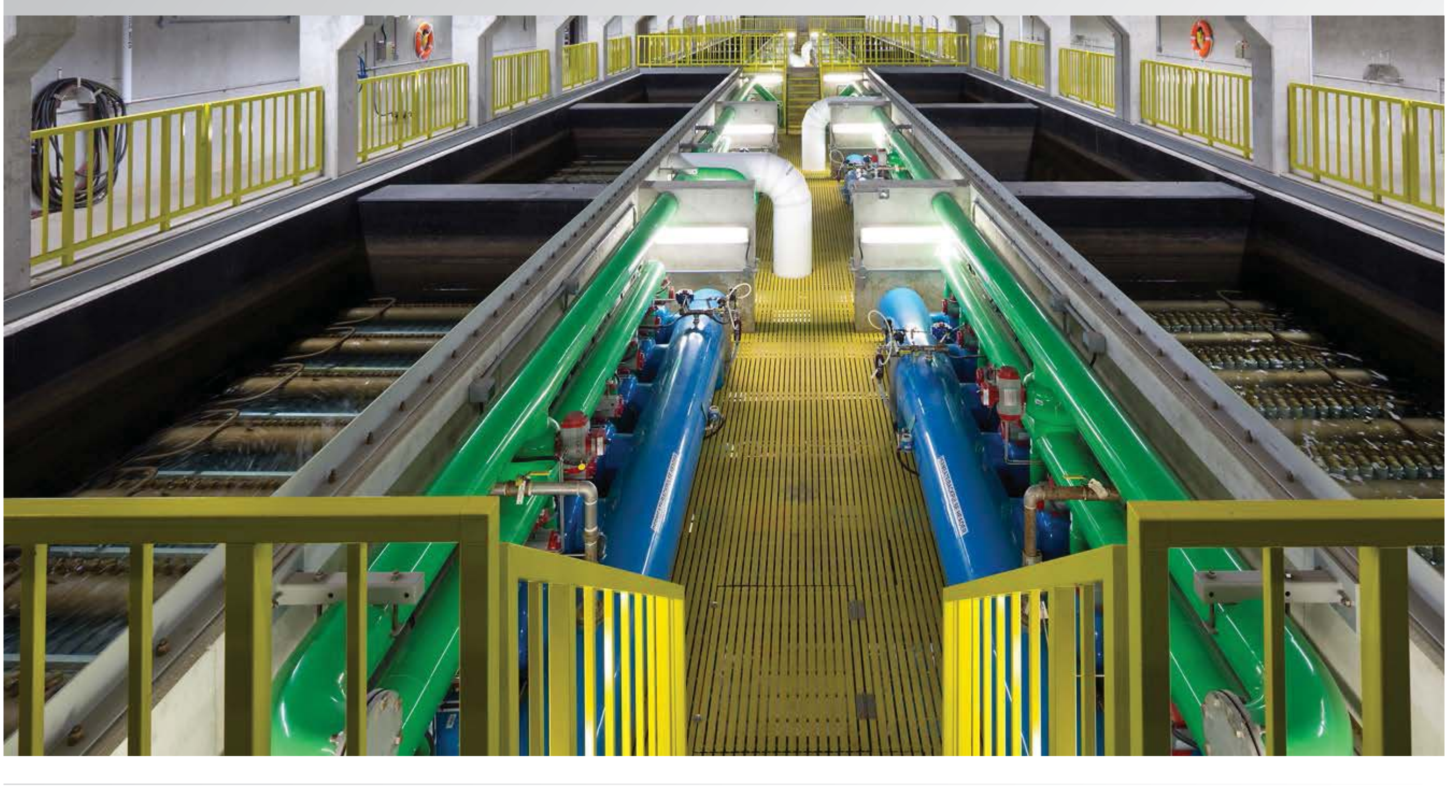
The State of Local Infrastructure has been prepared based on the most complete data set for each asset category. Moving forward, the asset inventory will need to be maintained and augmented to support the objectives of the City's Asset Management Planning framework and improve accuracy of future Asset Management Plan iterations.

Next steps have been identified and are provided in Table 2-15

Table 2-15 State of Infrastructure Next Steps

Category	Details
General Infrastructure	• Implement comprehensive asset identification standard that will be used in all relevant data sets including GIS, Hydraulic Model and PSAB, and in associated capital and O&M project lists. • Refine and improve risk framework introduced in this AMP; develop lists of critical assets, customers and environments and re-evaluate assigned weights.
Linear Infrastructure	• GIS vs. hydraulic model: ▪ Capture data existing in the hydraulic models (such as material and installation dates) and integrate into GIS. ▪ Significantly improve topology of GIS, to allow for small-scale trace analysis and to meet the hydraulic modelling requirements. ▪ Define clear relationship between the hydraulic model and the GIS; develop standard editing procedures for these two datasets with the aim of minimizing duplicate efforts and costs, and providing one source of data. • Capture installation dates from all relevant sources, including GIS, hydraulic model, as-built drawings and staff knowledge. • Accurately link pipe failure and condition data to allow for seamless computation. It is recommended that mobile GIS solutions be implemented for on-site digitization of data at a high resolution. • It is recommended that the City undertake a project to develop a corridor segmentation strategy that will enable realistic statistical computation of condition and risk ratings; and will further allow for the implementation of corridor based planning across different infrastructure disciplines, mainly roads.
Vertical Infrastructure	• Enhance vertical infrastructure asset inventory granularity, accuracy, and completeness including: o Construction or in-service year o Acquisition, replacement cost o Condition assessments and expected service lives o Risk assessment – consequence of failure in terms of regulatory requirements, environment and health and safety • Conduct detailed condition assessments to arrive at actual condition and needs

LEVELS OF SERVICE



3 LEVELS OF SERVICE

Levels of service provide the means to measure customers' needs and expectations of the City and the services provided, and offers a mechanism for communicating costs of services. The level of service metrics selected are driven by the City's Vision, Mission and Values and are therefore focused on the impact to citizens, communities and the natural environment. This section outlines the expected levels of service for the CGS's water and wastewater systems.

Since the objectives of this Asset Management Plan have been developed based on the City's documented objectives (Table 3-1), the asset management decision-making process can also be said to follow the City's Mission, Vision, and Values.

Table 3-1 Alignment of Asset Management Plan with Corporate Objectives

Mission, Vision and Values	Objective	Implication to Asset Management Plan
To support a growing community with quality municipal services	To ensure that all growth is well managed, well designed and sustainable.	New/upgraded infrastructure projects are focused in designated areas as outlined in the City's strategic planning documents. The recommendations from the Water and Wastewater Master Plan have been explicitly integrated into the Asset Management Plan's financial strategy.
To demonstrate innovative leadership amongst northern communities	Embrace infrastructure asset management as a best practice throughout the organization and become an Asset Management leader amongst Northern Ontario Municipalities	This first edition of the Asset Management Plan aims to move beyond basic asset management practices. Its development has included updates to the asset registry through data scrubbing efforts, identification of initial Levels of Service aligned with the City's core objectives, a detailed Risk analysis considering actual infrastructure failure records and advanced deterioration modeling, and a corridor-based Long-Term Financial Plan integrated with the City's Water and Wastewater Master Plan that will support future efforts to provide sustainable services to the community.
Acting today in the interests of tomorrow	Develop a strategic Asset Management Plan that relies upon social, environmental and financial risk as a means to prioritize infrastructure investment decisions	A risk-based prioritization framework has been implemented throughout this AMP to facilitate strategic infrastructure decision-making. Further, integration of the Water and Wastewater Master Plan recommendations provides an overall Plan that considers not only the ongoing management of existing infrastructure but also development to meet future needs.

3.1 STAKEHOLDER ANALYSIS

A customer satisfaction survey or measure of willingness to pay, was not undertaken as part of this iteration of the City's Asset Management Plan. Future asset management initiatives and updates to the Asset Management Plan should focus on stakeholder and community engagement in developing Levels of Service.

