Director	Municipal Manager/Deputy Municipal Manager

COUNCIL AGENDA

Date: October 21, 2024 Item: 4.

DISTRICT OF WEST VANCOUVER
750 17TH STREET, WEST VANCOUVER BC V7V 3T3

COUNCIL REPORT

Date:	October 7, 2024
From:	Emily Willobee, Senior Manager, Engineering Services
Subject:	Sanitary Utility System Asset Management Plan Update
File:	1700.09

RECOMMENDATION

THAT

1. The October 7, 2024, report from the Senior Manager, Engineering Services titled "Sanitary Utility System Asset Management Plan Update" be received for information.
2. Council endorse the 2021 Sanitary System Asset Management Plan.

1.0 Purpose

The purpose of this report is to provide Council an overview on the state of asset management planning for the District's local sanitary utility system infrastructure.

The report will present information about the sanitary system's assets including asset inventory, replacement costs, condition, servicing and renewal requirements, and long-term funding projections to address existing and future needs of the utility.

2.0 Executive Summary

The District first completed an Asset Management Plan (AMP) for the Sanitary System Utility in 2010. For a number of years, the District's sanitary utility has been operating under the guidance of the 2010 AMP. The 2010 plan was a large step forward in terms of strategic management at the time, but it has become outdated and less relevant to current conditions. After more than 10 years, a new updated sanitary system asset management study and plan was completed in late 2022.

The 2021 Sanitary System AMP provides an updated overview of the state of infrastructure within the utility, including a comprehensive review of system assets, their replacement value, their condition, and an anticipated distribution of replacement costs based on best available information at the time the report was produced. The key purpose of the 2021 Sanitary System AMP is to provide an updated long-term roadmap

to manage the wastewater system assets so that the District can effectively balance costs, risks, and benefits to deliver sustainable sanitary service to the community over the next 100 years.

The executive summary of the updated 2021 Sanitary System Asset Management Plan is provided as an attachment to this report, **Appendix A**, and this report summarizes the key findings of this work.

As of 2021, the District's sanitary system is comprised of 54 lift stations, more than 350,000 meters of collection mains, as well as service connections, manholes, and one municipal wastewater treatment plant (the Citrus Wynd Treatment Plant). The total replacement value of the District's sanitary system assets is $801,583,000 in 2021 dollars.

It is best practice that utility assets represent a range of physical conditions – this is how the utility disperses renewal costs over time. The study of District assets suggests 63.7% of assets are in good or very good condition. A third of assets are in fair condition (34.9%), and a very small portion of assets are in poor or very poor condition (1.4%). The 2021 AMP provides guidance for when and how to address these assets, which will be taken into consideration as part of the utility capital planning processes.

As part of the 2021 AMP, the District has assessed the service level risks across five risk categories that are relevant to the sanitary service and identified an appropriate action or strategy to mitigate risk. Many of the risk mitigation strategies proposed in the 2021 AMP have been implemented, including: establishing capital reserve funds to cover long-range costs, maintaining an operating reserve, and completing a Sanitary System Master Servicing Study.

The 2021 AMP presents a plan and financial projections for capital renewal cycles for local infrastructure on a 100 year timeframe. However, the 20-year forecast has the greatest importance because capital needs beyond the 20-year horizon are difficult to accurately predict. The updated 2021 AMP also analyzed the District's operating and maintenance (O&M) budget for the utility, as O&M practices impact asset condition and affect useful life.

Within the next 20 years, the District will require $96.5 million for capital expenditures, with 17% allocated for system expansion. This equates to approximately $5.8 million per year revenue requirement. As a result of past action, the current capital funding level in the sanitary utility is nearing the 2021 AMP's long-range target of $5.8 million per year, with recent capital budget of $5.4 million in 2024 and $5.67 million in 2025. Capital funding level is tracking to achieve long-range target of $5.8 million per year in 2026.

Operating and maintenance costs for the Sanitary System average $2.26 million annually and are 93% utilized, with unspent funds returning to the

utility reserve to offset future rate increases. Additionally, the District maintains a 90-day emergency operating reserve for operating emergencies that occur from time to time, which aligns with best practices for a municipal utility.

In summary, the 2021 Sanitary System AMP suggest that actions and advanced planning taken since the 2010 AMP have placed the District in a good position for long-range costs of renewing local system infrastructure on the 20-year horizon. The District's local operating budget provides sufficient resources to manage the system at its current level of service, based on best available information at the time the report was produced. The financial findings from the 2021 AMP have been reflected in the proposed 2025 Sanitary Sewer Utility rates and Five-Year Financial Plan.

The 2021 Sanitary System AMP also provides a great deal of guidance on opportunities for continued improvement. Areas of future work include continuing to improve data collection and condition assessment programs; maximize cost savings through smart planning and procurement; and on-going analysis of the impacts of construction costs changes and inflation on renewal costs over time, which should be included in financial plans.

Asset condition as well as capital and O&M budget needs are expected to continue to change over time due to the changing state of infrastructure (e.g. aging assets), economic situation (e.g. inflation) and environmental factors (e.g. impacts of climate change) and will need to be periodically reassessed through iterative asset management planning practices.

The District received grant funding from the Federation of Canadian Municipalities (FCM) and the Union of BC Municipalities (UBCM) to complete the 2021 Sanitary System AMP study.

3.0 Legislation/Bylaw/Policy

Greater Vancouver Sewerage and Drainage District Sewer Use Bylaw No. 299, 2007 and amendments - A bylaw to establish a regulatory system for liquid waste.

Metro Vancouver Regional District Integrated Liquid Waste and Resource Management Plan (ILWRMP) 2011 - A plan authorized and regulated through the BC Environmental Management Act, setting out liquid waste objectives within Metro Vancouver.

Sewerage and Drainage Regulation Bylaw No. 5263, 2023 - A bylaw to establish a municipal sewerage system, a municipal drainage system, and make provision for the usage of these municipal systems.

The District's first Sanitary System AMP for sewer utility assets was completed and endorsed by Council in 2010. At the time, the AMP identified the need for capital funding increases to provide for sustainable asset replacement funding levels.

4.0 Council Strategic Objective(s)/Official Community Plan

Official Community Plan

Section 2.5 of the 2018 Official Community Plan (OCP), Municipal Operations and Infrastructure, outlines several key policies related to sewage and drainage systems:

2.5.13 Pursue bylaw and policy changes and enhancements with the community to enable and support protection of watershed health, sustainable redevelopment, and public safety.

2.5.14 Consider 200-year storm events in the design of major drainage facilities and flood control works.

2.5.15 Employ low-impact storm and rainwater management techniques such as infiltration, absorbent landscaping, and natural environment conservation to mimic natural conditions and preserve pre-development conditions.

2.5.16 Reduce inflow and infiltration by rehabilitating and replacing older piping where appropriate and employ trenchless technologies where viable.

2.5.17 Employ green infrastructure or naturalized engineering strategies where possible to help manage anticipated increases in frequent storm events and associated flood risks.

Council Strategic Plan

This report also aligns with Council Strategic Goal:

5.0 Deliver municipal services efficiently.

5.0 Financial Implications

The objective of the 2021 Sanitary System AMP is to understand and plan for capital renewal cycles for local infrastructure on a 100 year timeframe. That said, the 20-year forecast has the greatest importance because capital needs beyond the 20-year horizon are difficult to accurately predict. The updated 2021 AMP also analyzed the District's O&M practices in the utility, as O&M practices impact asset condition and affect useful life.

The focus of the 2021 AMP is local capital infrastructure renewal, but the study does contemplate regional wastewater treatment as a critical part of the District's local sanitary system. Because the costs of wastewater treatment – including base costs of Metro Vancouver's North Shore Wastewater Treatment Plant ($1.058 billion) – have been historically paid in the form of a regional levy, these are considered with operating costs in updated 2021 AMP. Regional cost changes are not a focus of this report but will be examined in greater detail as part of the District's 2025 utility rate setting when it is brought forward to Council later this fall.

With regard to capital funding requirements for local infrastructure, the 2021 AMP indicates that the District will require $96.5 million for capital expenditures within the next 20 years, with 17% allocated for system expansion. Drivers for system expansion include population growth and responding to inflow and infiltration (I&I) challenges, which occur when storm water enters the sanitary sewer system either through unauthorized connections or due to aging infrastructure. This projected requirement equates to approximately $5.8 million per year to meet total funding requirements over the 20-year horizon.

Building on findings from the 2010 AMP, for some years the District has integrated an annual increase of 4% into the sanitary utility capital reserve in order to achieve more sustainable long-term capital funding levels. Council reviews and approves this as part of the annual utility rate setting process. As a result of past action, the current capital funding level in the sanitary utility is nearing the 2021 AMP's long-range target of $5.8 million per year, with recent capital budget of $5.4 million in 2024 and $5.67 million in 2025. Capital funding level is tracking to achieve long-range target of $5.8 million per year in 2026. Each year, any unspent capital funds are transferred to the capital reserve for future works.

In addition to capital infrastructure forecasting, the 2021 Sanitary System AMP project included a review of the District's O&M costs and expenditures. The District's O&M program includes, but is not limited to, asset inspection programs, materials and tools, labour costs, and wastewater treatment operational costs. Sustainable funding for O&M is a contributing factor that drives capital renewal schedules, and this had not been included as part of the 2010 AMP.

The O&M review indicated that operating and maintenance costs for the Sanitary System average $2.26 million annually and are 93% utilized with unspent funds returning to the utility to offset future rate increases.

The District's operating budget also includes an emergency reserve, set aside to address unexpected operating emergencies that occur from time-to-time. The recommended best practice for a sanitary utility's operating reserve is to hold 90 days of O&M costs. The District's operating reserve is currently aligned with best practice.

In summary, the financial findings of the 2021 Sanitary System AMP suggest that District is in a good position on the 20-year horizon with regard to advance planning for long-range costs of renewing local system infrastructure. The District's local operating budget provides sufficient resources to manage the system at its current level of service based on best available information at the time the report was produced.
The primary funding source for the sanitary utility is revenue from utility rates and the District's established statutory Sewer and Drainage Utility Reserve that hold funds for long term financing. Council approved the

creation of the statutory Sewer and Drainage Capital Reserve in 2016 to house funds for future Sanitary and Storm capital works separately from any operating surpluses. In 2017, Council approved refinements to the Sewer Utility's fund structure. These included creating an additional envelop within the Reserve to set aside funds for rate smoothing of the anticipated high increase to Metro Vancouver's annual levy for our portion of the North Shore Wastewater Treatment Plant and introducing a cap to the operating surplus at 90 days of Sanitary and Storm O&M costs. By the end of 2024, those Reserve balances are projected as follows:

90-day Operating Reserve for Sanitary and Storm:	$ 1.6 million
Capital Reserve for Long-term Financing:	$10.6 million
Regional Rate Smoothing Fund:	$ 5.7 million

Proposed 2025 rates and the Five-Year Financial Plan for the Sewer and Drainage Utility align with the recommendations of the updated sanitary system AMP.

Capital and O&M budget needs will continue to change over time due to the changing state of infrastructure (e.g. aging assets), economic factors (e.g. inflation) and environmental factors (e.g. impacts of climate change). O&M budget needs are reassessed on an annual basis as part of annual utility rate setting exercise, while longer-term capital funding requirements are reassessed through iterative asset management planning practices.

In addition to utility rates, the District continues to also explore other revenue streams to support future investment in service delivery for the community. Potential funding sources include development cost sharing arrangements, regular grants and funding programs available from other levels of government (e.g. Canada Community-Building Fund), or debt funding (loans).

The District received grant funding from the Federation of Canadian Municipalities (FCM) and the Union of BC Municipalities (UBCM) to complete the 2021 Sanitary System AMP study.

6.0 Background

6.1 Previous Decisions

Finance and Audit Committee, at its September 23, 2024, meeting, received a report titled "Proposed Sewer and Drainage Regulation Bylaw No 5263, 2023, Amendment Bylaw No 5350, 2024" and recommended the report be forwarded to Council for consideration. Section 6.2 of that report indicates this study would be brought forward for Council information and endorsement in fall 2024.
Council, at its November 27, 2023, regular meeting, adopted 2024 utility rates and the 2024 Five-Year Financial Plan for the Sewer and Drainage

Utility. Section 6.2 of that report refers to this Sanitary System Asset Management Plan study.

Council, at its October 30, 2023, regular Meeting, approved the following motions:

1. THAT proposed "Sewerage and Drainage Regulation Bylaw No. 5263, 2023" be adopted.
2. THAT proposed "Bylaw Notice Enforcement Bylaw No. 4368, 2004, Amendment Bylaw No. 5275, 2023" be adopted.

6.2 History

The District's Sewer and Drainage Utility conveys, treats, and disposes of sanitary sewage effluent and storm run-off for residents and businesses within the municipality.

Utility fees collected quarterly go directly to providing sewer and drainage services and can be broken down into regional and local components.This report primarily focuses the long-range asset management planning approach for the District's local sanitary system, which includes:

- operation and maintenance of the municipal Citrus Wynd Wastewater Treatment Plant;
- operation and maintenance of the sanitary sewer systems; and
- renewal of the sanitary sewer systems (infrastructure management capital) as well as financing of vehicles and equipment associated with these functions.

This section of the report provides a summary of the background and historical context relevant to the updated AMP.

The background includes an overview of asset management processes, as well as a refresher of scope and key findings from 2010 Sanitary System AMP. It also includes a summary of key milestones and studies that have been completed to support long-range asset management for the sanitary sewer utility, all of which serve as key inputs into the updated 2021 Sanitary System AMP.

Review of the Asset Management Planning Process

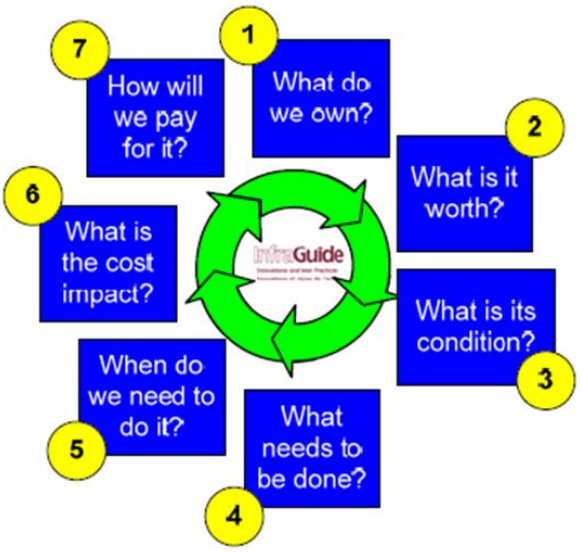
Asset management planning is a formalized and integrated approach to planning and budgeting for municipal infrastructure needs. It combines engineering principles with sound businesses practices and considers a wide variety of data to provide logical basis for decision-making. The goal of asset management planning is to maintain, upgrade, and operate District assets at an optimal and cost-effective level, with a long-term vision of providing sustainable service delivery.

The formalized process for developing an AMP has evolved but not fundamentally changed since the early 2000's when the Federal Government established asset management recommendations for

municipal governments to follow. Branded as *InfraGuide*, that work provided a framework to address infrastructure funding deficits at all levels of government in Canada.

At the time, media extensively covered the infrastructure funding gap that was becoming evident at all levels of government. While the topic of Canada's infrastructure deficit has receded from the mainstream news, it remains an important and on-going concern for owners of systems and those involved in the maintenance, planning, and financial decision-making of such systems.

Figure 1: *InfraGuide* Asset Management Planning Wheel[1]



The framework for an AMP can be described in terms of seven questions, as indicated in Figure 1. The process of developing an AMP for a sizeable municipal utility is an involved and lengthy one, and the process can take 12 to 18 months depending upon the complexity of the information that is examined.

A fundamental concept in asset management planning is that it is iterative. Multiple cycles through the planning wheel are required to fully understand strategic issues in complex infrastructure networks such as a municipal sanitary system, and AMPs must be renewed periodically to incorporate new information.

Review of Key Recommendations from 2010 AMP

[1] Taken from "Best Practice for Managing Infrastructure Assets" - InfraGuide: National guide to sustainable municipal infrastructure is a collection of technical best practices and principles to help better inform municipal staff and decision-makers, developed 2001-2006.

For a number of years, the District's sanitary utility has been operating under the guidance of the original AMP developed in 2010.

The 2010 Sanitary System AMP was the District's first state of infrastructure summary and AMP for the utility. It provided a comprehensive overview of system assets, their replacement value, their condition, and an anticipated distribution of replacement costs on the 100-year horizon.

The 2010 AMP helped to identify gaps in asset and condition data, leading to improved data collection programs. Using available information at the time, it quantified the scale of infrastructure funding gap in the sanitary sewer utility, and identified an alternative funding level that would better support local infrastructure renewal in the long term.

Following recommendations of the 2010 AMP, the District increased funding levels in order to meet asset renewal needs over the long term, and later, established a statutory reserve fund structure within the utility that would provide a mechanism to accumulate funds for future infrastructure investments.

The 2010 plan was a large step forward in terms of strategic management at the time, but it has become outdated and less relevant to current conditions.

Key Milestones in Sanitary Utility Asset Management

Over the last decade, the District has taken a number of steps to enhance asset management planning in the utility based on findings of the initial plan. Staff have also initiated a series of supporting studies to inform an updated AMP.

An overview of District's historical milestones supporting sanitary sewer system asset management are provided here:

- 2010 – The first District Sanitary System AMP completed and and endorsed by Council.
- 2016 – Establishment of a statutory Sanitary Utility Reserve Fund.
- 2017 - Adoption of a revised Sanitary Sewer rate structure that separately identifies local and regional sewer costs, improving transparency for ratepayers.
- 2018 – Completion of the Pump Station Prioritization Study.
- 2019 – Completion of the Sanitary System Master Servicing Study.