Some of the City's stakeholders include:

- Regulatory bodies
- City of Greater Sudbury community, visitors
- Local industry
- City Council
- City Departments

3.2 REGULATORY REQUIREMENTS

Regulatory bodies represent one of the City's critical stakeholders. As a minimum level of service, there are regulatory requirements associated with the CGS water and wastewater infrastructure that must be met (Table 3-2). These represent an absolute minimum level of service targets that must be met by the City, but are not expressly tracked within this Plan.

Table 3-2 Minimum Regulatory Requirements

ASSET CATEGORY	REGULATORY REQUIREMENTS
Water and Wastewater Infrastucture	Environmental Protection Act Ontario Water Resources Act, R.S.O. 1990 Safe Drinking Water Act, 2002
Facilities	Building Code Act, 1992(Ontario Regulation 332/12) Accessibility for Ontarians with Disabilities Act (AODA)

3.3 CUSTOMER LEVELS OF SERVICE

Levels of service are defined in terms of Customer Level of Service and Technical Level of Service. Customer levels of Service are Qualitative statements about the expectations of the customers served by the infrastructure. Technical Levels of Service are Quantitative objectives about the infrastructure that the City can measure their performance against.

Customer Levels of Service focus on the Quality, Function and Capacity of the infrastructure.

Quality How good is the service?

Function Does the service meet users' needs?

Capacity Is the service over- or under-utilized?

The City of Greater Sudbury water and wastewater division has established the following statement, describing its mission and commitment:

> *"The City of Greater Sudbury's Water and Wastewater Services Division is committed to providing its customers with safe, reliable, and environmentally responsible municipal water and wastewater services through a sustainable, cost effective approach."*

Specific performance measures, targets, and timelines have been established for water (Table 3-3) and wastewater (Table 3-4).

Table 3-3 Customer Level of Service Targets and Performance – Water

Service Attribute	Service Objective	Performance Measure	Current Performance	Future Objective
Quality	High quality potable water	Taste/Odour/Colour complaints	21	Complaints remain at/below the current level
Function	Minimal disruptions to service	Number of unplanned System Outages	TBD	Number of unplanned interruptions remain at the current level
Capacity /Utilization	Water supply system is adequately maintained and upgraded to meet current and future demands	Water pressure and water volume are meet / exceed minimum design requirements	TBD	Maintain 100% conformance

Table 3-4 Customer Level of Service Targets and Performance – Wastewater

Service Attribute	Service Objective	Performance Measure	Current Performance	Future Objective
Quality	Provide wastewater treatment meeting / exceeding effluent objectives	Number of non-conforming events i.e. sewage bypasses	33 /year	Number of bypass events remain at current levels
Function	Minimal disruptions to service	Number of City side sewer backups reported	52 /year	Number of backups remain at the current level

Service Attribute	Service Objective	Performance Measure	Current Performance	Future Objective
Capacity /Utilization	Collection and Treatment systems are adequately designed, maintained and operated to meet system requirements	Collection and Treatment facilities meet service requirements identified in design and planning documents	28% of system non-conforming	Reduction in % of non-conformance

3.4 TECHNICAL LEVELS OF SERVICE

Technical Levels of Service connect Customer Levels of Service to the physical characteristics of the asset(s). These measures are also used to relate the Customer Level of Service to resources required to achieve the specified targets.

Technical levels of service have been defined for both water (Table 3-5) and wastewater (Table 3-6) infrastructure, along with future objectives. Considering the City's considerable infrastructure renewal backlog and the significant infrastructure deficiencies identified through the Water and Wastewater Master Plan, affordable initial Level of Service targets have been selected.

Table 3-5 Technical Level of Service Performance Measures – Water

TECHNICAL PERFORMANCE MEASURE	UNIT	Current Performance	Future Objective
Water main breaks	No/year	98	Number of breaks remain at current level
Number of connection-days where a boil water advisory notice is in place	No/year	TBD	Boil water advisory notices remain at the current level
Cleaning and swabbing of small diameter water mains	KM/year	90	90
System valves inspected, operated and documented	No.	TBD	3,000
Planned vs. unplanned maintenance in facilities	%	TBD	Ratio remain at the current level

Table 3-6 Technical Level of Service Performance Measures – Wastewater

TECHNICAL PERFORMANCE MEASURE	UNIT	Current Performance	Future Objective
Total number of sewer and service connection blockages that resulted in a back up	No/ 100km/yr	13.35	Sewer blockages remain at the current level

TECHNICAL PERFORMANCE MEASURE	UNIT	Current Performance	Future Objective
CCTV inspection and flushing/cleaning program	KM/year	72	72
Total number of reported overflows	No.	10	Overflows remain at the current level
Number of bypasses	No/year	33	Number of bypass events remain at current level
Planned vs. unplanned maintenance in facilities	%	TBD	Ratio remain at current level

3.5 NEXT STEPS

The following recommendations have been identified:

Table 3-7 Levels of Service Next Steps

CATEGORY	DETAILS
Performance Measures	Continue to collect and report on performance measures currently tracked, while developing collection and reporting strategies for newly identified performance measures
Desired Levels of Service and Public Consultation Process	While select Levels of Service and Key Performance Indicators were identified for measuring the implementation of this AMP, additional work is recommended to identify and detail the true customer expectations. We recommend that the City approach its stakeholders and, through a public consultation process, document their expectations and desired service levels while gauging the willingness to pay. By connecting services provided with the money spent or forecast for the work to the stakeholder expectations, a complete line of sight can be provided that will support the City in providing justification for asset management decisions.

ASSET MANAGEMENT STRATEGY

4 ASSET MANAGEMENT STRATEGY

This section outlines strategies based on four (4) lifecycle strategies (operations & maintenance strategies, renewal / rehabilitation strategies, capital replacement strategies, and disposal strategies), expansion strategies and non-infrastructure strategies.

4.1 LIFECYCLE STRATEGIES

Implementing an annual maintenance program and completing timely renewal works will keep the infrastructure performing at the desired levels of service and at the same time prolong the life of the infrastructure and reduce overall spending. Therefore, the most cost effective strategy for managing the City's infrastructure is to perform annual maintenance and complete timely renewal works.

4.1.1 OPERATIONS & MAINTENANCE STRATEGIES

Maintenance is essential to managing infrastructure, as the expected level of service often relies on maintenance activities. Regular maintenance can also add significant life to assets. In addition to ongoing observations of condition and performance established during regular operation, it is important that the City schedule regular inspections of its assets to identify maintenance and capital requirements. An initial recommended inspection and testing strategy for the water and wastewater facilities has been developed (Table 4-1); it is recommended that the City continue to refine these strategies as the City's asset management practices evolve.

Table 4-1 Recommended Inspection and Testing Strategy for Water and Wastewater Facilities

Facility	Recommended Treatment	Timing (Years)	Estimated Annual Cost (2017 $)	Description
Water Reservoirs	Water Storage Facility Cleaning & Inspection	Every 3 Years	$80,000	Remotely operated vehicle (ROV) inspection program
Water Treatment Plants	Inspect Plant Intake Structure	Every 10 Years	$65,000	ROV/Diver inspection program
Wastewater Treatment Plants	Piping Inspection and Condition Assessment	Every 5 Years	$75,000	Non-destructive inspection and testing
Water Treatment Plants	Piping Inspection and Condition Assessment	Every 5 Years	$75,000	Non-destructive inspection and testing
Wastewater Treatment Plants	Transformer and MCC Inspection & Maintenance	Biannually	$15,000	Maintenance Testing and Inspection per ANSI/NETA MTS-2015

Facility	Recommended Treatment	Timing (Years)	Estimated Annual Cost (2017 $)	Description
Water Treatment Plants	Transformer and MCC Inspection & Maintenance	Biannually	$15,000	Maintenance Testing and Inspection per ANSI/NETA MTS-2015
Water Wells	Well Inspection	Every 3 Years	$310,000	Water Well Inspection program
W\WW Facilities	Facility Audits	10 Year Cycle	$300,000	Audits on all Facilities on a 10 year Cycle

It is recommended that the City undertake regular condition assessments of its infrastructure and apply maintenance records, local knowledge, and CCTV records of piping to update asset condition ratings. The City should use this information to develop suitable predictive and preventative maintenance strategies for assets as is commensurate with the inherent risk and importance of the assets, including refinement of the inspection and testing schedule.

Initial operations and maintenance strategies for the water and wastewater facilities have been recommended (Table 4-2); it is recommended that the City continue to refine these strategies as the City's asset management practices evolve.

Table 4-2 Recommended O&M Strategy for Water and Wastewater Facilities

Facility Assets	Recommended Treatment	Timing (Years)	Intervention Cost (% of Replacement Cost)	Description	Estimated Annual Cost (2017 $)
Architectural Components	Architectural Inspection/ Maintenance	Every 5 Years	5.0%	Roof debris removal (2x annually), visual inspection (2x annually), and minor roof membrane repairs	$700,000
Building Services	Building Services Equipment Inspection	Annually	1.0%	Heat, ventilation equipment inspection	$270,000
Electrical Components	Electrical System Inspection & Maintenance	Every 4 Years	1.0%	Electrical service & distribution system inspection and maintenance	$175,000
I&C Systems and Life Safety Systems	Instrumentation & Control Systems Inspection	Annually	2.0%	Maintenance & inspection of instrumentation and inspection/testing of health & safety systems i.e. Fire extinguishers, hoists, anchor points	$380,000

Facility Assets	Recommended Treatment	Timing (Years)	Intervention Cost (% of Replacement Cost)	Description	Estimated Annual Cost (2017 $)
W\WW Facilities	Tempered Water Upgrade Program for Water and Wastewater Facilities	As required	-	Assumed 10 water facility upgrades and 10 wastewater facility upgrades at $10,000 each	$200,000

A more detailed operation and maintenance strategy should be developed as the granularity of the asset inventory increases. The City should track the sufficiency and efficacy of its ongoing maintenance expenditures over time, and adjust as needs dictate.

Recommended infrastructure studies and programs (Table 4-3) should continue to be updated as the City's understanding of system behavior evolves.

Table 4-3 Recommended O&M Strategy for Linear Infrastructure

System	Recommended Strategies	Timing (Years)	Estimated Cost (CAD)	Description
Water Distribution	Corrosion Protection Program	Annually	$200,000	Combination of annual capital expenditures for cathodic protection installation and monitoring
Water Distribution	Transient (Air Release Valve) Studies	Annually	$40,000	Transient analysis (estimated 2 studies per year)
Water Distribution	Valve Chamber Inspection Program	Annually	$60,000	Structural inspection of valve chambers on 15-year cycle (200/year @ $300/chamber)
Water Distribution	Valve Turning Program	Annually	$180,000	Inspect and operate system valves once every three years (based on current costs)
Water Distribution	Water main Cleaning and Swabbing Program	Annually	400,000	Cleaning and swabbing all small diameter watermains on 10-year cycle (90km/year @ Current Cost)
Water Distribution	CPP condition assessment	Annually	$250,000	CPP condition assessment (Based on 5-10 cycle over 63 km @ 30,000\km)

System	Recommended Strategies	Timing (Years)	Estimated Cost (CAD)	Description
Water Distribution	Watermain Physical Failure Study	Every 10 Years	$150,000	System wide analysis to understand break frequency and potential mitigation measures
Water Distribution	Valve Criticality Study	As Required	$50,000	Engineering study to determine valve criticality
Water Distribution	Fire Hydrant Testing and Inspection Program	Annually	$800,000	Fire Hydrant Pressure Testing and Winter Inspection Program (based on current costs)
Wastewater Collection	Low Pressure Sewer System Inspection Program	Annually	$60,000	CCTV inspection of low pressure collection system on 10-year cycle (1,200m/year @ $50/m)
Wastewater Collection	Rock Tunnel Inspection and Mapping Program	Annually	$100,000	Inspection and mapping of rock tunnel
Wastewater Collection	Manhole & Sewer Inspection and Maintenance Program	Annually	$750,000	CCTV inspection and flushing/cleaning program (70km/year @ current costs)
Other	Other Strategic State of Good Repair Studies	Annually	250,000	Other strategic state of good repair studies

4.1.2 RENEWAL / REHABILITATION STRATEGIES

Rehabilitation is necessary when an asset does not perform to its desired level of service. Significant repairs designed to extend the life of the asset are determined through regular inspections. Rehabilitation over replacement is advantageous when there are only a few components that need repair.

The initial rehabilitation strategy recommended for the water and wastewater facilities (Table 4-4) and linear infrastructure (Table 4-5) should be revised as the City's asset management practices evolve;

Table 4-4 Recommended Renewal / Rehab Strategy for Water and Wastewater Facilities

Facility Assets	Recommended Treatment	Timing (Years)	Intervention Cost (% of Replacement Cost)	Description
Structural Components	Minor Structural Rehabilitation	Every 15 Years	2.0%	Concrete and masonry minor repairs
Structural Components	Minor Structural Rehabilitation	At 50% of Service Life	10.0%	Caulking replacement, minor repairs of floor construction and roof construction etc.
Structural Components	Major Structural Rehabilitation	At 75% of Service Life	20.0%	Building cladding rehabilitation
Architectural Components	Minor Architectural Repair	Every 15 years	18.5%	Roof covering doors, windows, and interior stairs minor repairs
Site Works	Minor Site Works Rehabilitation	Every 5 Years	5.0%	Minor site works rehabilitation including repairs of fence, barbed wire, facility gates, posts, pavement, etc.
Site Works	Minor Site Works Replacement	Every 10 Years	10.0%	Minor site works rehabilitation including repairs of fencing, asphalt and pavers.
Wastewater Facility Process Piping & Equipment	Minor Process Piping & Equipment Rehabilitation	Every 5 Years	10.0%	Minor equipment and process piping maintenance
Water Facility Process Piping & Equipment	Minor Process Piping & Equipment Rehabilitation	Every 5 Years	5.0%	Minor equipment and process maintenance, including well inspection and maintenance
Water Facility Process Piping & Equipment	Minor Process Piping & Equipment Rehabilitation	Every 10 Years	20.0%	Major equipment and process maintenance. May include membrane filter or media replacement
Electrical Components	Electrical System Inspection & Maintenance	Every 4 Years	1.0%	Electrical service & distribution system inspection and maintenance
I&C Systems and Life Safety Systems	Life Safety & Compliance Systems Replacement	Every 10 Years	20.0%	Replacement of life safety equipment

Table 4-5 Recommended Renewal / Rehab Strategy for Water and Wastewater Linear Infrastructure

Asset Type	Recommended Treatment	Timing (Years)	Estimated Cost (% Of Replacement Cost)	Description
Mains	Relining	As Required	25%-100%	Relining

A more detailed renewal/rehabilitation strategy should be developed as the granularity of the asset inventory increases. The City should track the sufficiency and efficacy of its ongoing renewal and rehabilitation initiatives over time, and adjust as needs dictate.

Maintenance hole rehabilitation recommendations were not included in this iteration of the AMP.

4.1.3 CAPITAL REPLACEMENT STRATEGIES

Occasionally, the extent of damage or deterioration to an asset is too great and rehabilitation is deemed unfeasible. At this point, replacement is necessary. As an asset approaches the end of its service life, more frequent inspection may be necessary to determine if replacement of the asset is critical in the short-term, or if deferral of the asset replacement is possible.

Recommended lifecycle rehabilitation for the water and wastewater facilities (Table 4-6) should be updated as the City's asset management practices evolve.