After more than 10 years, a new updated sanitary system asset management study and plan was commissioned as part of the Division's 2021 work plan and completed in late 2022. The District engaged a consultant, WSP Canada Inc., to support the work.

As the District was working with a consultant to update the Sanitary System AMP staff identified that the local sewerage and drainage utility fee bylaw established in 2007 did not provide an adequate regulatory framework for the management of the sewer and drainage utilities. Because the absence of specific regulations pertaining to sewerage and drainage had the potential to lead to various challenges, staff worked to modernize the District's bylaw prior to bringing forward the updated sanitary AMP for Council endorsement.

In October 2023, Council adopted Sewerage and Drainage Bylaw No 5263, 2023, replacing the former bylaw in its entirety. The new bylaw provides comprehensive regulations to establish a municipal sewerage system, a municipal drainage system, and make provision for the usage of these municipal systems.

7.0 Analysis

7.1 Discussion

This section of the report will provide an overview of 2021 Sanitary System AMP including asset inventory, replacement costs, condition, servicing and renewal requirements, and long-term funding projections to address existing and future needs of the utility.

It will summarize key findings and next steps.

Objectives and Inputs for the Updated 2021 Sanitary System AMP

The key purpose of the 2021 Sanitary System AMP is to provide an updated long-term roadmap to manage the wastewater system assets so that the District can effectively balance costs, risks, and benefits to deliver sustainable sanitary service to the community over the next 100 years.

To that end, the updated 2021 AMP incorporates new information and more thorough asset data resulting from:

- Advancements in condition assessment programming and CCTV resulting in more comprehensive and accurate data regarding assets and their condition.
- Introduction of computerized maintenance management system (Maintenance Connection) to coordinate preventative maintenance works, track maintenance activity in real time, and document changes in asset condition.
- Pump Station Condition Assessment study completed in 2018, providing a comprehensive condition assessment and a prioritization plan for the District's pump station infrastructure.

The 2021 AMP also incorporates improved financial information and cost projections, based on a decade of actual construction cost records and documented inflation and cost escalation factors.

Additionally, the 2021 AMP reflects new insights gained as a result of a Sanitary System Master Servicing Study completed in 2019. The Master Servicing Study examined the sanitary asset systems' ability to provide service levels to current and future populations, including the development of a hydraulic sanitary sewer computer model. The study evaluated the hydraulic performance of the system under existing and future development conditions and recommended a prioritized capital upgrading plan to support short and long term planning. The study also looked closely at challenges associated with I&I and provided recommendations on a strategy to address and prevent stormwater from entering the sanitary system.

Finally, the 2021 AMP update included a review and projections for O&M funding levels, which was not done as part of 2010 AMP. A summary of key findings of the 2021 AMP follows below.

System Assets & Replacement Costs

As of 2021, the District's sanitary system is comprised of lift stations, collection mains, service connections, manholes, and one municipal wastewater treatment plant (the Citrus Wynd Treatment Plant) as summarized in the table below. Estimated replacement values are provided in 2021 dollars.

Figure 2: Sanitary System Asset Summary

Asset Type	Quantity	Estimated Replacement Value	
		Component Value	Total Replacement Value
Wastewater Treatment Plant	1		$2,909,000
Lift (Pump) Stations	54		$43,248,000 (1)
Civil Component		$18,525,000	
Mechanical Component		$7,475,000	
Electrical Component		$15,660,000	
Pump Component		$1,589,000	
Gravity Mains	339,797 m		$495,471,000
Forcemains	11,769 m		$19,631,000
Service Connections	12,693		$177,702,000
Manholes	4,473		$62,622,000
Total			$801,583,000 (1)

(1) The value may not add up exactly due to rounding.

With this system, the District of West Vancouver provides wastewater collection and disposal to a population of over 42,000 residents. System service includes the collection, conveyance, pumping, and treatment, or connection to treatment by others (Metro Vancouver) of an estimated average of 20 million litres of wastewater daily.

The total replacement value of the District's sanitary system assets is $801,583,000 in 2021 dollars.

Asset Condition

Understanding asset condition is a critical step towards assessing current needs and forecasting future needs for an asset. Assessing condition of an asset will help the District:

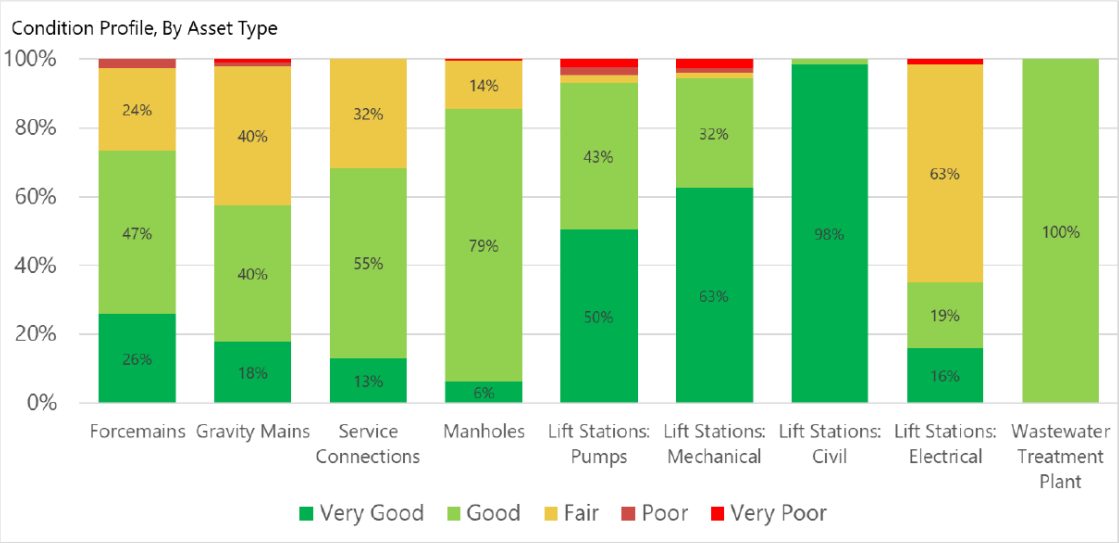
- estimate when an asset will reach the end of its life and require replacement;
- estimate loss in levels of service;
- estimate risk associated with asset's current condition; and
- identify appropriate and timely interventions.

The 2021 AMP looked at two primary types of condition: Physical and Functional. Physical condition analyzes physical characteristics of assets, such as age, material, expected useful life to make projections regarding asset deterioration. Functional condition assesses whether infrastructure is right-sized with adequate capacity to meet the needs for current and future wastewater flows. Where infrastructure does not meet functional requirements, it is likely to require upgrading when it is replaced, which has different cost implications than like-for-like replacement. Drivers for upsizing infrastructure include population growth and responding to I&I challenges, which occur when storm water enters the sanitary sewer system, either through unauthorized connections or due to aging infrastructure.

The 2021 AMP expresses the physical condition of the District's sanitary system assets on a range from very poor to very good. It is best practice that utility assets represent a range of physical conditions – this is how the utility disperses renewal costs over time. An objective of asset management planning is to identify optimal renewal cycles that maximize the useful life of infrastructure but replace assets before they reach a critical point in their deterioration that might result in failure.

The study of District assets based on best available information at this time suggests 63.7% of assets are in good or very good condition. A third of assets are in fair condition (34.9%), and a very small portion of assets are in poor or very poor condition (1.4%). The graphic below provides a breakdown of physical condition by asset type.

Figure 3: Asset Condition Distribution by Asset Type



These projections will continue to change as assets age, and the District should seek to continually improve its condition assessment programs to analyze and re-evaluate physical condition on regular basis. Note that physical condition of lift stations could be assessed by their major attributes, informed by the 2018 Pump Station Condition Assessment study. As an example of continual improvement, the District could further refine its lift station condition assessment by more closely examining the component parts of each attribute. The physical condition assessment indicates that some lift station components (pumps, mechanical, electrical) are near end of life. These will be near-term priorities as part of the utility's annual capital plan.

The 2021 AMP also evaluated the functional condition of the District's sanitary system assets by comparing existing peak sanitary flows with maximum capacity. Approximately 7.6 km of gravity mains are at or over capacity, and 1.2 km have less than 10% reserve capacity. In total, these represent 3% of the sanitary main asset base. The 2021 AMP provides guidance for when and how to address these assets, which will be taken into consideration as part of the utility's capital planning processes.

Managing Risk

In addition to asset condition, the 2021 AMP considers strategies for balancing risk. Service level risks are the risks that affect the delivery of the service to the District's customers. In this case, the service provision by the District is to provide an efficient, reliable, responsive, affordable, safe, and environmentally responsible sanitary service to its communities.

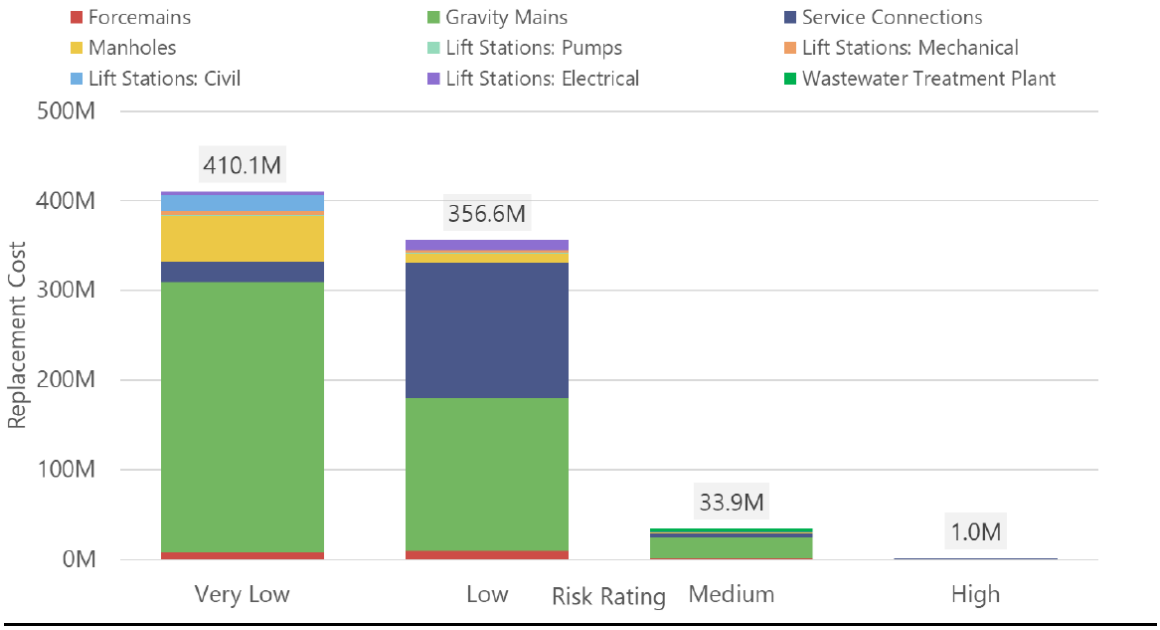
The AMP process recognizes that different assets or asset classes present different levels of risk and criticality. The risks are characterized by the consequence of failure or impact to service delivery and the likelihood of that impact event occurring. Some assets have a more critical

risk factor than others, either because the likelihood of failure is higher or the outcome of failure has a more substantial impact on the sanitary utility system and community.

As part of the 2021 AMP, the District has assessed the service level risks across five risk categories that are relevant to the sanitary service and identified an appropriate action or strategy to mitigate risk.

The figure below represents the overall risk profile of District's asset classes, by asset type and replacement cost.

Figure 4: Risk Profile, All Assets including Replacement Cost



Many of the risk mitigation strategies proposed in the 2021 AMP have been implemented, including: establishing capital reserve funds to cover long-range costs, maintaining an operating reserve, and completing a Sanitary System Master Servicing Study.

Planning for Asset Renewal and System Growth

The strategic planning horizon used for the AMP is 100 years. The Figure 5 below shows the long-term 100-year financial forecast for capital renewals and includes capital upgrades as well as new capital creation forecast to occur within the next 20-year period.

Figure 5: Sanitary System 100-Year Renewal Forecast by Asset Type

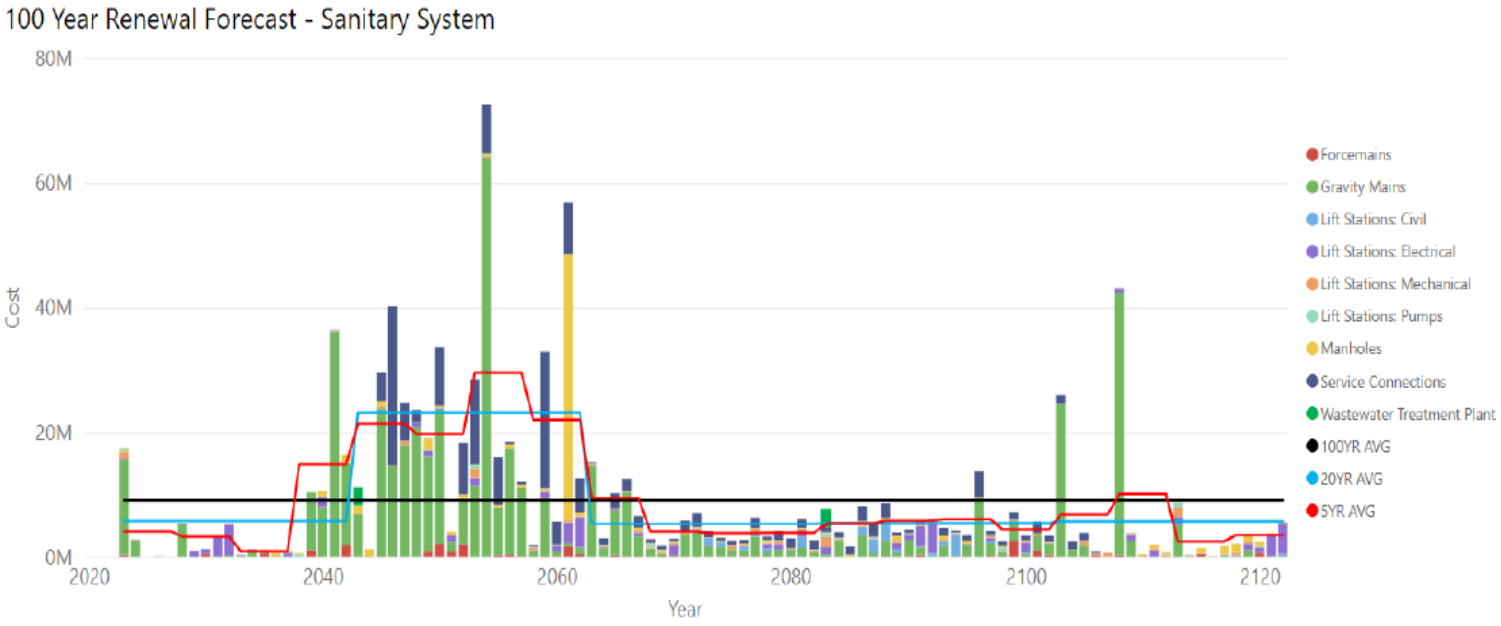


Figure 8-6 Sanitary System 100-year Financial Forecast, by Asset Type

The total forecast capital expenditure for the 100-year analysis period is $907 million, averaging $9 million per year. However, because capital improvement needs beyond the 20-year horizon are difficult to accurately predict, it is the immediate 20-year forecast that is of key importance.

Within the next 20 years, the District will require $96.5 million for capital expenditures, with 17% allocated for system expansion. This equates to approximately $5.8 million per year revenue requirement, which the District is on target to achieve by 2026. A sensitivity analysis shows peak 5-year and 20-year average capital expenditures ranging from $8.7 million to $33.9 million, to be funded from the Sanitary Sewer Utility Capital Reserve.

Operating and maintenance costs for the Sanitary System average $2.26 million annually and are 93% utilized with unspent funds returning to the utility to offset future rate increases. The District maintains a 90-day emergency operating reserve for fiscal emergencies, which aligns with best practices for a municipal utility.

In summary, while the updated AMP provides a great deal of guidance on opportunities for improvement, the findings of the 2021 Sanitary System AMP are not a major departure from trajectory identified in the 2010 AMP. The financial findings from the 2021 AMP have been reflected in the proposed 2025 Sanitary Sewer Utility rates and Five-Year Financial Plan.

Key Areas for On-going Improvement

The 2021 Sanitary System AMP is intended to be a living document and provides a number of recommendations for continuous improvement.

Areas of future work include:

- Continuing to improve data collection and condition assessment programs.
- Maximizing cost savings through smart planning and procurement by continuing to:
    - adhere to prioritization plans in the annual capital infrastructure renewal program for the utility;
    - coordinate capital plans between Water, Sewer and Drainage, and Roads to the extent possible, ensuring capital works are delivered in a cost-effective manner; and
    - employ trenchless construction technologies where feasible, which are more cost-effective, produce fewer GHG emissions, and can be less disruptive to residents.
- on-going analysis of the impacts of construction costs changes and inflation on renewal costs over time, which should be included in financial plans. Inflation is not included in the 2021 AMP cost projections.
- monitoring and responding to risk associated with climate change such as challenges with I&I – including surcharging – and damage to infrastructure due to sea level rise or extreme weather.

Finally, the 2021 AMP also refers to financial planning challenges in the operating budget associated with on-going uncertainty with regard to regional infrastructure costs.

7.2 Climate Change & Sustainability

Timely renewal of assets is a key component in maintaining a healthy sanitary sewer utility system and contributes to effective service delivery.

The District has made notable progress in integrating climate change considerations into its infrastructure renewal planning. By understanding and planning for the impacts, risks, and threats posed by climate change and aging infrastructure, the District can design infrastructure projects that are resilient and adaptive to evolving environmental conditions. This approach enables the District to proactively identify and address potential climate-related challenges, thereby enhancing its capacity to manage and mitigate risks.

Furthermore, staff continually seek new and more sustainable solutions that lower GHG emissions and reduce environmental impacts.

7.3 Public Engagement and Outreach

The District has engaged with residents on numerous occasions over the years related to utilities asset management and impact on utilities rates. On-going communications include Council's annual utility rate setting exercises, the District web page, and an annual "utilities insert" that is provided to all ratepayers with the first quarter utilities statement.

Utility rate setting exercises in 2023 and 2024 have referred to the forthcoming update to the Sanitary System AMP. The 2021 first quarter utilities insert included information about updated AMPs for water and sanitary.

In addition to annual communications, the District has undertaken several more substantial engagement exercises specific to asset management.

- In 2009-10, staff initiated a public engagement process to educate residents about findings of the first series of utility AMPs. This included workshops and presentations to ratepayers' associations, where staff received overall support for addressing the anticipated asset funding gap in utilities rate-setting process.
- In 2017, staff completed another engagement process to inform ratepayers in advance of the District's introduction of separate line items for municipal and regional sewer charges to improve transparency for ratepayers. The rate restructuring was the result of an update to the District's rate model, which is used for annual rate setting. This process included additional utility bill inserts with information about proposed changes, and in-person workshops.

Outside of the municipal utilities, the District has made other efforts to engage and educate ratepayers about the concepts of asset management and long-term funding requirements of the District's many assets. This public engagement annually occurs as part of the District's general fund budgeting process. The District established a general fund Asset Levy in 2016 to provide long-term funding mechanism for renewal of non-utilities assets.

7.4 Other Communication, Consultation, and Research

This report is informed by the 2021 Sanitary Utility AMP that was completed in 2022, with consultant support from WSP Canada Inc. The report and the upcoming rate setting process for the Sanitary Sewer and Drainage Utility Fund is a collaborative effort with the Finance Department.

Staff will continue to provide information to the public on utilities rates, asset management, and District owned and operated utility systems and services using available communication channels with the support of the District's Communications Department.

8.0 Options

8.1 Recommended Option

THAT

1. The October 7, 2024 report from the Senior Manager, Engineering Services titled “Sanitary Utility System Asset Management Plan Update” be received for information.
2. Council endorse the 2021 Sanitary System Asset Management Plan.

8.2 **Considered Options**

Council may request additional information on the Sanitary System AMP and utility finances or provide alternate direction (to be specified).

9.0 Conclusion

This report provides Council an overview on the state of asset management planning for the District’s local sanitary utility system infrastructure. In 2010, the District completed its first Sanitary System AMP, and the utility has operated under this plan for a decade. The 2010 plan is outdated and is being replaced by the 2021 Sanitary System AMP.

In summary, the financial findings of the 2021 Sanitary System AMP suggest that District is in a good position with regard to advance planning for long-range costs of renewing local system infrastructure on the 20-year horizon. The District’s local operating budget provides sufficient resources to manage system at its current level of service based on best available information at the time the report was produced.

Capital and O&M budget needs will continue to change over time due to the change state of infrastructure (e.g. aging assets), economic factors (e.g. inflation) and environmental factors (e.g. impacts of climate change). O&M budget needs are reassessed on an annual basis as part of annual utility rate setting exercise, while longer-term capital funding requirements are reassessed through iterative asset management planning practices.

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Appendices:

Appendix A: 2021 District of West Vancouver Sanitary System Asset Management Plan Summary

APPENDIX A

District of West Vancouver

Sanitary System Asset Management Plan

2021

Document Control

Version: 2021 Wastewater System Asset Management Plan

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Document History and Status

Revision	Date	Revision Details	Author	Reviewer	Approver

The preparation of this project was carried out with assistance from the Government of Canada and the Federation of Canadian Municipalities. Notwithstanding this support, the views expressed are the personal views of the authors, and the Federation of Canadian Municipalities and the Government of Canada accept no responsibility for them.

Contents

1 Executive Summary

1.1 Background

The District of West Vancouver (District) has commissioned the development of an updated Sanitary System Asset Management Plan (SSAMP) using the latest standards and best practices, up-to-date asset information, pertinent studies, and financial information available since the first asset management plan originally developed in 2010. The long-range forecast (100 years) of future sanitary infrastructure renewal requirements will assist in planning for the financial sustainability of the District's infrastructure and service delivery in perpetuity. Key to the success of the SSAMP is the development of an Asset Forecast Model which will require close collaboration with District staff to ensure that modelling parameters are represented accurately for optimal functionality, including estimated service lives and remaining service lives, physical condition calculations, unit construction costs and replacement values, sensitivity-based long-range renewal forecasts, and input from the 2019 Master Sanitary Servicing Study (MSSS).

1.2 System Description (Inventory, Value)

As of 2021, the District's sanitary system is comprised of one wastewater treatment plant (WWTP), lift stations, collection mains, service connections, and manholes as summarized in Table 1 below.

Table 1 Sanitary System Asset Summary

Asset Type	Quantity	Estimated Replacement Value	
		Component Value	Total Replacement Value
WWTP-Citrus Wynd	1		$2,909,000
Lift (Pump) Stations	54		$43,248,000
Civil Component		$18,525,000	
Mechanical Component		$7,475,000	
Electrical Component		$15,660,000	
Pump Component		$1,589,000	
Gravity Mains	339,797 m		$495,471,000
Forcemains	11,769 m		$19,631,000
Service Connections	12,693		$177,702,000
Manholes	4,473		$62,622,000
Total			**$801,583,000** [(1)]

(1) Note: The value may not add up exactly due to rounding numbers for reporting.

1.3 State of Infrastructure (Condition, Capacity)

A state-of-infrastructure assessment provides information on what infrastructure assets are owned by the District and their physical and financial status. These insights can be used to inform the District of any trends such as aging infrastructure, increasing asset base, and/or decreasing condition.

Figure 1-1 below summarizes the overall condition for the sanitary system infrastructure assets. Asset condition ranges from very poor to very good, the majority being in good (45%) or fair (35%) condition. A small portion of assets are in poor (0.74%, approx. $6.4M) or very poor (0.7%, approx. $5M) condition.

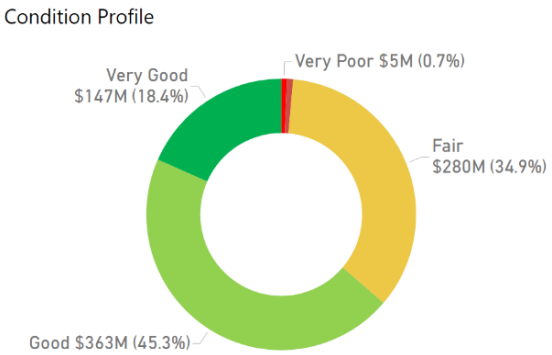


Figure 1-1 Asset Condition Distribution, All Assets

It is crucial to ensure that the assets are meeting their functional (i.e., capacity) requirements as well as their physical condition. To evaluate the asset's functional condition, existing sanitary peak flow rates are compared to the maximum capacity. Figure 1-2 below illustrates reserve capacity distribution for gravity mains by replacement cost. Approximately 7.6 km of gravity mains are at, or over capacity ($12M) and 1.7 km of gravity mains have less than 10% reserve capacity left ($3M).

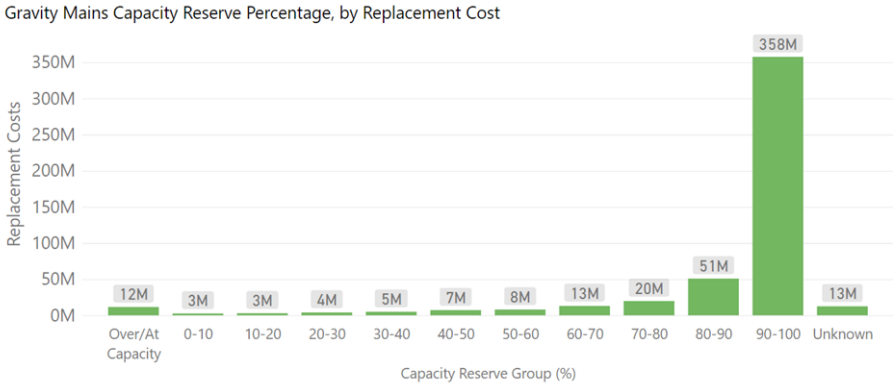


Figure 1-2 Gravity Mains Reserve Capacity Distribution

Table 2 below presents a summary of the state of the sanitary infrastructure assets owned by the District.

Table 2 Dashboard on State of Sanitary Infrastructure Asset Portfolio – 2022

Asset Type	Quantity	Current Average Asset Age [years]	Average Expected Useful Life [years]	Average Asset Condition	Current Asset Replacement Value [$'000]	100 YR Average Per Annum Renewals Cost [$'000]
Forcemains	11,769 m	37	77	2	$19,631	$208
Gravity Mains	339,797 m	48	82	2	$495,471	$5,063
Service Connections	12,693	46	85	2	$177,702	$1,778
Manholes	4,473	44	75	2	$62,622	$698
Lift Stations	54					
LS: Mechanical	54	34	42	1	$7,475	$203
LS: Pumps	54	32	35	2	$1,589	$88
LS: Electrical	54	33	38	3	$15,660	$567
LS: Civil	54	32	62	1	$18,525	$193
WWTP-Citrus Wynd	1	20	40	2	$2,909	$58
Total		**46**	**80**	**2**	**$801,583**(1)	**$8,854**(1)

(1) Note: The value may not add up exactly due to rounding numbers for reporting.

1.4 Levels of Service and Demand Management

Levels of service are statements describing the outputs the District intends to deliver from a customer point of view. A well-defined level of service framework will allow the District to collaborate with its customers and key stakeholders to identify the appropriate balance between community expectations and affordability for target service levels.

The service criteria considered for definition of current level of service are:

- **Environmental Responsibility** – Is the discharged effluent environmentally safe, odourless, and compliant with recommended standards and regulations?
- **Service Reliability** – Are assets maintained in a state of good repair and functionality to reliably deliver the service?
- **Responsiveness** – Are unexpected service disruptions dealt with efficiently and adequately?
- **Efficiency** – Are resources used in the most productive way possible to deliver the agreed levels of service?
- **Affordability** – Does the District deliver the agreed levels of service at a reasonable cost that is comparable to other municipalities?

The major asset classes considered for supporting the wastewater service levels are wastewater treatment plants, lift stations, and pipes. Sewer manholes and other associated infrastructure are considered integral within these three major asset classes.

1.5 Managing Risk

Risk is the effect of uncertainty on the achievement of an organization's objectives. Risk management includes to implement a systematic approach of identifying, analyzing, evaluating, and treating any risks that may impede the District's achievement of objectives and delivery of the agreed level of service to the District's customers.

Risk is evaluated at both the service level and the asset level. Service level risks are system, procedure, and external influences and events that affect the delivery of the service to the District's customers. Asset level risks are the likelihood of failure of each asset and the consequence the asset failure would have on delivery of the service.

The results of service level risk guide decisions about business processes, planning, and service management. The results of asset level risk assessments inform decisions for asset lifecycle strategies to determine the most appropriate treatments, planned maintenance, and inspection frequencies for a particular asset or group of assets and guide

decisions on priorities for capital replacement projects. Figure 1-3 below illustrates the mitigated risk scores for each service category.

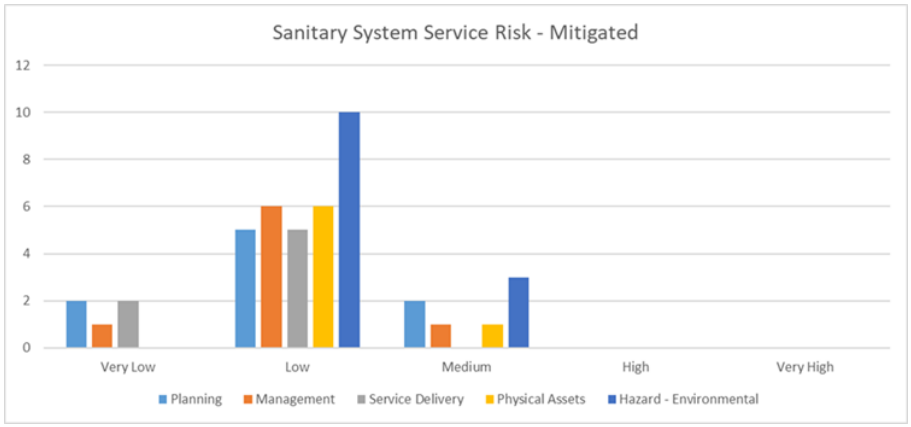


Figure 1-3 Service Level Risks - Mitigated

Note that mitigated risk scores can only be achieved after identified mitigation measures are in place. Section 1 of the SSAMP provides details on mitigation measures and current risk scores.

Figure 1-4 below illustrates the current asset risk profile summarized by replacement cost. Most sanitary sewer assets are rated low risk because they are in good and very good condition and not a high risk of failure currently. Asset risk changes as assets age and physical or functional condition deteriorates.

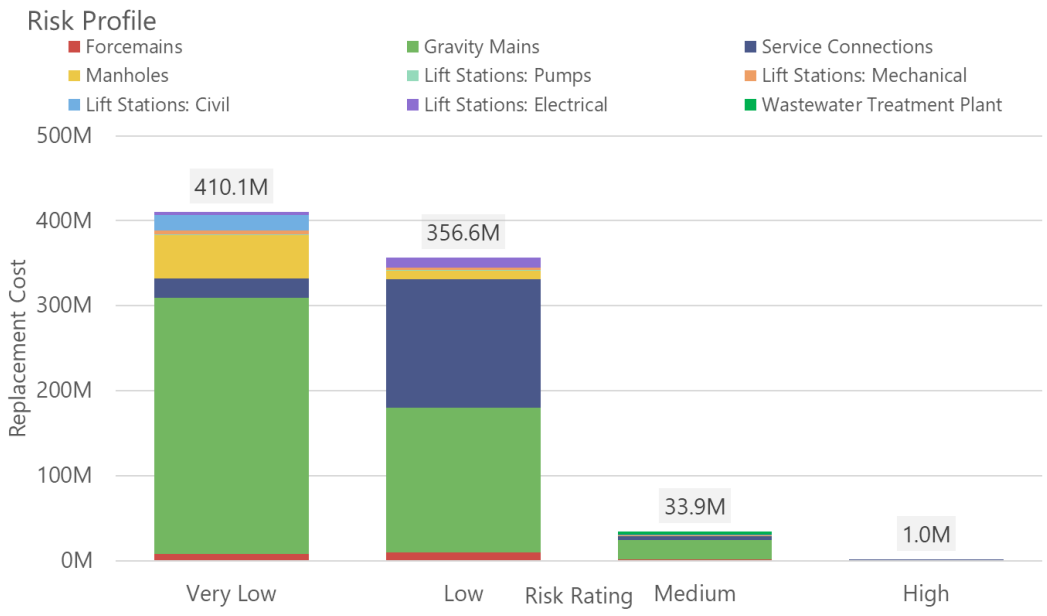


Figure 1-4 Risk Profile, All Assets by Replacement Cost

1.6 Financial Forecast

The District's Sewer Utility and its financial plans includes the regional sewage treatment levy from Metro Vancouver (MV), the Greater Vancouver Sewerage and Drainage District. The regional wastewater treatment levy reflects the District's actual costs of treatment, but also embedded in the levy are the District's share of regional capital asset renewal costs for treatment infrastructure. Regional capital renewal costs are expected to rise as regional infrastructure reaches end-of-life. The District has limited control over regional asset renewal schedules, but has been taking steps to build up a Reserve fund and smooth future rate impacts for rate payers in anticipation of regional cost increases.

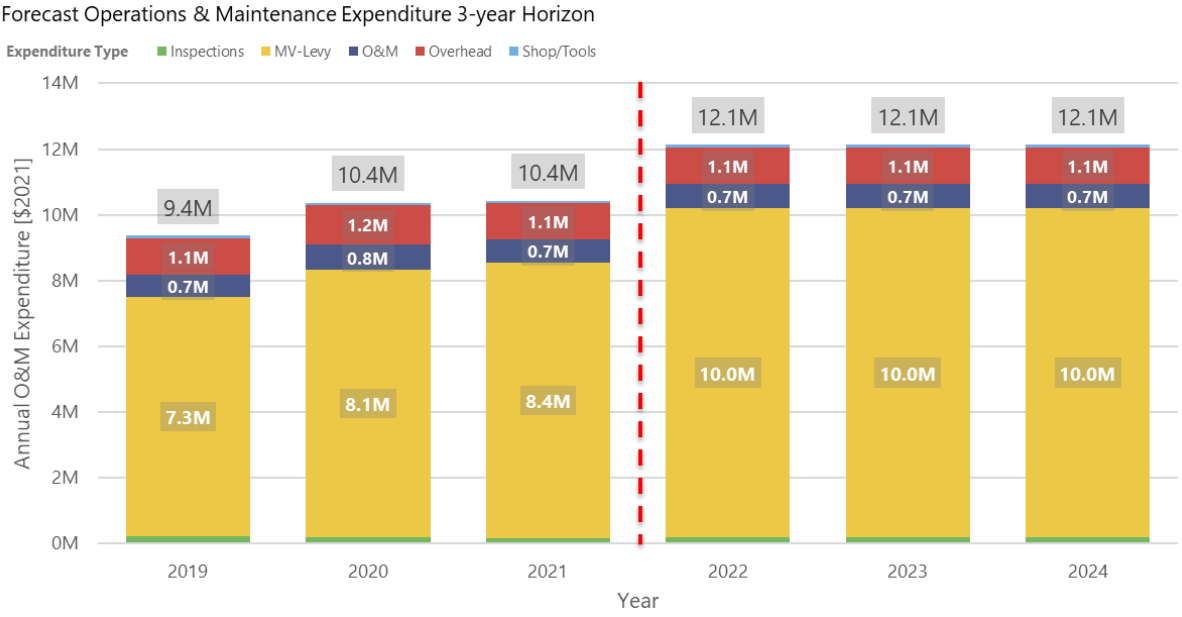


Figure 1-5 Forecast Operations and Maintenance Expenditure 3-year Horizon

To meet or exceed the expected useful life of all sanitary system assets, the planning horizon for the SSAMP financial forecast is 100 years. This provides necessary context for decision-makers. The long-term financial forecast is developed based on average values for two key input parameters - unit costs and expected useful lives of assets. Figure 1-6 shows the total forecast capital expenditure for the 100-year analysis period by asset type. The total forecast is $907M over 100 years (or approx. $9M per annum).