Table 4-6 Recommended Capital Replacement Strategy for Water and Wastewater Facilities

Facility Assets	Recommended Treatment	Timing (Years)	Intervention Cost (% of Replacement Cost)	Description
Architectural Components	Major Architectural	End Of Service Life	100.0%	Replacement of roof coverings, celling, door, windows, floor, etc.
Building Services	Building Services	End of Service Life	100.0%	Replace all heating, ventilation and air conditioning (HVAC), air distribution system, and water supply systems (excludes piping).
Site Works	Major Site Works Replacement	End of Service Life	50.0%	Full replacement not anticipated, resurface asphalt, sidewalks pavers and retaining walls. Underground services i.e. Piping and valve chambers inspection/rehabilitation.

Facility Assets	Recommended Treatment	Timing (Years)	Intervention Cost (% of Replacement Cost)	Description
Wastewater Facility Process Piping & Equipment	Major Process Piping & Equipment Replacement	End of Service Life	50.0%	Major process equipment replacement, full replacement not anticipated, replace pumps, motors, motor starters, etc.
Water Facility Process Piping & Equipment	Major Process Piping & Equipment Replacement	End of Service Life	60.0%	Major process equipment replacement, full replacement not anticipated, replace pumps, motors, motor starters etc.
Electrical Components	Major Electrical Replacement	End of Service Life	100.0%	Electrical service & distribution system replacement, lighting and branch wiring replacement, communication & security system replacement
I&C Systems and Life Safety Systems	Instrumentation & Control Systems Replacement	End of Service Life	80.0%	Replacement of instrumentation & general control systems
Standby Power	Standby Power Replacement	End of Service Life	100.0%	Full replacement of standby power equipment
Wastewater Facility Sanitary Forcemain	Sanitary Forcemain	End of Service Life	100.0%	Sanitary forcemain replacement

A more detailed operation and maintenance strategy should be developed as the granularity of the asset inventory increases. The City should track the sufficiency and efficacy of its ongoing renewal and rehabilitation initiatives over time, and adjust as needs dictate.

Recommended replacement for the water distribution system and wastewater collection system (Table 4-7) include the replacement at the end of service life.

Table 4-7 Recommended Capital Replacement Strategy for Linear Infrastructure

Asset Type	Recommended Treatment	Timing (Years)	Estimated Cost (% Of Replacement Cost)	Description
Mains, Appurtenances and Meters	Replacement	End of Service Life	100.0%	Full replacement of infrastructure at the end of their service life

4.1.4 DISPOSAL STRATEGIES

Disposal costs that have been specifically identified in the Master Plan were integrated for the estimation of overall expenditures; asset disposal costs associated with other infrastructure replacement activities are generally included with the estimates made for asset replacement. This section refers to disposal costs associated with the reduction of services or elimination of demands placed on systems. By establishing target levels of service, an organization can clearly determine whether or not infrastructure or particular assets are needed.

No assets were identified in the process of developing this AMP that were not required to deliver the specified levels of service.

4.2 EXPANSION ACTIVITIES

Expansion activities are required to extend services to previously un-serviced areas or to expand services to accommodate growth demands. The City of Greater Sudbury had a population of 166,300 in 2011, and is expected to grow to a population of 176,800 in 2036. The current Water and Wastewater Master Plan has identified the needs for infrastructure expansion, upgrade and/or replacement in order to meet the water and wastewater system requirements. The Master Plan recommended projects have been included in the financial analysis for this Asset Management Plan in order to address the City's objectives such as cost effectiveness, environmental responsibility, reliability and safety.

4.3 NON INFRASTRUCTURE SOLUTIONS

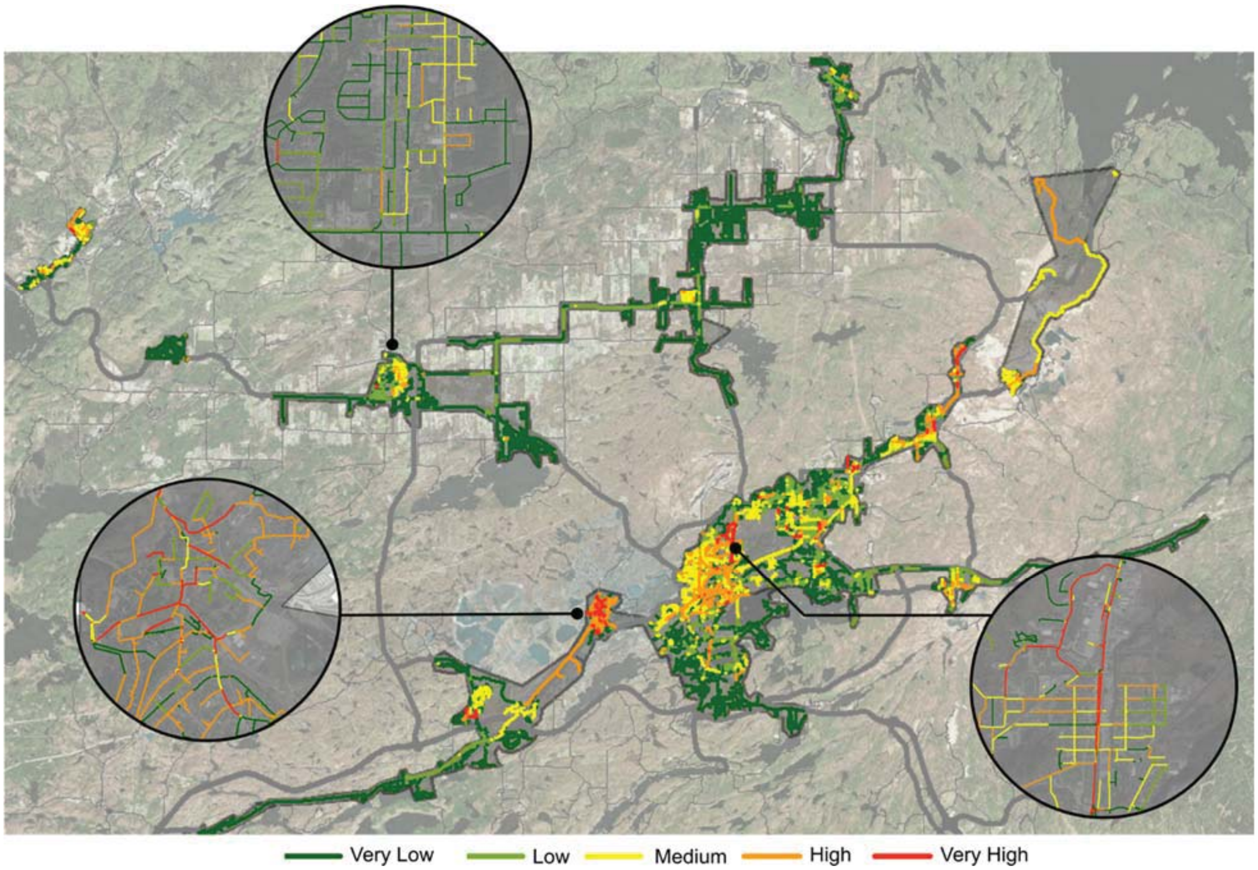
Non-infrastructure solutions produce lower costs for long-term asset sustainability. Cost and time savings are optimized by implementing an organizational approach for all infrastructure works. Important non-infrastructure solutions include implementation of an Asset Management Plan and regular inspections of the various infrastructure assets. A key non-infrastructure strategy identified in this AMP is implementing a corridor based strategy, combining priorities of other divisions (i.e. Roads) with the priorities of the Water and Wastewater Department for linear infrastructure. In this AMP, an initial aggregation of the linear assets from both the water and wastewater inventories has been introduced, and a recommendation has been included for a systematic segmentation of the network to allow for strategic and realistic corridor based planning.