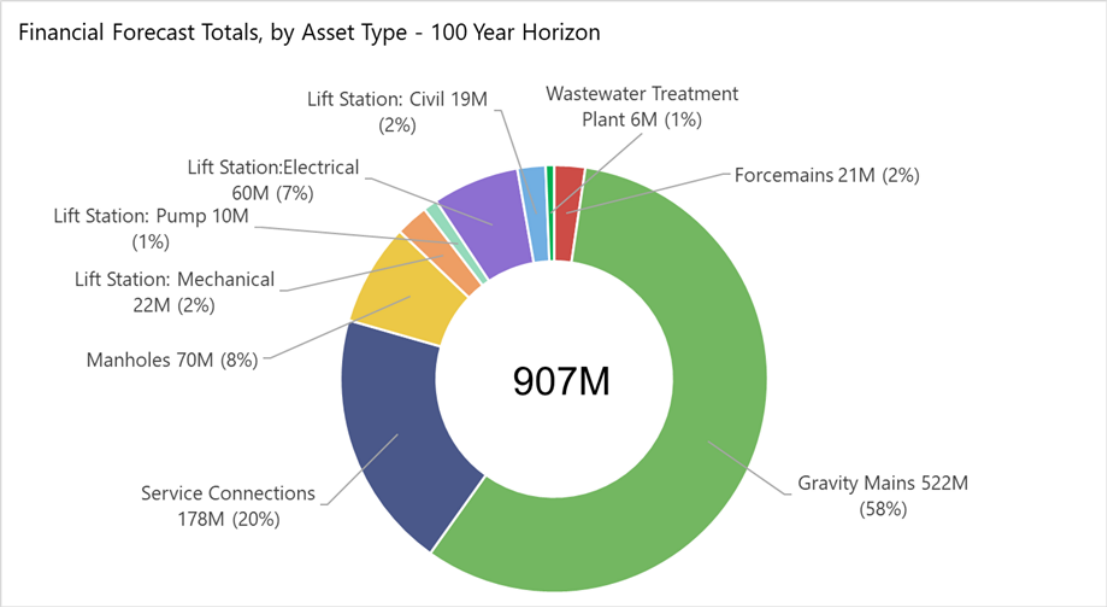


Figure 1-6 Total Forecast Capital Expenditure - 100-Year Horizon, By Asset Type

To address uncertainty related to expected useful lives of assets, the financial forecast was developed for 3 scenarios (estimated most likely lifespan and +15% and -15% lifespan values). Table 3 below reports peak 5-year and 20-year averages for capital expenditure for each scenario as well as the total 100-year expenditures and the average per annum expenditure based on the 100-year totals.

Table 3 Sensitivity Analysis Summary – Capital Expenditure Forecast [in $2021]

Planning Period	Worst Case [-15% EUL(1)]	Most Likely [EUL(1)]	Best Case [+15% EUL(1)]
Peak 5 Year Average per Annum Total Capital Expenditures	$33.9M	$29.5M	$29.1M
Peak 20 Year Average Per Annum Total Capital Expenditures	$23.4M	$23.2M	$17.2M
Total 100 Year Average Per Annum Total Capital Expenditures	$14.3M	$9.1M	$8.7M
Total 100 Year Capital Expenditures	$1,426.2M	$907.4M	$871.9M

(1) EUL = Estimated Useful Life

Table 4 below shows a breakdown of the forecast capital expenditure within the next 20-year period between 2023 and 2043. The analysis shows that the District will require $96.5M in the next 20 years (or $5.8M per year) for capital expenditures. Out of $96.5M, about 17% ($19.3M) is for expansion of the existing system.

Table 4 Sanitary System 20-Year Financial Forecast, By Asset Type and By Expenditure Type

Asset Type	Total 20-Year Expenditures	Total 20-Year New & Upgrade Expenditures	Total 20-Year Expenditures	20-Year Average Per Annum
Forcemains	$4,616K	$343K	$4,273K	$231K
Gravity mains	$91,132K	$14,417K	$76,716K	$4557K
Service connections	$56K	-	$56K	$3K
Manholes	$3,696K	-	$3,696K	$185K
Lift Station: Mechanical	$1,927K	$1,122K	$805K	$96K
Lift Station: Pump	$1,322K	$358K	$964K	$66K

Asset Type	Total 20-Year Expenditures	Total 20-Year New & Upgrade Expenditures	Total 20-Year Expenditures	20-Year Average Per Annum
Lift Station: Electrical	$12,984K	$3,044K	$9,940K	$649K
Lift Station: Civil	$125K	-	$125K	$6K
WWTP-Citrus Wynd	-	-	-	-
Total	$115,858K	$19,282K	$96,576K	$5,793K

Figure 1-7 below shows the long-term 100-year financial forecast for capital renewals and includes capital upgrades and new capital creation forecast to occur within the next 20-year period. Capital improvement needs beyond the 20-year horizon are not currently known/assessed.

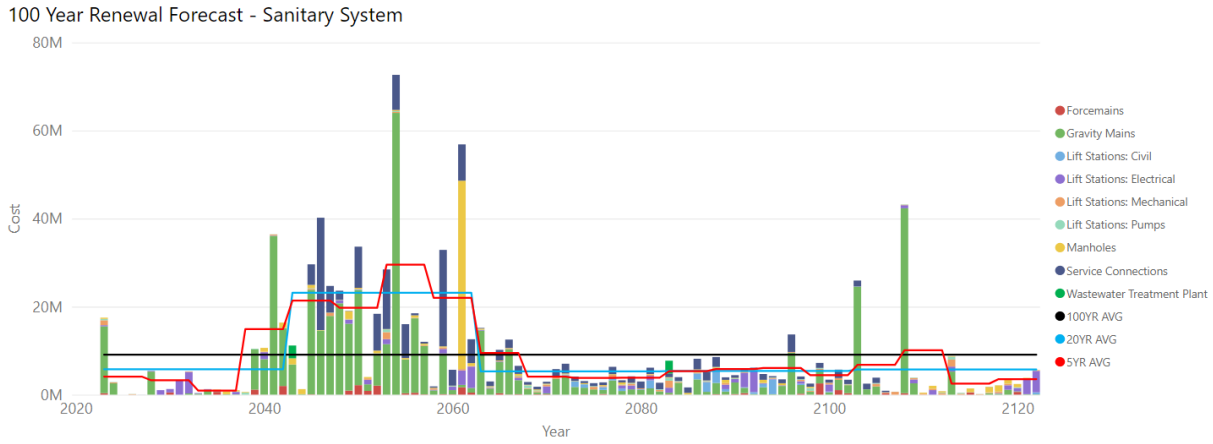


Figure 1-7 Sanitary System 100-year Financial Forecast, by Asset Type

The District has several revenue streams to support the future investment in service delivery to the community, including Property taxes and utility fees; Regular grants and other revenue streams from other levels of government (e.g. Canada Community-Building Fund); Development cost sharing arrangements; Operating fund surplus reserves; Capital fund surplus reserves; Capital replacement reserves; Debt funding (loans). Section 1 of the SSAMP provides further details on financial forecasts and strategies.

1.7 Mitigative Measures / Next Steps

The demand on District infrastructure can impact how the infrastructure is managed and maintained. The demand drivers that may impact the District's service delivery include changes in population, land use, per capita usage, legislation changes, and climate change.

Mitigative measures such as monitoring change in external influences on the wastewater utility and implementing strategies to maintain assets in good working order and education to manage service level expectations will help to manage risks on the wastewater service. However, such measures will not eliminate the need for a comprehensive funding strategy to pay for the proposed improvements required to maintain the system at the expected level of service.

A "pay-as-you-go" is currently the primary approach to utility funding but this will not adequately bridge the gap between current and required funding levels without steep utility rate increases. Considerations towards grant funding, debt servicing, DCC's, and any other possible funding mechanisms are being considered and is part of the District's funding strategy.

This Plan has been prepared to contribute to informed decision-making, improved management of risks, and a reduction in costs over time. A key purpose of the Plan is to provide an updated long-term roadmap to manage the wastewater system assets so that costs, risks, and benefits are effectively balanced over the next 100 years to deliver a sustainable service to the community.

The following figure (Figure 1-8) illustrates the financial forecast over the entire 100-year planning horizon.

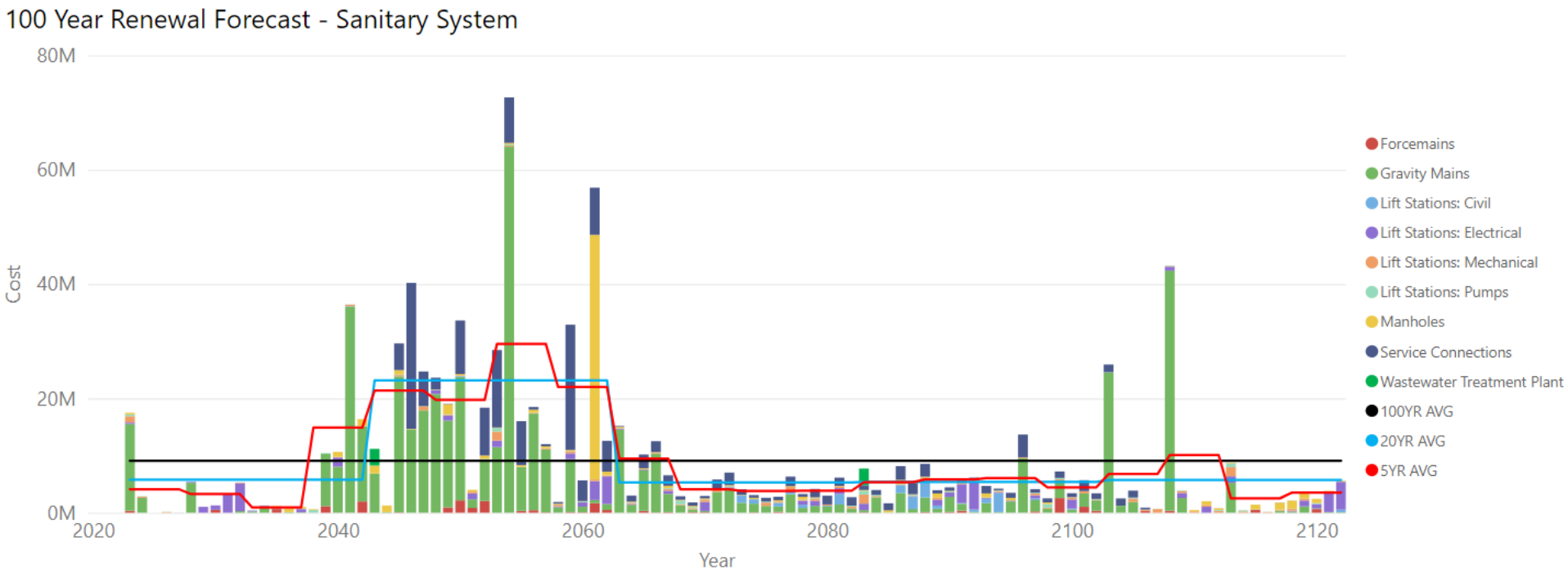


Figure 1-8 Sanitary System 100-year Financial Forecast, by Asset Type

2 Introduction

2.1 Purpose

The District of West Vancouver provides wastewater collection and disposal to a population of over 42,470 residents. This includes the collection, conveyance, pumping, and treatment, or connection to treatment by others (Metro Vancouver) of an estimated average of 20 million litres of wastewater daily. Each aspect of the municipal wastewater network requires responsible operation, maintenance, and renewal of physical assets.

Asset management helps deliver services in a way that achieves the required level of service for the least overall cost and within acceptable risk boundaries. Value is delivered to the community by effectively managing existing and new physical assets. This will help build a resilient community over the long-term.

This Asset Management Plan (Plan) provides details on the District's wastewater services. It outlines the current state of the District's wastewater infrastructure assets, objectives, level of service, lifecycle practices, and risk strategies, that will be taken when delivering services to the District's customers.

This Plan is a public document that provides short, medium, and long-term views. It has been prepared to contribute to informed decision-making, improved management of risks, and a reduction in lifecycle costs over time. A key purpose of the Plan is to provide an updated roadmap to manage the wastewater system assets so that costs, risks, and benefits are effectively balanced to deliver a sustainable service to the community.

2.2 Scope

Table 5 outlines the sections included in this Asset Management Plan, along with the key question each section will answer, and a brief content description.

Table 5 Asset Management Plan Sections

Plan section	Key question to be answered	Content description
Executive Summary	Key outcome points	Provides an introduction and overview of the plan and answers key questions about the asset portfolio for the reader and discusses next steps.
Introduction	Why is a plan needed?	Purpose and scope of the plan.
Asset Management System	What is an asset management system and its key components?	Outlines the key components of an asset management system. Provides a summary of the asset management policy and asset management strategy.
State of Infrastructure	How is the District doing?	Outlines the state of infrastructure including: • What does the District own and where it is? • Core and high value assets • The condition of assets • The cost to replace assets • Understanding the confidence in forecast based on data reliability
Levels of Service	Why does the District own assets?	Discusses customer expectations and describes the outputs the District intends to deliver. In the future this section will also discuss trade-offs customers are willing to make between costs and services after consultation on this.

Plan section	Key question to be answered	Content description
Lifecycle Management	How does the District provide service?	Optimizing the management of its existing and future assets to provide the required services by: • Maintaining and operating existing assets • Renewing existing assets • Providing new assets
Risk Strategy	How does the District manage risk	Identifying and managing risk.
Financial Forecast	What will it cost and how to pay for it?	Estimates the costs to operate, maintain, renew, or replace existing assets, and acquire new assets, and identifies funding sources to cover the costs.
Continuous Improvement Plan	How can the District do things better?	A prioritised list of the areas for future improvement within the Asset Management Plan.

2.3 Plan Updates and Endorsement

This latest iteration of the Wastewater System Asset Management Plan, dubbed 2021 SSAMP, is built upon the 2010 SSAMP and the findings and recommendations of the 2014 CCTV Program – Sanitary report (OPUS DK, 2014), information from the annual CCTV program, Sanitary Master Planning Study (Kerr Wood Leidal, 2019), and the Sanitary Pump Station Condition Assessment Report (KWL, 2018).

The District's asset management journey since 2010 reflects that all asset management strategies and plans are "living documents". In the future it is intended that the SSAMP will be regularly reviewed (every 3-5 years) and updated to reflect continuous improvement.

The Council and Chief Administration Officer will be given the opportunity to review this plan and acknowledge the need to support implementation and continuous improvement of asset management by the District.

2.4 Plan Icons

Table 6 shows some key icons that are used throughout this Plan to emphasize areas for improvement of the Plan.

Table 6 Plan Icons

Icon	Definition
	**SSAMP Update** - Indicates how new information has been incorporated in this Asset Management Plan revision and how this may revise assumptions found in the previous Asset Management Plan.
	**Opportunity for Improvement** - Indicates an opportunity to develop asset management practices or activities to improve the performance or outcomes of the system or activities.

3 Asset Management System

3.1 What is the Asset Management System?

An Asset Management System is more than just asset management software. An asset management system would encompass the District's policies, plans, business processes, and information systems, which together achieve the District's asset management objectives, and ultimately its long-term vision. It includes the people, processes, and technology needed to help the District achieve these.

While there is a strong knowledge base within the District regarding asset issues, documentation and monitoring of the issues is sometimes informal, which can lead to inconsistencies and missed opportunities. For example, when future programs are not documented and shared, operational decisions could be made without being awareof planned replacement or upgrade work. This can result in lost opportunity to coordinate work and save money. In recent years, the District has started a more formalised asset management system structure and continue to make improvements to the system. This will continue to assist the District in describing how asset management functions within the organization and establish this communication and a consistent business approach and business plan.

The overview and framework provided in this section shows how separate asset management processes and resources relate to each other in the asset management system. This sets the context for the remainder of the Asset Management Plan.

3.2 "Line of Sight" for Asset Management

The Asset Management Plan shows how the management and operation of assets contributes to achieving goals and objectives. There needs to be a clear "line of sight" between the high-level objectives of the organization and the day-to-day activities and decisions carried out on the District's assets.

Figure 3-1 shows the concept of "line of sight" from the District's Vision, Mission and Values down through the District's strategic plans, Asset Management Policy, Asset Management Strategy, and Asset Management Plans, through to implementation of physical works and performance of assets.

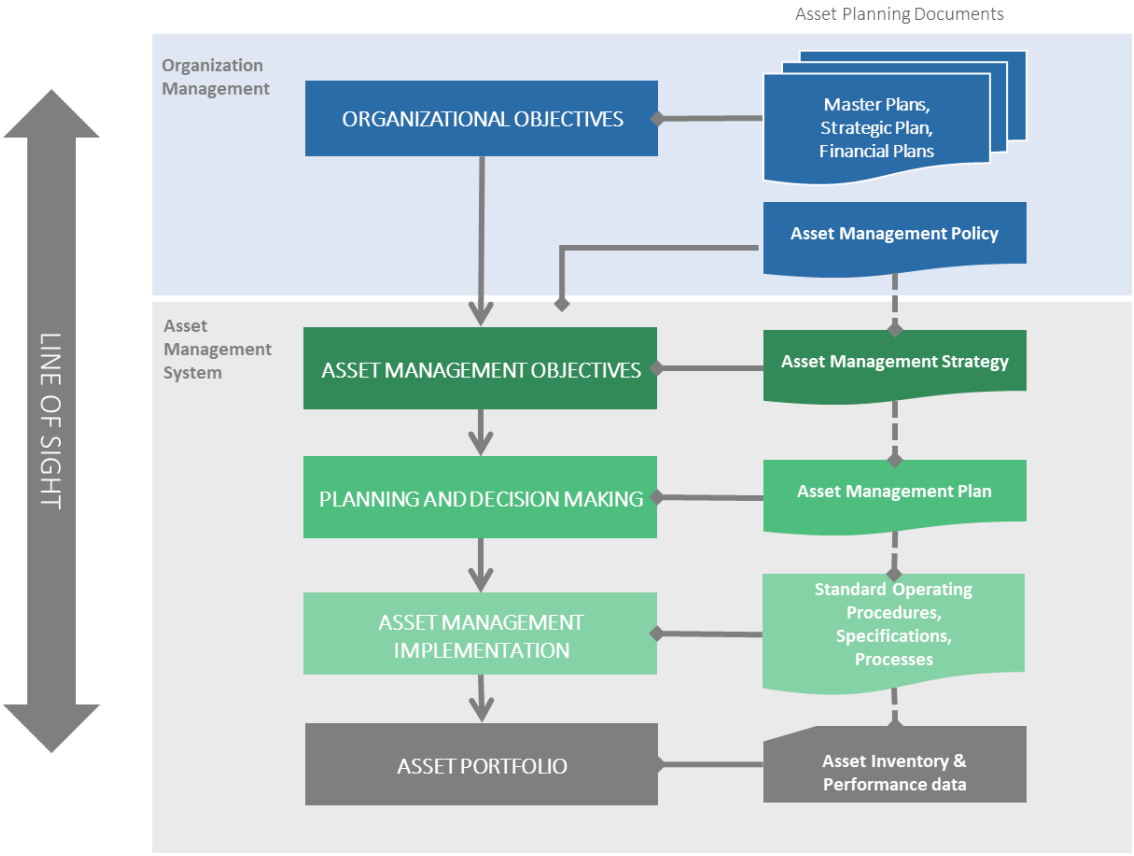


Figure 3-1 Line of Sight for asset management outcomes

3.3 Asset Management Policy

The District's Capital Asset Management Policy (#0054) establishes guidelines for an effective system for the management of the District's investment in capital assets, to comply with legislation, and to ensure that best practices in asset accounting and financing are followed. The Capital Asset Management policy is based on asset management principles set out by Asset Management BC, and on principles for the accounting treatment of public sector capital assets which comply with General Accepted Accounting Principles (GAAP) and with the Public Sector Accounting Board (PSAB) Section 3150.

3.4 Asset Management Strategy

District assets are managed by several departments and personnel, and team integration and collaboration has been an ongoing focus to increase communication and establish common approaches. The objective of the Strategy is to establish a framework that guides more consistent planning and decision-making across the District, supporting the District's ability to provide services to the community more efficiently through its assets.

The District's Capital Asset Management Procedure (#0055) is associated with the Capital Asset Management Policy (#0054). The purpose of the procedure is to outline the process to be undertaken to achieve effective ongoing management and planning for the District's capital assets, recognizing that effective management of capital assets is crucial to the long-term fiscal sustainability of the District. The procedure document (#0055) articulates the District's focus on sound management and funding practices for the District's capital assets through a coordinated, cost effective and sustainable approach.

The Wastewater System Asset Management Plan for the District has been developed with the District's Capital Asset Management Policy (#0054) and Capital Asset Management Procedure (#0055) in mind, to align with key corporate objectives and procedures for the safe and effective management of the District's wastewater utility.

The following two figures outline the context, framework, and responsibilities for the District's Management System for Asset Management.

- Figure 3-2 presents a framework to demonstrate an asset management system showing the key practices, processes, and tools, including the Asset Management Plan.
- Figure 3-3 identifies the asset management roles and high-level responsibilities within the District.

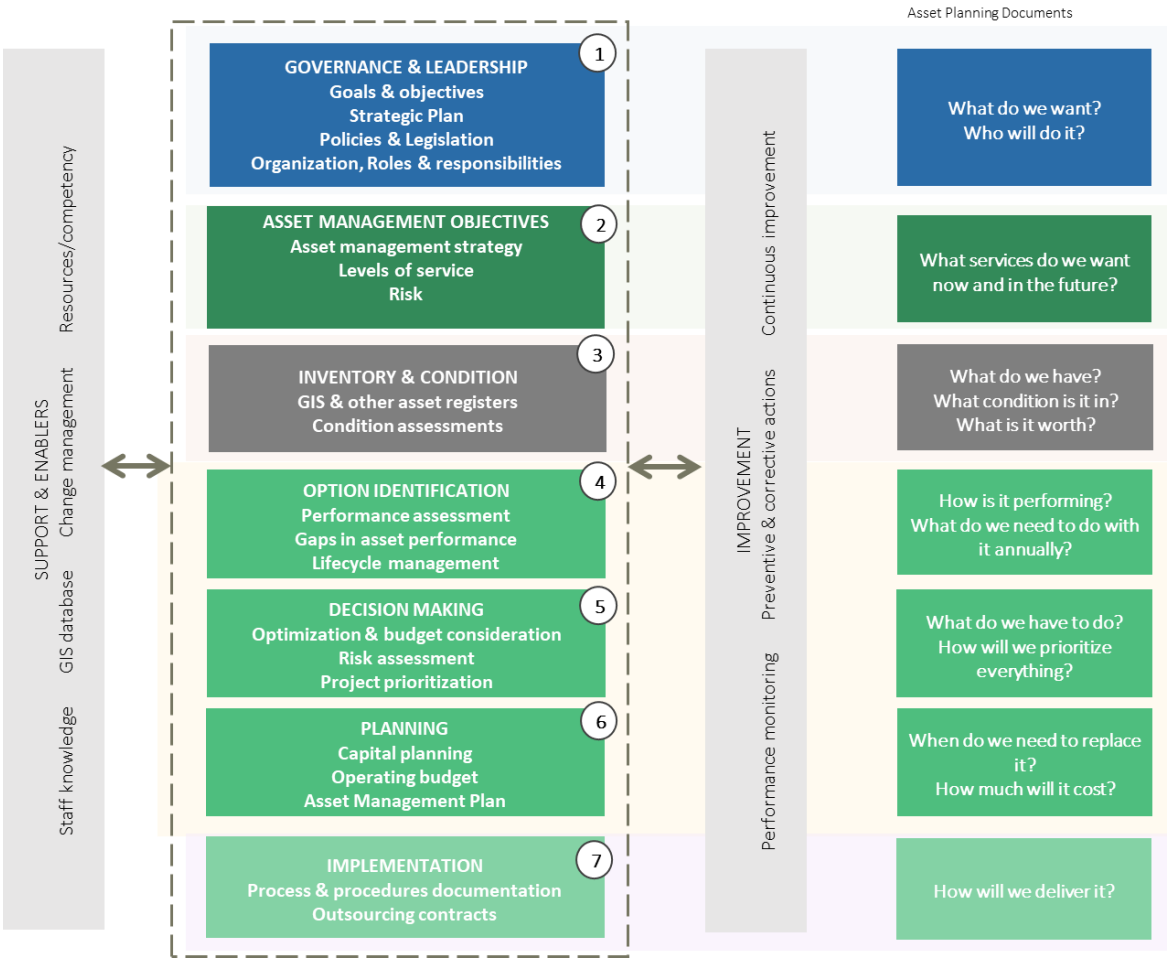


Figure 3-2 Asset Management Framework

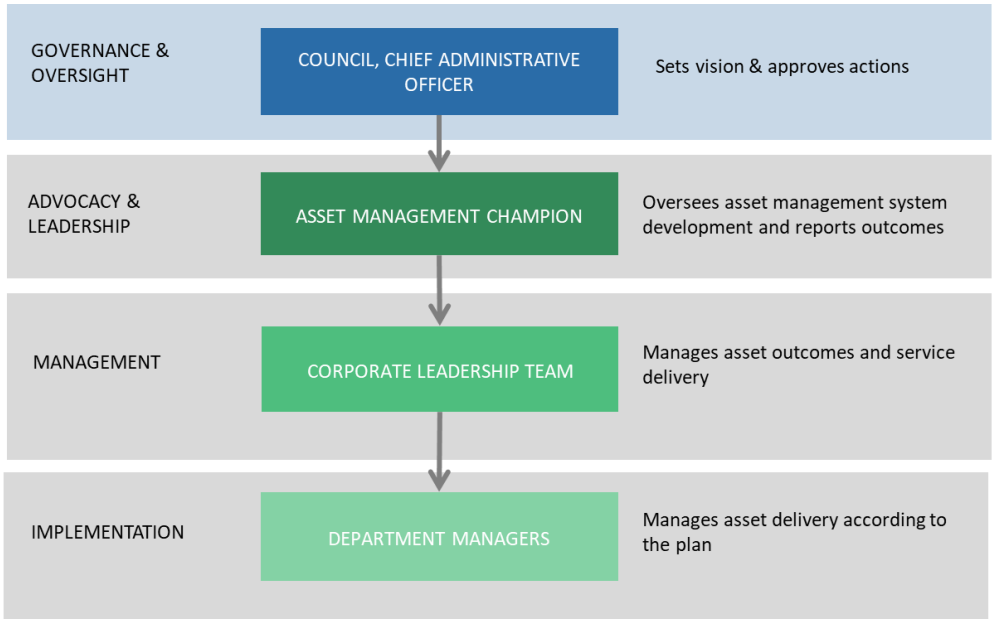


Figure 3-3 Governance Roles and Responsibilities

3.5 Asset Management System Improvement Actions

Table 7 lists the improvement actions that will improve the quality and usefulness of the key asset management system elements, including the asset management strategy.

Table 7 Asset Management System Improvement Actions

Task No.	Improvement Task Name	Improvement Task Description
3.1	Asset Management Policy & Procedure	Review and revise draft Capital Asset Management Policy (#0054) and Procedure (#0055).
3.2	Roles and Responsibilities	Review key asset management roles and responsibilities and identify who will fulfill these.
3.3	Resource Plan	Develop a Resource Plan to identify resource needs for completing asset management improvement tasks.
3.4	Asset Management Goals	Document departmental asset management goals.
3.5	Asset Management Training	Establish an asset management education and training program to support staff in learning key asset management principles and applying these to their everyday work.

Opportunity for Improvement

A. The new AMBC Competency Framework can be used to identify capabilities and skillsets that the District needs and design a training program to deliver those capabilities and skills and build capacity within the organization.

B. The Service Sustainability Assessment Tool is also a useful AMBC resource made to help local governments identify current sustainability performance and prepare for the future. Once populated with data, the SSAT dashboard tool generates reports for all levels of organization (i.e. staff, managements, Council).

4 State of Infrastructure

4.1 Overview

This section of the plan provides a State of the Infrastructure assessment of the District's current sanitary system infrastructure assets. A state-of-infrastructure report provides an objective assessment of the physical and financial status of infrastructure assets. The purpose of this section is to answer the following fundamental questions:

- What assets does the District own?
- What are the District's assets worth (i.e., what is the current replacement value)?
- What is the condition of the District's assets?

The results provide an objective assessment of infrastructure age, value, and condition. These insights can be used over time to inform the District of any trends such as aging infrastructure, increasing asset base, and/or decreasing condition. By helping the District understand what it owns, where it is, what condition it is in, and how much it would cost to replace it, a well-defined state of infrastructure report guides the District's investment decisions aimed at achieving the levels of service.

4.2 Asset Data

Robust asset data is the foundation of a broader asset management information system and is a key resource that enables most asset management functions. Well-defined, granular, and reliable data allows owners to derive key information on an organization's assets which serves as the basic starting point for many asset management processes.

Table 8 outlines the data that has been captured for this plan and where it can be found.

Table 8 Types of Data

Type of Data	Where it can be located
Location	The District keeps As-built drawings and GIS shapefiles as records of location for their assets. This information is housed and accessible from the Maintenance Connection platform, software used to schedule and organise maintenance of infrastructure.
Quantity	Number of assets is also contained in Maintenance Connection inventory.
Performance/Condition Data	The District undertakes regular maintenance and inspection programs, including annual CCTV inspections of gravity mains and condition assessment of lift (pump) stations. The following reports and sources were reviewed: • Sanitary Pump Station Condition Assessment (KWL, 2018) • CCTV inspections data • CCTV Export from CMMS
Theoretical Useful Life	Multiple data sources were used. The theoretical useful life values are based on typical useful lives used across numerous municipalities as well as values supplied by the District's Engineering Department. The following reports and sources were reviewed: • Sanitary Master Planning Study (KWL, 2019) • Sanitary Pump Station Condition Assessment (KWL, 2018)
Remaining Useful Life	Determined by known condition data, or if this information was not available it was estimated based on age.

Type of Data	Where it can be located
Replacement Value	Multiple data sources were used, and as required, translated into 2021 costs using ENR(1) Cost Index. The following reports and sources were reviewed: • Water System Asset Management Plan (WSP, 2021) • Sanitary Master Planning Study (KWL, 2019) • Unit rates as supplied by the District

(1) ENR Cost Index used due to discontinuation of Statistics Canada's Infrastructure Construction Index in 2019

The District's Maintenance Connection is proprietary software used to coordinate maintenance and work orders. It is a database of the District's assets, and includes information on asset install date, make, and size. All major asset groups are represented, as well as important sub-components. The software includes a GIS interface so that the location of each asset and components are also detailed.

The Maintenance Connection (MC) was established in recent years and inputting data for each asset category is an ongoing work in progress. Maintenance Connection contains some information on physical condition. MC is designed to contain both internal and external condition assessments as well as replacement details.

A robust asset data inventory is the foundation for enabling most asset management functions. All financial and technical data associated with an asset's lifecycle should be linked directly to the asset. A similar approach has been implemented with the District's water asset and will be reciprocated for the sanitary assets.

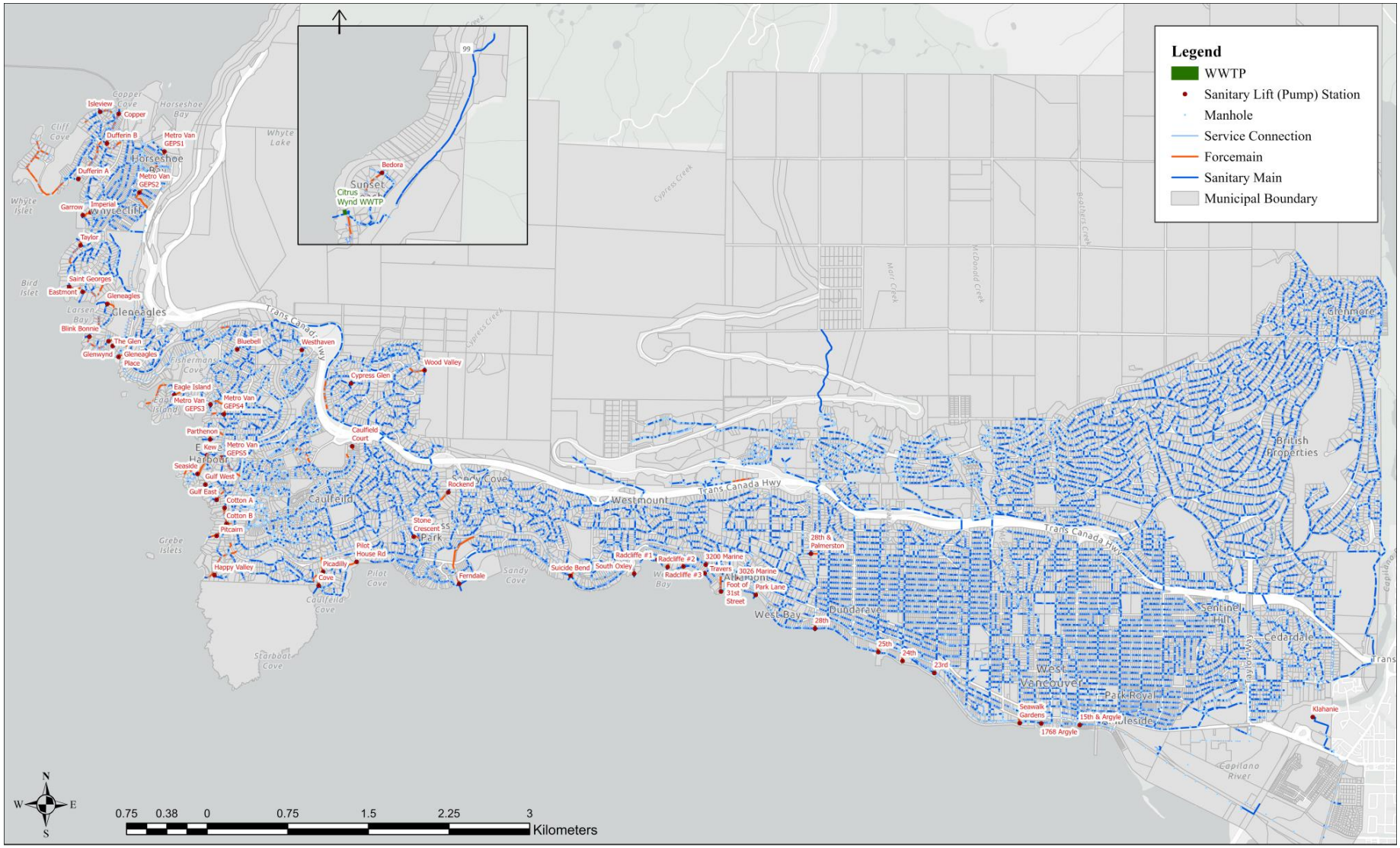


Figure 4-1 Sanitary System Layout

4.3 Asset Value

This section provides an overview of the sanitary system assets by type.