4.4 RISK-BASED PRIORITIZATION AND PROJECT LISTS

The scheduling and the application of the above described strategies within the CGS's aging system and limited capital, O&M and staffing resources, requires careful allocation of the available resources and prioritizing critical and aging assets.

The risk framework introduced in this AMP and described above in section 2 - State of Infrastructure can guide the City with this prioritization process. A summary of the vertical inventory, including risk rates, is attached as appendix A to this AMP. Risks for the linear network have been mapped; an overview is presented in Figure 4-1, and a set of detailed maps is attached as Appendix B to this report. The digital media accompanying this report includes a digital version of the entire inventory with asset-level risk rates, and in addition, includes prioritized lists, in the form of four spreadsheets for (1) Facilities Renewal Projects, (2) Watermains Projects, (3) Sanitary Sewer Projects, and (4) Water system valves. These lists have been developed based on desktop estimations and condition has largely been estimated based on age and expected service life. It is recommended that these critical assets be monitored and prioritized in terms of maintenance, inspections and asset renewal strategies, and that over time the City develop and refine its practices for documenting and maintaining its critical infrastructure.

Figure 4-1 Linear Risk, based on age/material and Criticality (a set of detailed maps is included as appendix B)



While condition across the asset portfolio was initially assessed based on age and expected service life, an additional more detailed study was conducted on the City's watermains, based on historical break data provided by the City. This dataset was geocoded as part of this AMP, and an initial prioritization framework has been developed, where failing watermains were identified and weighed based on their criticality scores. A prioritized list of these watermains projects is attached as Appendix C to this report. It should be mentioned that the City is currently working on linking its historic break data to GIS, which is expected to greatly improve the accuracy of this data. As the underlying dataset improves it is also recommended that this study will be enhanced to take into consideration additional factors such as pipe material, failure characteristics, soil type and spatiotemporal patterns to develop a more robust physical failure model that can then be combined with an economic failure model for optimized decision making. It is important to note that in lack of more detailed physical and economic models, a failure driven approach alone is not sufficient for strategic asset management. At the same time, the critical and aging portions of the network that have been identified through the age-based risk assessment described above, should be monitored and inspected to ensure acceptable levels of risk. Large diameter pipes typically experience less failure, and the direct and indirect costs associated with a potential failure of a critical watermain might easily prioritize it over other failing not-critical watermains.

4.5 NEXT STEPS

The following next steps have been identified for the asset management strategies section:

Table 4-8 Asset Management Strategies Next Steps

CATEGORY	DETAILS
Lifecycle interventions	• The City should review and update its lifecycle interventions strategies as the City's asset management practices evolve.
Risk-based prioritization	• Critical assets should be monitored and prioritized in terms of maintenance and inspections, and that over time the City develop and refine its practices for documenting and maintaining its critical infrastructure. • As the watermains failure data management advances, physical and economical failure models should be developed taking into consideration factors such as pipe material, failure characteristics, soil type and spatiotemporal patterns together with direct and indirect failure costs, to allow for optimized decision making. • Base risk ratings of facilities on detailed condition assessments

FINANCING STRATEGY

5 FINANCING STRATEGY

5.1 METHODOLOGY

Building on the current state of infrastructure (section 2) and asset management strategies (section 4), different capital funding scenarios were tested and their impact on the overall system risk was assessed in order to answer one fundamental question:

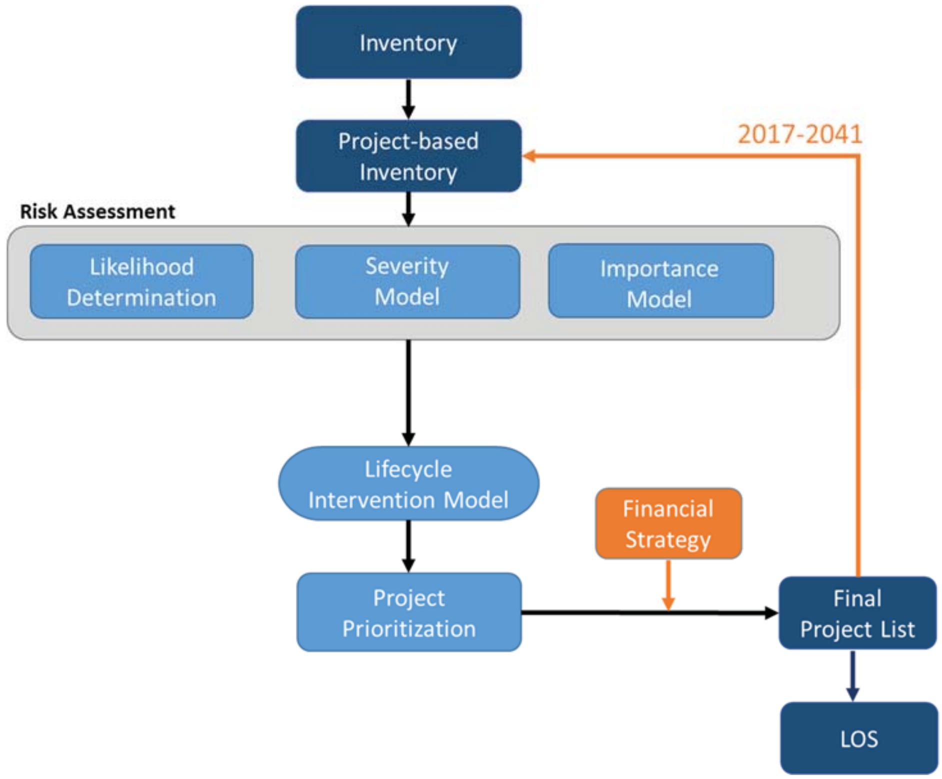
> What is the right level of capital investment necessary to achieve long-term sustainability?

A decision support system was developed specifically to answer this question based on the CGS inventory, prioritizing investments and simulating the long-term impact of funding scenarios over the entire asset portfolio. The process iterates over the following steps over a time horizon of 25 years (Figure 5-1)

1. Set annual available capital (user input)
2. Apply asset specific risk models to all assets and determine risk rating; linear assets have been aggregated to the corridor-project level for this assignment.
3. Assign renewal strategies by asset type.
4. Prioritize renewal projects based on asset risk.
5. Create a project list identified as the highest priority projects, feasible within available capital; unused budget from a given year is set aside in reserves for use in future years.
6. Move on to the next year, triggering the creation of a new inventory that reflects the results of the previous year's projects. Probability of failure and resulting risk score are recalculated across the updated portfolio taking into account the characteristics of the newly replaced assets, and the aging of the entire inventory by one year.
7. Calculate expected levels of service expressed as average system risk.

The result of this simulation process is a series of year-specific inventories that reflect the impact of the annual investment that has been tested. Multiple scenarios have been run to arrive at the desired expenditures; these are presented below.