As of 2021, the system is comprised of one wastewater treatment plant, lift stations, collection mains, service connections, and manholes as summarized in Table 9.

Table 9 Sanitary System Asset Summary

Asset Type	Quantity	Estimated Replacement Value	
		Component Value	Total Replacement Value
Wastewater Treatment Plant	1		$2,909,000
Lift (Pump) Stations	54		$43,248,000 (1)
Civil Component		$18,525,000	
Mechanical Component		$7,475,000	
Electrical Component		$15,660,000	
Pump Component		$1,589,000	
Gravity Mains	339,797 m		$495,471,000
Forcemains	11,769 m		$19,631,000
Service Connections	12,693		$177,702,000
Manholes	4,473		$62,622,000
Total			$801,583,000 (1)

(1) The value may not add up exactly due to rounding.

Figure 4-2 is a visual representation of the District's sanitary system asset base, with a breakdown of each asset type replacement cost as a percentage of the total. Gravity mains are the largest asset group and represent 62% of the asset base. The Citrus Wynd Wastewater Treatment Plant comprises the smallest asset group by replacement cost and represents only 0.4% of the asset base. Forcemains are the second smallest asset group by replacement cost and represent 2.4% of the asset base.

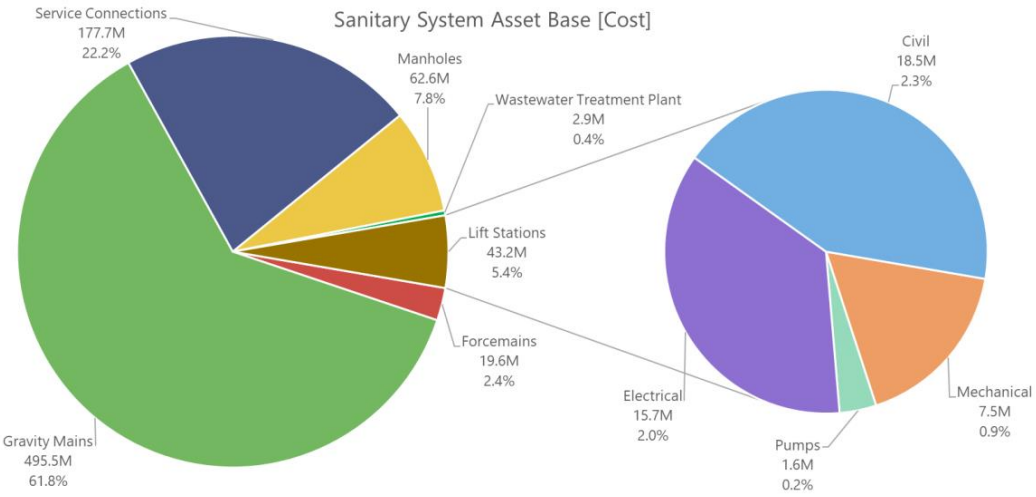


Figure 4-2 Sanitary System Asset Base, By Asset Type

4.4 Asset Condition

Understanding asset condition is a critical step towards assessing current needs and forecasting future needs for an asset. Assessing condition of an asset will help the District:

- Estimate when an asset will reach the end of its life and require replacement,

- Estimate loss in levels of service,
- Estimate risk associated with asset's current condition,
- Identify appropriate and timely interventions.

4.4.1 Physical Condition Assessment Approach

Using a standardized physical condition rating assessment method helps to compare asset condition across the different asset types.

Where condition ratings from physical inspection data are available these are used. However, where no inspected condition data is available, an "aged-based-performance" profile is assumed for the physical condition assessment. This method is shown in Table 10 and reflects the expected performance of assets at different stages in their service life.

Table 10 Age-based Condition Rating System

Score	Condition Rating	Criteria	Condition Rating Description
1	Very Good	RUL ≥ 75%	The infrastructure in the system or network has greater than or equal to 75% of its remaining useful life. It is generally in very good condition, typically new or recently rehabilitated.
2	Good	75% > RUL ≥ 35%	The infrastructure in the system or network has less than 75% (and greater than or equal to 35%) of its remaining service life. It is in good condition.
3	Fair	35% > RUL ≥ 13%	The infrastructure in the system or network has less than 35% (and greater than or equal to 13%) of its remaining service life. It is in fair condition.
4	Poor	13% > RUL ≥ 3%	The infrastructure in the system or network has less than 13% (and greater than or equal to 3%) of its remaining service life. It is in poor condition and mostly below standard, with many elements approaching the end of their service life.
5	Very Poor	RUL < 3%	The infrastructure in the system or network has less than 3% of its remaining service life. It is in very poor, unacceptable condition and should be replaced or rehabilitated.

The age-based condition rating of assets is based on an initial default deterioration curve shown in Figure 4-3. The District does not currently have sufficient information to calibrate deterioration profiles for wastewater assets based on observed condition at different asset ages. It is anticipated that the default curve in Figure 4-3 will be calibrated when observed information is available, to reflect the asset age and condition relationship within the District's wastewater system. Over time, it is expected that the default deterioration curve will be split into a set of curves for different asset types, as required.

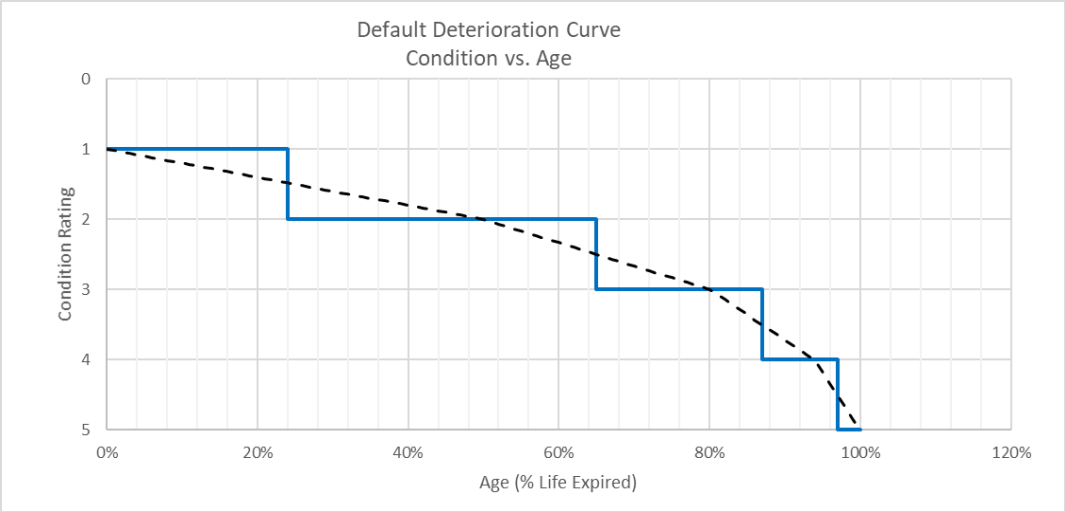


Figure 4-3 Typical Asset Condition Profile

Table 11 gives the percentage of assets in each sub-category for which physical condition data is available from inspection reports.

Table 11 Percent of Assets with Known Condition Data

Asset Type	Quantity	Available Condition Data	Condition Data Source	Comments	Condition Data Used
Lift (Pump) Stations	54	2018: 51	KWL (2018) Sanitary Pump Station Condition Assessment	Three lift stations were under construction at the time inspections were conducted. These new lift stations were given an assumed condition rating of very good.	Yes
Gravity Mains	339,640 m	2011: 9.447 m 2012: 8.013 m 2013: 13,549 m 2014: 6,712 m 2015: 9,973 m 2016: 8,744 m 2017: 20,177 m 2018: 15,400 m 2019: 6,465 m 2020: 10,616 m 2021: 9,266 m	CCTV Inspection Sheet CCTV information from CMMS	Condition ratings from the past 5 years of CCTV inspection data was used for assessment of current condition rating.	Yes
Forcemains	11,769 m	-	-	-	-
Service Connections	12,693	-	-	-	-
Manholes	4,473	3,186	DWV Shapefiles with latest sanitary manhole layer	Year of condition assessment is unknown.	Yes

Condition data is available for lift stations and a portion of gravity mains and manholes (also called maintenance holes). Condition rating for any assets with unknown condition was estimated based on their age compared to expected useful life, as per Table 12.

Table 12 summarizes the Expected Useful Life (EUL) for non-linear asset groups.

Table 12 Estimated Useful Life for Non-Linear Infrastructure

Asset Group	EUL (Years)	Assumptions / Comments
Lift (Pump) Stations		
Civil Component	50	
Mechanical Component	30	
Electrical Component	30	
Pump Component	15	
Manholes	75	
Wastewater Treatment Plant	40	

Table 13 summarizes the Expected Useful Life (EUL) for linear asset groups.

Table 13 Estimated Useful Life for Linear Infrastructure

Pipe Material	EUL (Years)	Assumptions / Comments
Asbestos Cement (AC)	65	
Cast Iron (CI)	70	
Cured In Place Pipe (CIPP)	85	
Corrugated Metal Pipe (CMP)	60	
Concrete	85	
Copper	60	
Ductile Iron (DI)	75	
High Density Polyethylene (HDPE)	85	
Polyethylene (PE)	85	
Polyvinyl Chloride (PVC)	85	
Reinforced Concrete (RC)	85	
Steel	70	
Vitrified Clay (VC)	80	

4.4.2 Physical Condition Summary

Figure 4-4 summarizes the overall condition for the sanitary system infrastructure assets. Asset condition ranges from very poor to very good, the majority being in good (45%) or fair (35%) condition. A very small portion of assets are in poor or very poor condition and constitute approximately $11.4M worth of assets (1.42%).

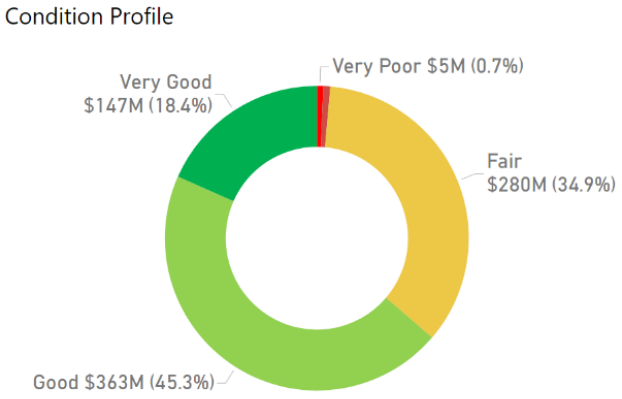


Figure 4-4 Asset Condition Distribution, All Assets

Figure 4-5 presents condition of the assets grouped by asset type. For most asset types, asset condition ranges from fair to very good, except for forcemains, and electrical, mechanical, and pump components of lift stations where some assets are in poor or very poor condition.

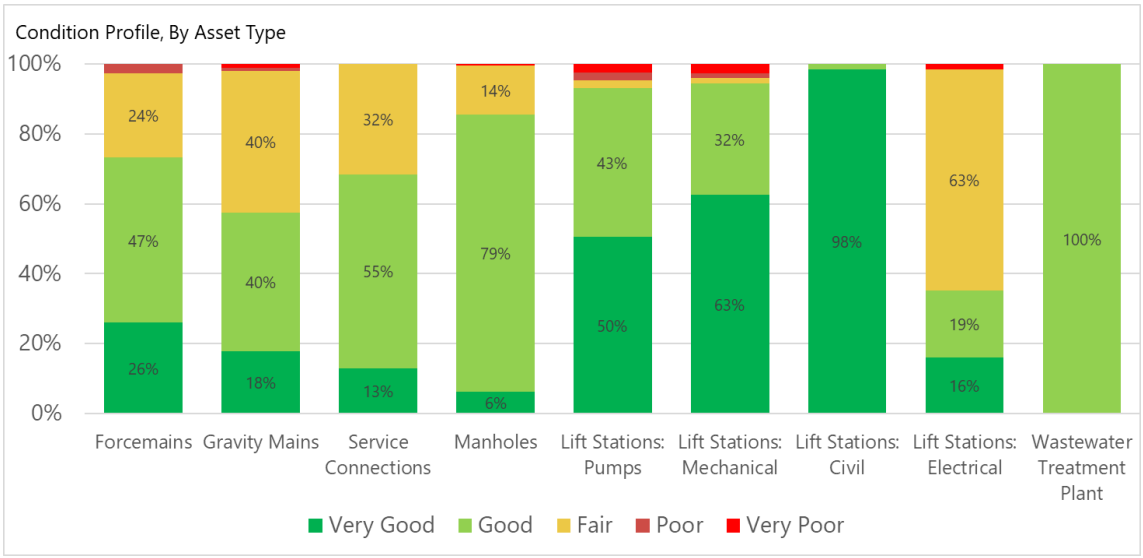


Figure 4-5 Asset Condition Distribution, By Asset Type

4.4.3 Functional Condition Assessment

In addition to evaluating asset's physical condition, it is crucial to ensure that an asset is meeting the requirements for functional condition (i.e., has adequate capacity to deliver required level of service). To evaluate asset's functional condition, existing sanitary peak flow rates are compared to the maximum capacity.

Figure 4-6 illustrates reserve capacity distribution for gravity mains by replacement cost. Approximately 7.6 km of gravity mains are below, at, or over capacity ($12M) and 1.7 km of gravity mains have less than 10% reserve capacity left ($3M). In total, they represent 3% of the sanitary main asset base ($15M out of $495M).

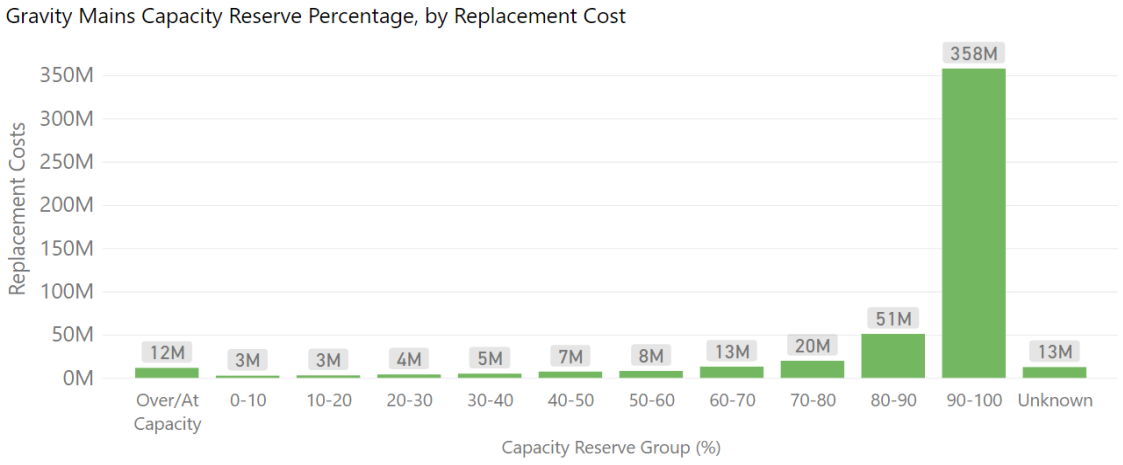


Figure 4-6 Gravity Mains Reserve Capacity Distribution

Only 2% ($0.3M of $15M) of the mains with less than 10% reserve capacity or at/over capacity are in very poor physical condition. The remaining 98% of these mains are rated as fair (51%), good (30%) or very good (17%) condition, as shown in Figure 4-7.

Most of these mains are however, 50 years or older and the pipe material is primarily vitrified clay (see Table 13). The condition of these pipes can be expected to deteriorate at increasing rates over the next 10 – 15 years.

The infiltration risk for these pipes will also increase with age. Therefore, the cost-risk-benefit of replacing these mains due to capacity failure is likely to be favourable even if pipes are rated as still being in a fair or good physical condition.

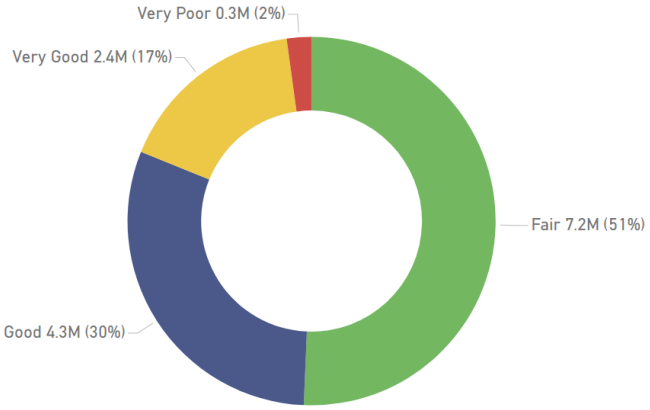


Figure 4-7 Condition Distribution, Gravity Mains Less than 10% Reserve Capacity

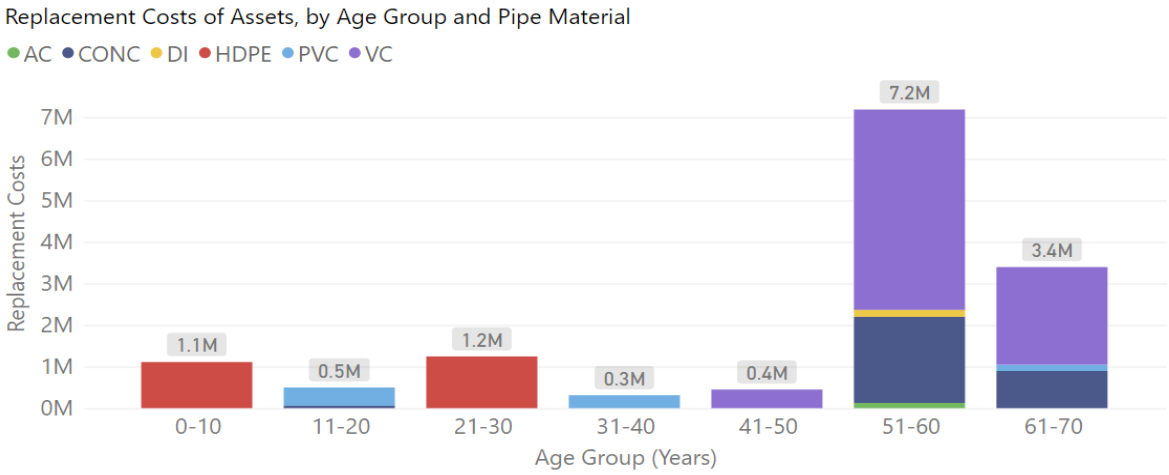


Figure 4-8 Age Profile, Gravity Mains Less than 10% Reserve Capacity

4.5 Asset Age

Most of the Districts sanitary system assets were built before 1960s and 1970s, as shown in Table 14.