Figure 5-1 Simulation Model Flow Chart

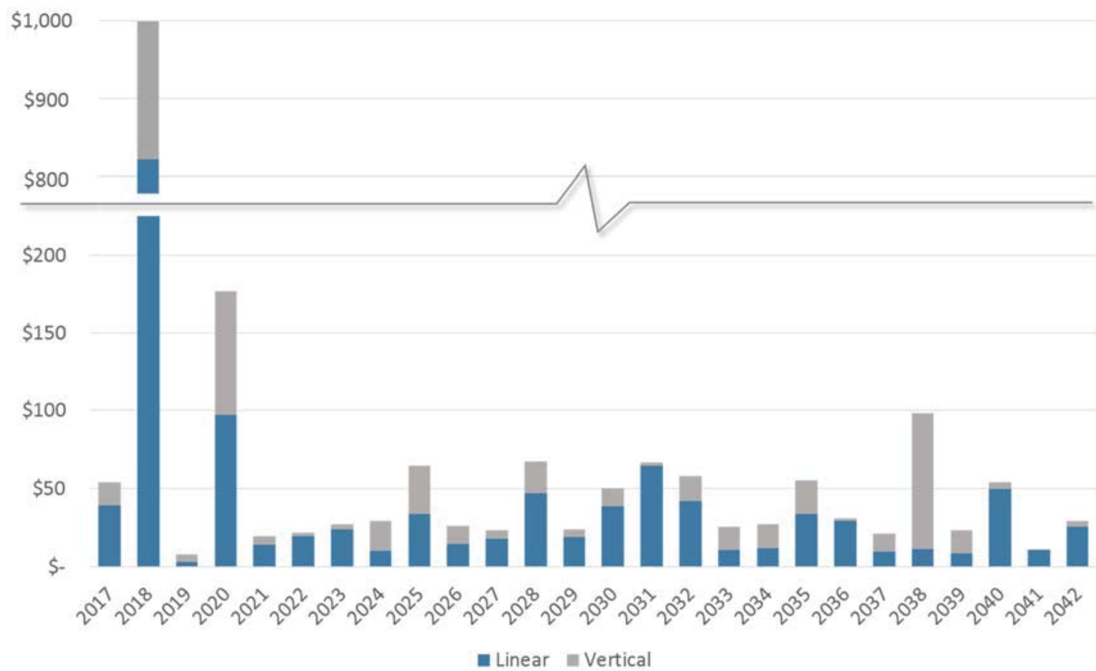


In the following sections, the infrastructure funding gap and infrastructure backlog are identified, and two scenarios are analyzed: first, a "business as usual" scenario which identifies sustainable long-term funding, not yet taking into account the ongoing W&WW Master Plan's recommendations, and in the second scenario integrating the Master Plan recommendations with the asset management renewal needs.– The first scenario is important for understanding infrastructure renewal needs without taking into account the Master Plan growth and upgrade projects and enables a comparison with current City expenditures. The second scenario identifies a comprehensive and sustainable long-term capital plan for the City's Water and Wastewater infrastructure that incorporates growth, demographic changes, and other operational issues.

5.2 IDENTIFYING THE FUNDING GAP

Based on the asset life expectancies and asset management strategy outlined in section 4, a significant infrastructure backlog has been identified. Figure 5-2 demonstrates the system's *needs*, not yet taking into consideration any budgeting limitations. An immediate need of approximately one billion dollars reflects the current significant infrastructure gap. In the theoretical scenario where this backlog is completely addressed at the year 2018, the identified level of infrastructure renewal drops to an average of $43M annually.

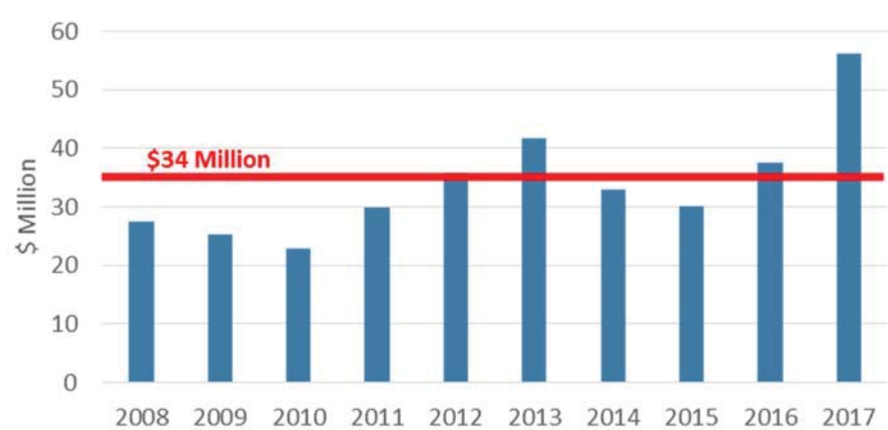
Figure 5-2 Forecasted Renewal Needs



These figures reflect good practice asset management strategies that have been presented in the AMP. If the infrastructure backlog was to be spread over 25 years, the required average infrastructure renewal investment would be $82M annually.

Figure 5-3 summarizes the CGS's actual capital investments in the water and wastewater systems over the last 10 years, with an average of $34 million. Although the historical capital investment is below the projected sustainable level of investment of $88 Million identified by KPMG in 2016, it should be noted that the CGS is on track towards a sustainable level of capital investment and have budgeted $56 Million dollars in 2017 for infrastructure renewal.

Figure 5-3 Historic Capital Investment



The infrastructure and capital investment gaps of the last decade are apparent, but the long term consequences of this deficit need to be assessed prior to arriving at a recommendation for annual investment rates. A number of scenarios were explored to identify sustainable funding requirements, these are presented in the following section.

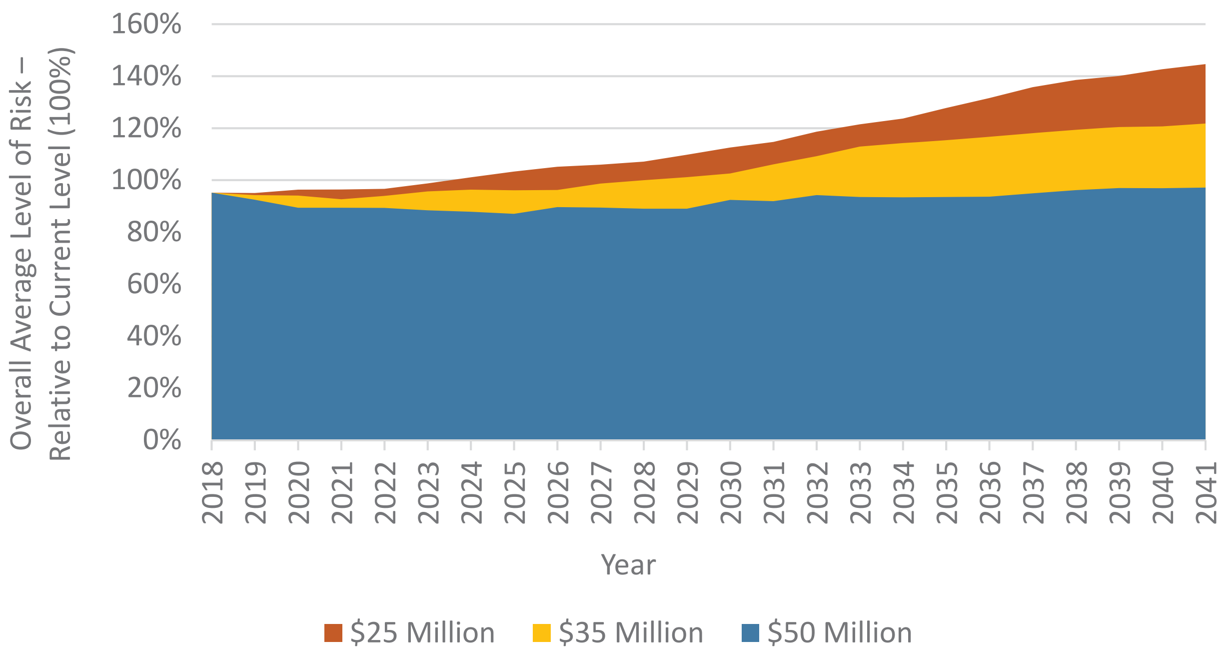
5.3 IDENTIFYING SUSTAINABLE FUNDING

5.3.1 ANALYSIS OF REINVESTMENT FINANCIAL STRATEGIES

Three capital budgeting scenarios of $25, $35 and $50 million annual expenditures were tested against the forecasted system renewal needs.

Figure 5-4 presents the result of this analysis, where the percentages on the y-axis reflect the overall system level of risk, relative to the current level (100%). As described above, these results reflect a risk-based prioritization methodology, that simulates the long term effect by reassessing levels of risk on an annual basis, taking into consideration the previous year's projects that were completed as high priority and feasible within the budget limits.