Table 14 Asset Build Decade, Count by Asset Type

Build Decade	Forcemains [meters]	Gravity mains [meters]	Lift station - Civil[1] [count]	Lift station - Electrical[1] [count]	Lift station - Mechanical[1] [count]	Lift station - Pumps[1] [count]	Manholes [count]	SERVICE [count]
1960s	303m	165,923m					1,789	5,444
1970s	7,802m	98,360	22	22	22	22	1,061	3,520
1980s	930m	25,518	13	13	13	13	520	935
1990s	457m	16,097	7	7	7	7	400	786
2000s	415m	13,064	5	5	5	5	321	832
2010s	1,677m	19,532	7	7	7	7	344	965
2020s	180m	1,303					38	111
Total	11,769m	339,707m	54	54	54	54	4,473	12,693

(1) Currently available data does not provide installation year for each component of lift stations. Therefore, age of lift station components is temporarily assumed to be equal to the overall age assigned to the lift station.

Figure 4-9 below, compares the current average age of each group of assets with the average expected useful life for the same group. Asset age was determined as follows:

- For assets with known condition data (Table 11), age was assumed based on inspection condition of the asset and a typical useful life (Figure 4-3, Table 12 and Table 13).
- All assets have expected useful lives as outlined in Table 12 and Table 13.
- For each of the four components of lift stations, age was assumed based on install year of each lift station (i.e., age is the same across all four components).

The assets in each group vary in size and length and this is reflected in the replacement value for each asset. Therefore, to determine an average age for each group, it was necessary to weight the age and expected life of each asset by its replacement value. The weighted averages for current age and the expected useful life of each group of assets, was determined by the following process:

1. Multiply the age and expected useful life of each asset in the group by its replacement value
2. Sum the values from step 1 for age and expected useful life for each asset group
3. Sum the replacement values for assets in each group
4. Divide the total value for age and expected useful life for each asset group (from step 2), by the total replacement value for each group (from step 3) to calculate the weighted average age for the group and the weighted average expected useful life.

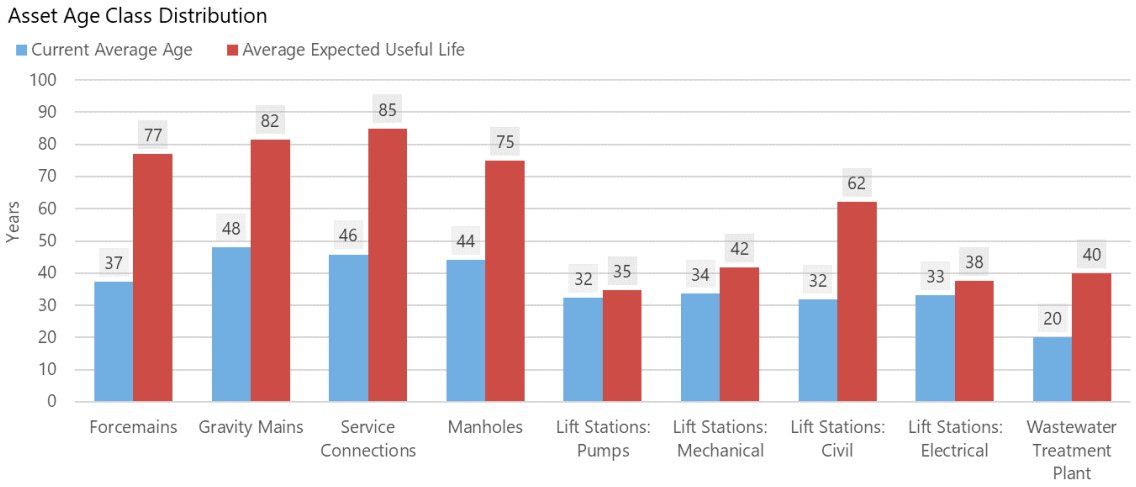


Figure 4-9 Average Asset Ages Class Distribution, by Asset Type weighted by Replacement Cost

Comparing values for each asset group, Figure 4-9 shows that, on average:

- Forcemains have reached 48% of their useful lives.
- Gravity mains have reached 59% of their useful lives.
- Manholes have reached 59% of their useful lives.
- Service connections have reached 54% of their useful lives.
- Lift station civil components have reached 51% of their useful lives, and electrical, mechanical, and pump components have reached 88%, 81%, and 93% of their useful lives, respectively.
- Citrus Wynd Wastewater Treatment Plant has reached 50% of its useful life.

4.6 State Of Infrastructure Summary

Table 15 presents a summary of the state of the sanitary infrastructure assets owned by the District. The dashboard includes:

- Asset types and their quantities,
- Asset values, defined as replacement costs,
- Asset average ages, weighted by their value,
- Asset conditions, and
- Asset renewal forecast.

Table 15 Dashboard On State of Sanitary Infrastructure Asset Portfolio – 2022

Asset Type	Quantity	Current Average Asset Age [years]	Average Expected Useful Life [years]	Average Asset Condition	Current Asset Replacement Value [$'000]	100 YR Average Per Annum Renewals Cost [$'000]
Forcemains	11,769 m	37	77	2	$19,631	$208
Gravity Mains	339,797 m	48	82	2	$495,471	$5,063
Service Connections	12,693	46	85	2	$177,702	$1,778
Manholes	4,473	44	75	2	$62,622	$698
Lift Station: Mechanical	54	34	42	1	$7,475	$203
Lift Station: Pumps	54	32	35	2	$1,589	$88
Lift Station: Electrical	54	33	38	3	$15,660	$567
Lift Station: Civil	54	32	62	1	$18,525	$193
Wastewater Treatment Plant	1	20	40	2	$2,909	$58
Total		46	80	2	$801,583	$8,854

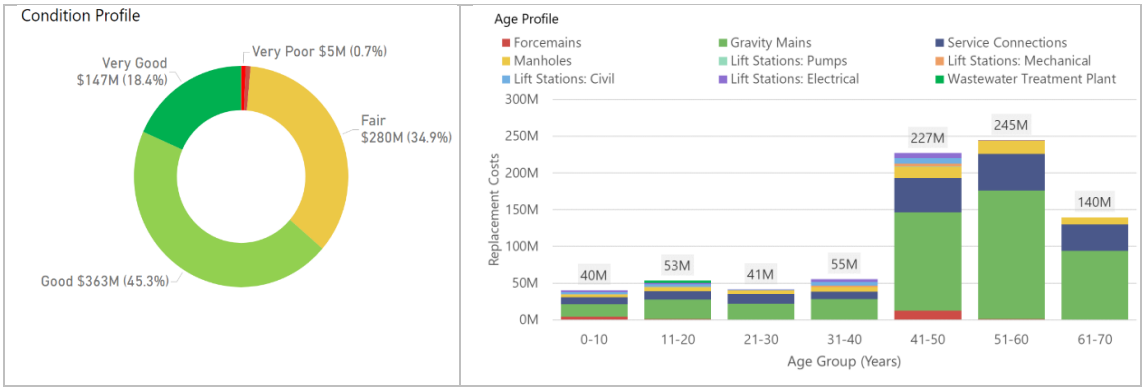


Figure 4-10 Condition and Age Profiles

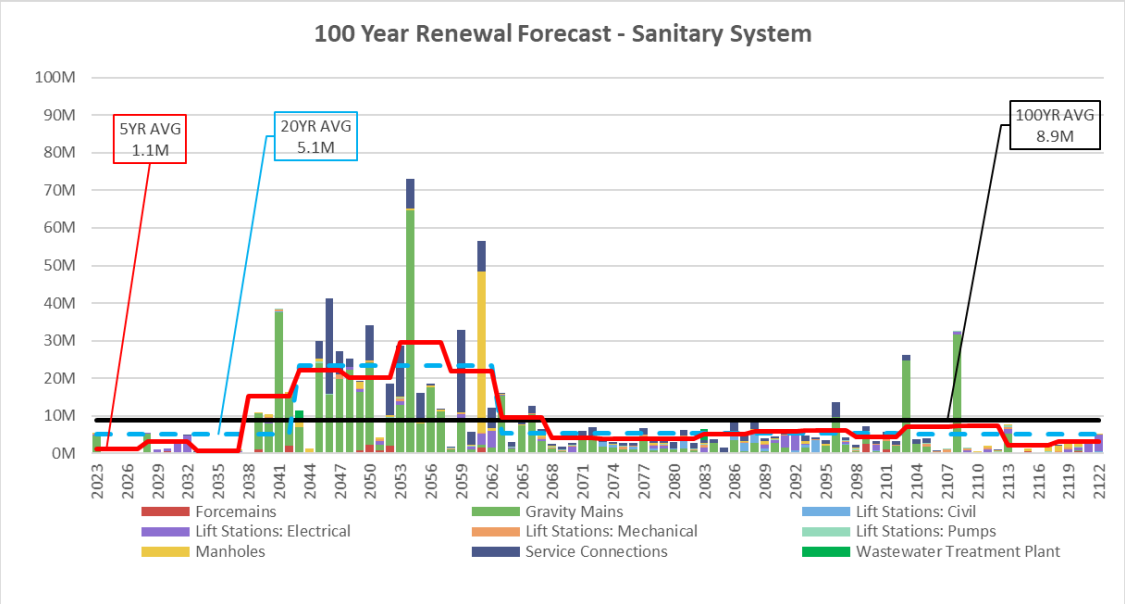


Figure 4-11 100 Year Renewal Forecast for the Sanitary System

Note: The 100 Year Forecast shown above does not include any capital new and upgrade cost to the District's sanitary system and only represents cost to renew existing assets in the system as is.

4.7 State of Infrastructure Improvement Actions

Table 16 lists recommended improvements for the District's State of Infrastructure reporting for sanitary system assets.

Table 16 State of Infrastructure Improvement Plan

Task No.	Improvement Task Name	Improvement Task Description
4.1	Review asset hierarchy for lift stations and improve asset attribute data for lift station components	Currently, lift stations GIS data contains a mix of information for all four components (i.e., pumps, mechanical, civil, electrical). Asset attribute data within the database does not consistently record critical information (e.g., year renewed, condition) for each separate component. This limits analysis of the data and usefulness for reliable reporting and to support evidence-based decision-making. It is recommended that the District implements consistent componentization of lift stations and maintains asset attribute data at the component level.
4.2	Data Updating	Design, document and implement procedure for returning field information to asset register and GIS when work is undertaken on any asset, or when missing or default information is verified, for example the year when condition was assessed and install year of manholes.

Opportunity for Improvement – The District does not currently collect much data when sewer pipes are excavated or replaced for planned or emergency repairs/renewals. Detailed testing and opportunistic sampling would need to be evaluated for reliability and cost-effectiveness in managing the collection network, however taking photos for future reference, especially on old mains to note condition and mode of failure, is a low-cost effort which could be useful in future iterations of the AMP.

5 Levels of Service

5.1 Overview

Levels of service are statements describing the outputs the District intends to deliver from customer point of view (e.g., affordable disposal of effluent). A key objective of asset management is to match levels of service the District plans on delivering, given its available resources, with the levels of service expected by its customers. This involves understanding customer expectations, and the trade-offs they are willing to make between costs and services. Therefore, levels of service must be written in terms that the end user can understand, and the District can effectively communicate. Having a well-defined levels of service framework will allow the District to effectively collaborate with its customers and key stakeholders to identify the appropriate balance between community expectations and affordability for target service levels.

This section of the plan describes:

- The services the District currently delivers
- Key stakeholders or customers using the District's services
- Legislation setting service requirements
- How levels of service are defined,
- What performance indicators are used to measure levels of service, and
- Current levels of service provided by the District where these are documented.

5.2 Customers & Key Stakeholders

One of the first steps in understanding what customers expect is to identify who uses the services, and other stakeholders who have a valid interest in how the services are provided.

Customers are those people who use services provided by the District. This includes people living in the community, local industry, visitors, and emergency services.

Key stakeholders are those groups or individuals who have a valid interest in the service. This can include groups who use the service in a particular way, or they have information and knowledge to help the District make better decisions about the service, or they have some form of authority over the service. They may also contribute funding to meet the cost of providing wastewater assets for use by customers. Stakeholder groups can help the District to focus asset management planning on the right things.

Generally, service users (customers) and other key stakeholders can be categorized as shown in Table 17. These stakeholder categories can be used as a starting point toward identifying a full list of stakeholders and developing an understanding of their needs and expectations for the services the District provides.

Table 17 Key Stakeholders

Stakeholder Categories	Description
Service users - Customers (current & future taxpayers, residents, businesses, & visitors)	Includes everyone who uses the wastewater services, such as people who live and/or work in the community, temporarily or permanently, visitors and anyone who uses the wastewater services or its associated infrastructure, as well as developers and users in future developments.
Service providers	District staff and other entities using the wastewater service to provide their services – this includes Engineering, Parks, Culture and Community Services, and Facilities departments, among others.
Regulators	Provincial or Federal Government expressing their influence through legislation, regulations, and higher-level plans.

Stakeholder Categories	Description
Neighbouring Communities	Stakeholders who share inter-collaboration agreements, services, and responsibilities with West Vancouver.
Wider community	Other stakeholders in the community outside of the areas directly serviced by sanitary assets such as rural communities and taxpayers not currently using the District's assets.

5.3 Legislative Requirements

The services provided by District assets must meet the legislative requirements at the municipal, provincial and federal levels. Key legislative requirements applicable to wastewater services and municipal organizations are included in Table 18.

Table 18 Organizational Legislation

Legislation	Requirement
Community Charter Local Government Act	Sets out role, purpose, responsibilities, and powers of local governments
Municipal by-laws	Regulations approved by Council to safeguard and protect persons and properties
Building Act	Rules and regulations for buildings and building codes
Public Health Act	Rules and regulations for public health and safety
Environmental Management Act	Sets out rules and requirements for environmental regulations and requirements, including: Municipal Wastewater Regulation, Liquid Waste Management Plan, Waste Discharge Regulation, Solid Waste Management Plan
Wildlife Act	Rules around wildlife protection and management
Water Sustainability Act	Rules and regulations around surface and groundwater use and projection, including: Water Sustainability Regulation, Groundwater Projection Regulation, Dam Safety Regulation, Water Sustainability Fees, Rentals and Charges Tariff Regulation
Water Protection Act	Defines ownership of surface and groundwater resources
Riparian Areas Protection Act	Requirements for protection of riparian areas in developed areas
Workers Compensation Act (WorkSafeBC)	Rules governing health and safety in workplaces, including Occupational Health and Safety Regulation
Fisheries and Oceans Canada (DFO)	Provides guidelines and laws to protect fisheries habitat in proximity to roadways and bridges, including Wastewater systems effluent regulations under the Fisheries Act
Migratory Birds Convention Act	Protects migratory birds
Canada Water Act	Contains provisions for formal consultation and agreements with the provinces
Drinking Water Protection Act	Rules and regulations for drinking water, including Drinking Water Protection Regulation

5.4 Defining Levels of Service

Levels of service are typically expressed in relation to service attributes such as quality, quantity, reliability, responsiveness, sustainability, timeliness, accessibility, environmental acceptability, and cost.

Levels of service are the link between higher level corporate and community objectives, and more detailed technical and operational objectives. Well-defined levels of services are the cornerstone of service delivery in local government. Service levels set the targets that the municipality strives to meet. They have a significant impact on the cost to provide services to communities and define requirements for equipment, personnel, and capital budgets. The higher the service level, the higher the cost.

Figure 5-1 shows the process that the District will use for future levels of service development.