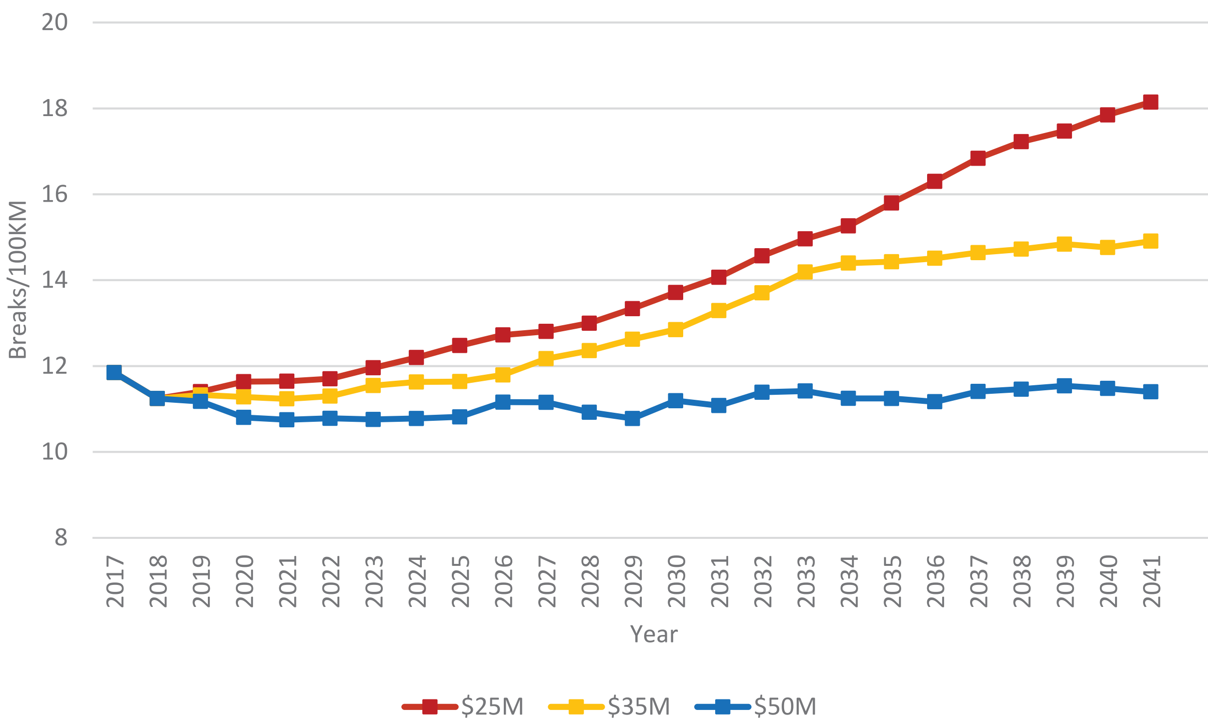
Figure 5-4 Risk Simulation by Annual Expenditure



Under a 25 million dollar reinvestment strategy it can be seen that the overall system risk at the end of the 25-year horizon rises to over 140% of the current levels of risk. This increase in overall system deterioration will lead to increased levels of reactive maintenance and emergency repairs, unplanned water outages and sewage spills. Under a 35 million dollar reinvestment strategy levels of risk rise up to over 120%. It is only under a 50 million dollar reinvestment strategy that the overall system risk stays relatively constant in the mid and long term. This level of reinvestment should provide the City with a reliable water and wastewater system at or slightly better than current conditions.

The levels of risk has been calculated for all water and wastewater linear and vertical infrastructure. Quantifying the consequences of increasing system level risk is difficult and requires high resolution data inputs, yet we are able to relate these strategies in to the level of watermain breaks experienced each year. The watermain breaks per year per 100KM were forecasted under the three funding scenarios (Figure 5-5).

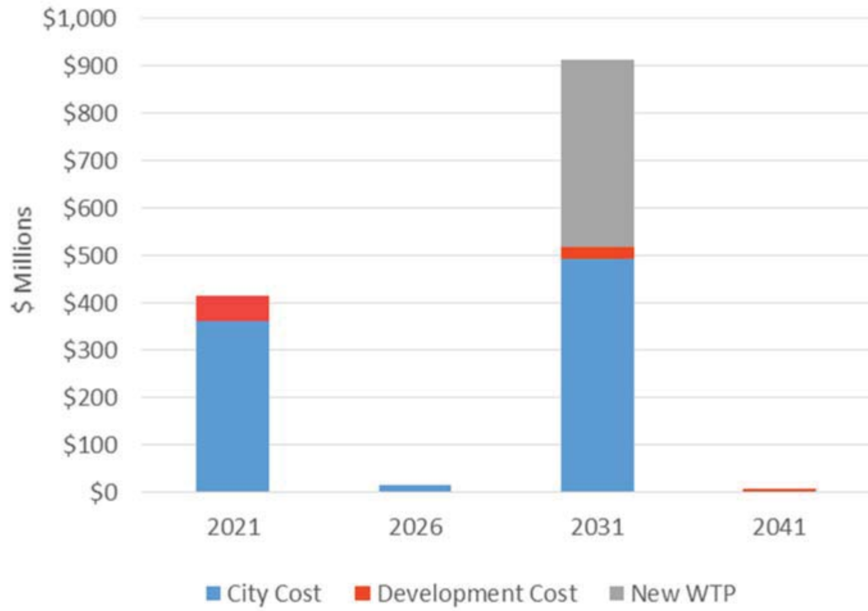
Figure 5-5 Projected Watermain Breaks by Funding Scenario



5.3.2 INTEGRATING MASTER PLAN RECOMMENDATIONS

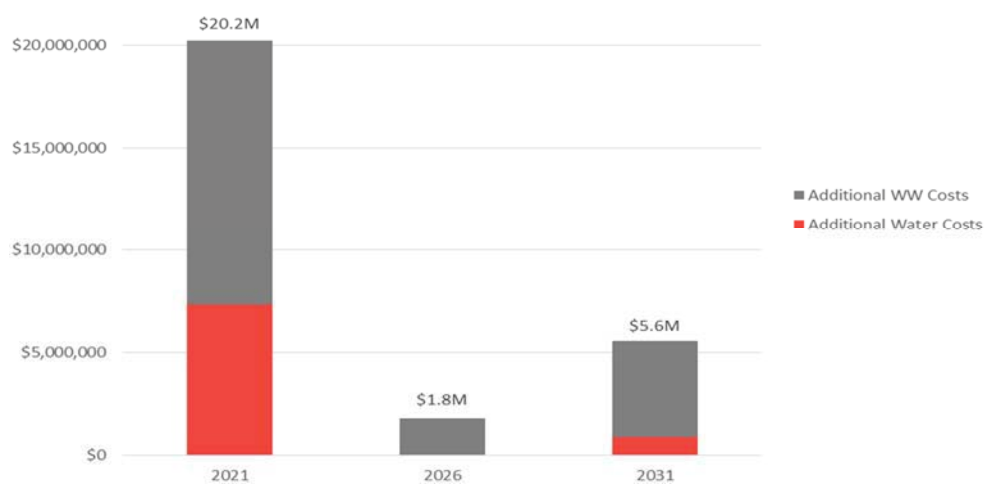
This AMP is being developed at the same time as the CGS Water and Wastewater Master Plan recommendations are being finalized. Substantial costs are allocated to the 1st and 3rd five-year-ranges: years 2017-2021 and 2027-2031 (Figure 5-6). These costs and their considerable consequences on comprehensive asset management will be discussed below.

Figure 5-6 Master Plan Water and Wastewater Recommendations Cost by Implementation Year



To integrate the financial strategy of this Asset Management Plan with the recommendations from the Master Plan, linear assets that have reached the end of their service life, or are near to reaching it, that are located in the same corridors as the W&WW Master Plan projects have been planned for renewal to coincide with the W&WW Master Plan identified project. For instance, a W&WW Master Plan recommendation for a replacement of a water main is likely to include the sanitary sewer main located in the same corridor or portions of it if that sanitary sewer has reached or is very near to reaching its end of service life. These assets are recommended to be replaced together with the W&WW Master Plan projects (Figure 5-7). A detailed list is attached as Appendix D to this report.

Figure 5-7 Additional Corridor Based Costs Associated with Master Plan Recommendations



The total City costs for W&WW Master Plan projects Plus corridor based additional costs reach $898M (Table 5-1, Figure 5-1).

Table 5-1 Master Plan Total Costs Including Corridor Based Additional Costs

YEAR	EXPENDITURE REQUIRED (MILLION $)
2017-2021	$382
2022-2026	$16
2027-2031	$500
Total:	$898

Spreading these costs over the corresponding ranges of 5 years results in significant expenditure needs. For instance, after taking into consideration the current 2017 budget of $56.2M for the 2017-2021 projects, an annual average investment of over $80M is needed for the remaining years 2018-2021. Adding the previously-identified $50M would result in an annual investment need of over $130M. However, since the W&WW Master Plan projects themselves are driven by capacity and reliability needs and are in some instances replacing aging assets, they too are contributing to the overall level of service of the system. In other words, the Master Plan and Asset Management Plan are not two entirely independent approaches; rather, they partially overlap common goals and should therefore be treated as a comprehensive set of recommendations. The Master Plan recommendations have therefore been integrated with the AMP renewal recommendations and risk simulations were run once again on different funding scenarios.

Development projects have been included in these simulations in order to assess total system risk, yet development projects have been assigned a separate external funding source and therefore do not affect the forecasted City's capital requirements. Running these simulations showed that an average annual investment of approximately $100M was needed between 2017 and 2036 to maintain sustainable levels of risk. After 2036 sustainability can be maintained with an annual investment of $50M. To address the highly differentiated investment needs identified in the Master Plan between the different five-year ranges, this amount of $100M was then slightly redistributed, allocating more to the years with intensive Master Plan recommendations (2017-2021 and 2027-2031) and less to the years with less needs (Table 5-2).

Table 5-2 Recommended 25 Year Capital Budget

YEAR	REQUIRED ANNUAL BUDGET (MILLION $)
2017	56.2 *approved budget
2018-2021	110
2022- 2026	90
2027-2031	110
2032-2036	90
2037-2041	50

Building on the recommended capital plan, the following table summarizes by planning horizon the funds that are available for Master Plan upgrade projects, and funds that are available for asset renewal projects.

Table 5-3 Projected Budget Allocation for Upgrade/Renewal Projects

PLANNING HORIZON	TOTAL BUDGET	BUDGETED UPGRADE PROJECTS (MASTER PLAN)	BUDGET AVAILABLE FOR RENEWAL PROJECTS (AMP)
2017-2021	$496	$382	$114 (Annual $23)
2022- 2026	$450	$16	$434 (Annual $87)
2027-2031	$550	$500	$50 (Annual $10)
2032-2036	$450	$0	$450 (Annual $90)
2037-2041	$250	$0	$250 (Annual $50)

5.4 NEXT STEPS

The following next steps have been identified for the financing strategy section:

Table 5-4 Financing Strategy Next Steps

CATEGORY	DETAILS
Funding Sources	• Determine the appropriate strategies going forward to fund the identified investment needs and recommendations.

NEXT STEPS

6 NEXT STEPS

"Next steps" tables have been provided at the end of each of the previous sections; a compiled list is presented below (Table 6-1).

Table 6-1 Compiled List of Next Steps

Section	Category	Details
State of Infrastructure	General Infrastructure	• Implement comprehensive asset identification standard that will be used in all relevant data sets including GIS, Hydraulic Model and PSAB, and in associated capital and O&M project lists. • Refine and improve risk framework introduced in this AMP; develop lists of critical assets, customers and environments and re-evaluate assigned weights.

	Linear Infrastructure	• GIS vs. hydraulic model:
		  ▪ Capture data existing in the hydraulic models (such as material and installation dates) and integrate into GIS.
		  ▪ Significantly improve topology of GIS, to allow for small-scale trace analysis and to meet the hydraulic modelling requirements.
		  ▪ Define clear relationship between the hydraulic model and the GIS; develop standard editing procedures for these two datasets with the aim of minimizing double efforts and costs, and providing one source of truth.
		• Capture installation dates from all relevant sources, including GIS, hydraulic model, as-built drawings and staff knowledge.
		• Accurately link pipe failure and condition data to allow for seamless computation. It is recommended that mobile GIS solutions be implemented for on-site digitization of data at a high resolution.
		• It is recommended that the City undertake a project to develop a corridor segmentation strategy that will enable realistic statistical computation of condition and risk ratings; and will further allow for the implementation of corridor based planning across different infrastructure disciplines, mainly roads.

Section	Category	Details
	Vertical Infrastructure	• Enhance vertical infrastructure asset inventory granularity, accuracy, and completeness including: o Construction or in-service year o Acquisition, replacement cost o Condition assessments and expected service lives o Risk assessment – consequence of failure in terms of regulatory requirements, environment and health and safety • Conduct detailed condition assessments to arrive at actual rates
Levels of Service	Collect Performance Measures	Continue to collect and report on performance measures currently tracked, while developing collection and reporting strategies for newly identified performance measures
	Desired Levels of Service and Public Consultation Process	While select Levels of Service and Key Performance Indicators were identified for measuring the implementation of this AMP, additional work is recommended to identify and detail the true customer expectations. We recommend that the City approach its stakeholders and, through a public consultation process, document their expectations and desired service levels while gauging the willingness to pay. By connecting services provided with the money spent or forecast for the work to the stakeholder expectations, a complete line of sight can be provided that will support the City in providing justification for asset management decisions made.
Asset Management Strategy	Lifecycle interventions	• The City should review and update its lifecycle interventions strategies as the City's asset management practices evolve.

Section	Category	Details
	Risk-based prioritization	• Critical assets should be monitored and prioritized in terms of maintenance and inspections, and that over time the City develop and refine its practices for documenting and maintaining its critical infrastructure. • As the watermains failure data management advances, physical and economical failure models should be developed taking into consideration factors such as pipe material, failure characteristics, soil type and spatiotemporal patterns together with direct and indirect failure costs, to allow for optimized decision making. • Base risk ratings of facilities on detailed condition assessments
Financing Strategy	Funding Sources	• Determine the appropriate strategies going forward to fund the identified investment needs and recommendations.

Going forward, the key challenges identified in this AMP for the management of the City of Greater Sudbury's water and wastewater systems can be divided into those related to the maintenance and renewal of the existing infrastructure, and those specifically related to the Master Plan recommendations.

With regard to optimizing the maintenance and renewal of the existing infrastructure, the challenges are securing a sustainable budget, establishing a comprehensive framework for defining, tracking and securing levels of service and implementing a robust risk-driven infrastructure management framework. The framework introduced in this AMP should be developed and refined on an ongoing basis, and guide the City's maintenance and renewal efforts. Another key factor for success will be the implementation of corridor based planning, taking into consideration not only water and wastewater assets, but also other infrastructure disciplines, mainly roads.

With regard to the implementation of the Master Plan projects, careful review of project limits should be undertaken to ensure adjacent aging water/wastewater infrastructure is captured within the corridor, maximizing the benefits of the project from an asset management point of view. Securing the considerable costs associated with these recommendations is essential to ensure that the on-going renewal efforts can continue at the same time and are not unreasonably deferred.

Finally, good asset management relies on good data management. Several recommendations have been provided in this AMP regarding data management; the City of Greater Sudbury has developed an impressive data set that has made this AMP possible, and is continuously improving its data collection and management practices. As the City's asset and data management practices evolve, so will its ability to optimize its decision making process.