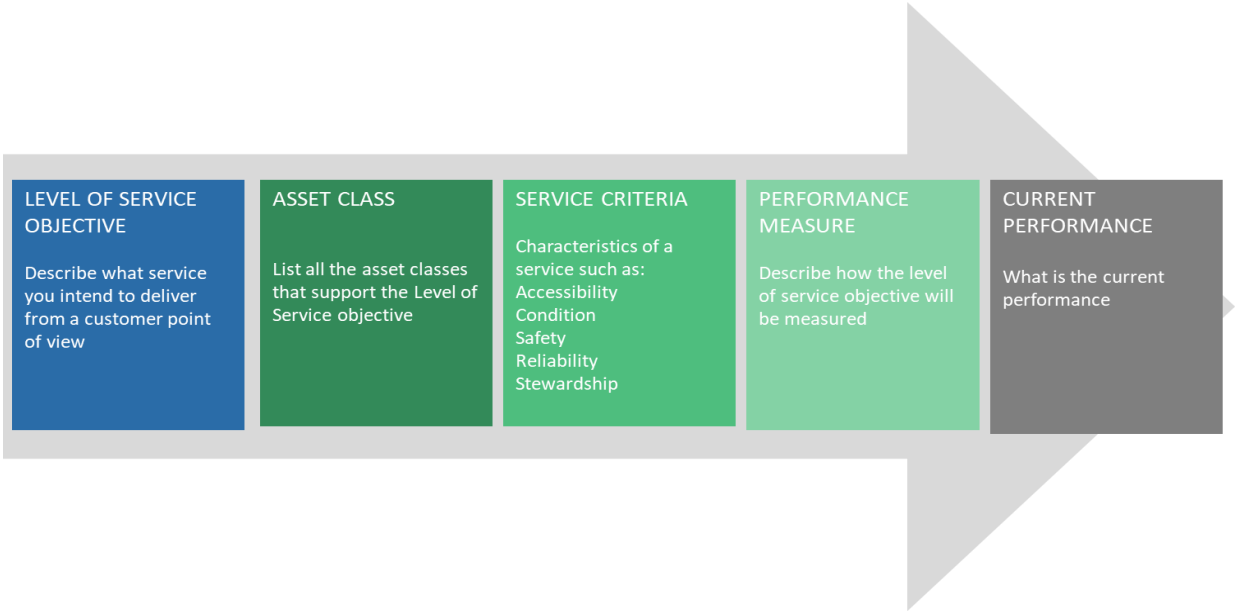


Figure 5-1 Levels of Service Development Process

5.5 Current Levels of Service

The service criteria considered for definition of current level of service are:

- Environmentally Responsible – Is the discharged effluent environmentally safe, odourless, and compliant with recommended standards and regulations?
- Reliable – Is the service maintained in a state of good repair and functionality?
- Responsiveness – Are unexpected service disruptions dealt with efficiently and adequately?
- Efficient – Are resources used in the most productive way possible to deliver the agreed levels of service?
- Affordable – Does the District deliver the agreed levels of service at a reasonable cost that is comparable to other municipalities?

The major asset classes considered for supporting the wastewater service levels are wastewater treatment plants, lift stations, and pipes. Sewer manholes and other associated infrastructure are considered integral within these three major asset classes.

Current levels of service for wastewater treatment plants are detailed in Table 19 and current levels of service for both lift stations and wastewater pipes are detailed in Table 20.

Table 19 Levels of Service – WWTP (Citrus Wynd)

Service Criteria	Service Objective	Technical Performance Measure	Measurement Procedure	Current Performance	Performance Target
Environmentally Responsible	Disposal of effluent that is environmentally safe, odourless, and compliant with recommended standards and regulations.	X% p.a. WWTP permit compliance	Manual Count	Unknown	TBD
		#X p.a. unauthorized release of wastewater to the surface	Manual Count	Unknown	TBD
Reliable	Provide continuous service with no interruptions, outages, and/or blockages to facilitate continual enjoyment of day-to-day activities	X% avg p.a. WWTP weekly planned activities completed	TBD	Unknown	TBD
		#X p.a. unplanned interruptions to service	Manual Count	Unknown	TBD

Table 20 Levels of Service - Lift Stations & Pipes

Service Criteria	Service Objective	Technical Performance Measure	Measurement Procedure	Current Performance	Performance Target
Environmentally responsible	Disposal of effluent that is environmentally safe, odourless, and compliant with recommended standards and regulations.	#X p.a. verified customer complaints regarding noise, odour, or overflow	TBD	Unknown	TBD
		#X p.a. unauthorized release of wastewater to the surface	Run report query in MC	2019: 6 events 2020: 6 events 2021: 3 events	Unknown
Reliable	Provide continuous service with no interruptions, outages, and/or blockages to facilitate continual enjoyment of day-to-day activities	Flushing program for grease completed for commercial businesses %complete p.a.	TBD	Unknown	TBD
		Less than #X p.a. unplanned service disruptions	TBD	Unknown	TBD
		Average duration of unplanned interruptions less than #X hrs	TBD	Unknown	TBD
		% of length CCTV Inspected per year	Run asset list report and calculate length of inspected assets.	2019: 2% 2020: 2% 2021: Unknown	TBD
		No. of safety-related training hours per employee (average, per year)	TBD	Unknown	TBD

Service Criteria	Service Objective	Technical Performance Measure	Measurement Procedure	Current Performance	Performance Target
Responsive	Minimize the impact of unplanned outages to the community	X% avg p.a. call outs responded to within Xhr of notification (during normal business hours)	TBD	Unknown	TBD
		X% avg p.a. complaints resolved within agreed time for problem type	TBD	Unknown	TBD
Efficient	Facilitate efficient collection and conveyance of wastewater	# call outs by type	Count of Open/Closed Reports in MC	2019: 408 2020: 416 2021: 415	TBD
		Manage I&I – ratio between WWF and DWF (annual average for total system)	TBD	Unknown	TBD
Affordable	Maintain cost of service at an adequate level that is comparable to similar organizations	Track comparison of average WV utility rate to average Metro Vancouver rate	Manual Calculation	Unknown	TBD
		Track ratio of average property value to average utility rate	Manual Calculation	Unknown	TBD
		X% satisfaction for overall cost of service	TBD	Unknown	TBD

SSAMP Update – The 2010 SSAMP recommended a bottom-up assessment of the wastewater system to determine infrastructure renewal priorities. The District followed up the 2010 SSAMP with the Sanitary Master Planning Study (Kerr Wood Leidal, 2019), which through hydraulic modelling, condition assessments, and risk-based renewal planning, provided the District with a Capital Projects List identifying and prioritizing renewals and upgrades to the wastewater system. Renewals and upgrades identified in the masterplan aim to achieve and maintain appropriate levels of service to accommodate growth and prevent negative impact on health, property, and environment.

5.6 Levels of Service Improvement Actions

Table 21 lists the improvement actions that will improve levels of service definition and use.

Table 21 Levels of Service Improvement Plan

Task No.	Improvement Task Name	Improvement Task Description
5.1	Performance Measures Data Sources and Collection Methods Identification	Conduct workshops to identify data sources and collection methods for all performance measures. Where significant data gaps exist, develop, and implement data collection strategies that will provide the necessary support to inform performance measures and decision-making.

Task No.	Improvement Task Name	Improvement Task Description
5.2	Performance Targets Identification	Identify performance targets for each performance measure. It is recommended to set targets after at least one year of measured performance values are available to confirm the current level of service being achieved.
5.3	Levels of Service Sustainability	Review the relationship between cost of service, level of service and risk, to establish if current levels of service are sustainable into the future.
5.4	Stakeholder Consultation	Consult with stakeholders to confirm the levels of service and performance measures. LOS, cost of service options, and measured performance results must be available prior to consultation, to support this task and inform both the District and the Stakeholders.
5.5	Levels of Service Statements Updates	Regularly review LOS statements to ensure their alignment with the District's strategic and corporate objectives as well as stakeholder expectations.

6 Lifecycle Management

6.1 Overview

Lifecycle management refers to the different phases through which an asset passes as it ages. An awareness of these phases is important because different management interventions are appropriate (or required) for different phases of the asset lifecycle and will affect both the achievable lifespan of the asset and future financial planning. Figure 6-1 demonstrates eight stages of an asset's lifecycle. As condition deteriorates over time, various opportunities for intervention are available to extend the service life of the asset. Preventive maintenance treatments are less costly than rehabilitation. Likewise, rehabilitation treatments are less costly than reconstruction. Both rehabilitation and preventative maintenance need to be assessed on cost and level of effort required against the asset life extension. The purpose of lifecycle strategies is to maintain the assets in an appropriate way that will deliver the required level of service for least overall cost, while keeping risk within agreed boundaries.

This section of the Plan includes the District's plans for:

- Addressing demand drivers that might impact future service delivery
- Operating and maintaining assets
- Renewing or replacing assets
- Adding new assets or improving existing assets
- Disposing of assets that are no longer needed or have met the end of service life
- Any decision processes to manage the assets to the current levels of service (defined in Section 5) for the lowest whole-of-life cost.

Associated costs and the timing of the above efforts over the Plan's 100-year horizon are detailed in Section 8.

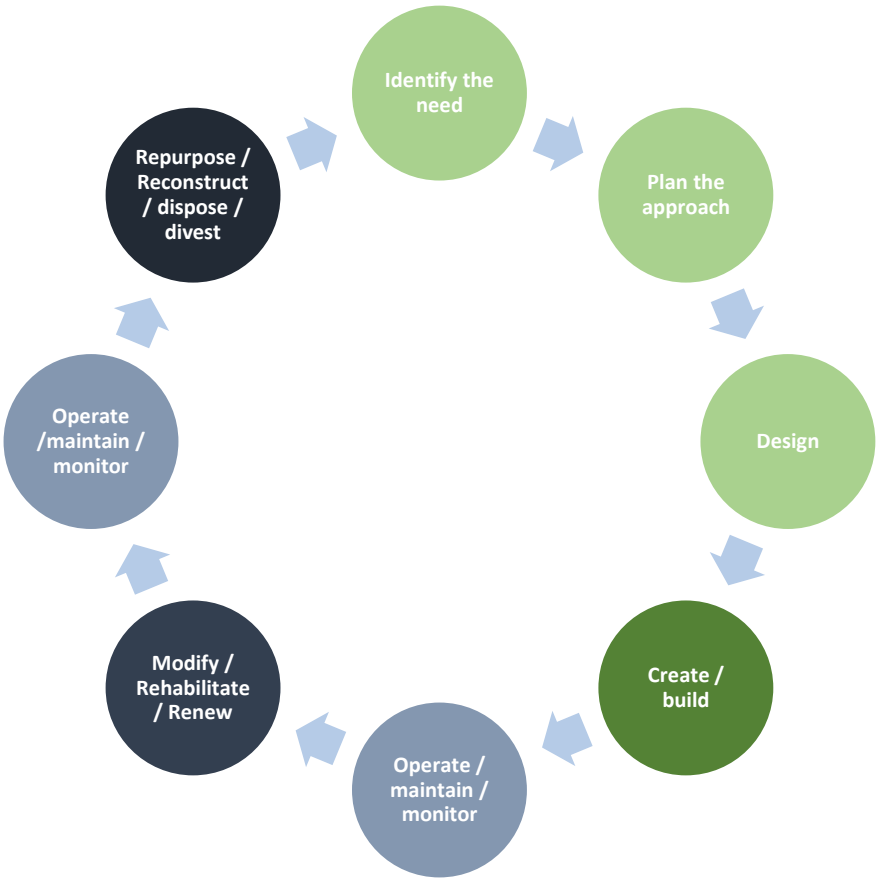


Figure 6-1 Phases of an Assets Lifecycle

6.2 Demand Management

The demand on District infrastructure can impact how the infrastructure is managed and maintained. The demand drivers that may impact the District's service delivery include changes in population, land use, per capita usage, and climate change. The present position and projections for key demand drivers that may have possible impacts on the District's service delivery are summarized in Table 22.

Table 22 Example Demand Drivers

Demand Driver	Anticipated Trend	Present Position	Projection	Possible Impact on Services	Mitigation Strategy
Population	Increase	42,474 ppl (2016)	60,000 by 2041 (based on regional projections from 2016 MWSS)	Demand Increase	Monitor trends / Identify intervention triggers
Land Use Changes	Infill & New Buildout	Single Family – 89% Multi-Family – 11% (% residential consumption)	Single Family – 82% Multi-Family – 18% (% residential consumption)	Demand Decrease	-
Per Capita Use	Reduction	High Single-Family usage in summer	Increased water conservation	Demand Decrease	-
Climate Change	Increasing demand in summer / reduced lake supply	Peak summer dependence on MV supply	Eagle Lake less reliable during peak summer	Cost increases / strain on service deliver	Water Conservation Strategy & Education

Opportunity for Improvement – As the District continues to pursue high-priority upgrades to the wastewater utility, the next iteration of the SSAMP can include an up-to-date capital projects list with recommended improvements and upgrades based on consideration towards demand drivers beyond the 2042 buildout horizon.

6.3 Operations and Maintenance

Operating assets means completing the regular (both cyclic and periodic) activities needed to make sure they are providing the required services. Maintenance may be classified into reactive, planned, or specific maintenance work activities as outlined below:

- **Reactive maintenance** is unplanned repair work carried out in response to service requests and management / supervisory directions.
- **Planned maintenance** is repair work that is identified and managed through a maintenance management system. Such activities include inspection, assessment of the condition against failure/breakdown experience, prioritization, scheduling, actioning of the work and reporting what was done. These actions help develop a maintenance history and improve maintenance and service delivery performance.
- **Preventative maintenance** is the set of servicing activities necessary to ensure assets achieve their expected lifespans (e.g., repainting, replacing components, etc.). This work typically falls below the capital/maintenance threshold but may require a specific budget allocation.

Generally, operating and maintenance works are completed by the District's operations staff. Where specialized maintenance requires external contractors, they are engaged to complete the work. Decision approaches to planned and preventative maintenance use available asset information such as condition, wherever possible. This is supplemented with knowledge from experienced District operations staff and from external experts and reports,

pump station condition assessment, etc.). Planned maintenance works are prioritized by engineering and operations staff. Maintenance Connection work orders are used to schedule, track and document reactive, planned and preventative maintenance work for the District's sanitary system assets.

6.4 Asset Renewals

Renewal and replacement of assets is major work which does not increase the asset's design capacity but restores the asset to its original (as designed/installed) service potential. Any work over and above this is considered an upgrade to provide a higher level of service or an expansion of the service (adding new assets that did not previously exist).

The age and condition of major components in non-linear assets such as lift stations were used to estimate replacement years for key structural, mechanical, and electrical components. The Sanitary Master Planning Study (Kerr Wood Leidal, 2019) prioritized renewals for non-linear assets to the 2042 horizon, however it only captured the first renewal event for each asset. This Plan (SSAMP) considers a 100-year outlook; therefore, renewals were assumed at regular intervals based on the estimated service lives. For example, if the estimated service life of an electrical component was assumed at 20 years old and was prioritized for renewal in 2032, then the previous report would have only captured one renewal cycle in the capital plan. However, for the 100-year outlook in this Plan (SSAMP), the financial forecast captures additional renewal cycles at 20-year intervals including 2052, 2072, 2092, and 2112.

For mains, an age-based risk approach was used to prioritize renewals, described in more detail in Section 8.1 of this Plan. The previous report used a risk-based model to prioritize renewals to the 2041 horizon. For this Plan, the risk model was expanded to prioritize asset renewals to the 100-year horizon.

For manholes, renewal timelines in this report are estimated due to gaps in historical installation dates and condition data. In practice, the District typically embeds manhole renewal along with main renewal. Manhole data is anticipated to improve over time, so a clearer picture of manhole condition, renewal timelines, and replacement costs will be available in future plans.

6.5 Asset Upgrades and Expansion

It is important to plan works for creation of new assets that did not previously exist or works which will upgrade or improve an existing asset beyond its existing capacity, where these are required within the planning period. These new assets may result from growth, social or environmental needs. Where there is a component of future growth, the District will have the opportunity to recover the costs associated with the growth components through future development.

Previous reports identified priority renewals and upgrades for linear and non-linear wastewater assets to the 2041 horizon. In some cases, capacity or redundancy related upgrades overlapped with prioritized renewal works, in which case the earliest intervention timeframe was used, and the ultimate sizing approach taken (i.e., an existing gravity sewer slated for upsizing in 2035 to meet growth needs but due for renewal in 2025 would be prioritized for upsizing in 2025 with an eye towards having sufficient capacity to meet 2035 needs).

SSAMP Update – the previous SSAMP in 2010 did not include forecasts or assessment for future system upgrades and network expansion. This 2021 version of the SSAMP now includes a forecast of future infrastructure investments and the long-term needs associated with these additions and network upgrades.

6.6 Disposal of Assets

Disposal includes any activity associated with the disposal of a decommissioned asset including sale, demolition, or relocation. For this Plan, it is assumed that all disposed assets have no residual value.

6.7 Lifecycle Management Improvement Items

Table 23 lists the improvement actions that will improve lifecycle management asset management practices.

Table 23 Lifecycle Management Improvement Items

Task No.	Improvement Task Name	Improvement Task Description
6.1	Document existing lifecycle strategies	Investigate and capture any existing lifecycle strategies that staff are currently implementing. Formalize and document these strategies in this plan.
6.2	Maintenance strategies	Document information regarding roles and responsibilities; maintenance goals; typical maintenance options, methods, and protocols; decision criteria and rules for evaluating maintenance options; what maintenance performance indicators are to be tracked and reported; when to flag an asset for renewal.
6.3	Asset Valuations	Continue to review and update unit rate tables and asset lifespans, update replacement cost estimates for all assets.
6.4	Update 20-year capital works plan	Based on the asset valuation, inventory data established, and capital planning and risk-based planning exercises conducted, update and prioritize a list of high impact projects.

7 Risk Strategy

Risk is the effect of uncertainty on the achievement of an organization's objectives. Risk represents the potential of gaining or losing service capabilities and, consequently, its impacts on service performance. Risk management involves establishing a systematic approach of identifying, analyzing, evaluating, and treating any risks that may impede the District's achievement of objectives and delivery of the agreed service to the District's customers.

Risk is evaluated at both the service level and the asset level. This is important to provide early warning of all issues that could potentially have an adverse affect on service delivery. When risks are known and rated, District staff can prioritize activities to focus on assets with high-risk scores and implement mitigation measures to reduce risk levels.

The results of asset level risk assessments are considered when reviewing lifecycle strategies (refer to Section 5) to determine the most appropriate treatments, planned maintenance, and inspection frequencies for a particular asset or group of assets. The results of service level risk guide decisions about business processes, planning, and management. Both asset level risk and service risks are considered in prioritizing capital works projects and other funding decisions.

7.1 Service-Level Risks

Service level risks are the risks that affect the delivery of the service to the District's customers. In this case, the service provision by the District is to provide an efficient, reliable, responsive, affordable, safe, and environmentally responsible sanitary service to its communities (see Section 4, Levels of Service).

The service level risks are grouped into 5 categories. The categories and examples of the risks in each category are shown in Table 24 below:

Table 24 Service level risk categories

Category	Description of Common Risk Events
Planning	Regulatory changes, Council changing strategic priorities, demand management, etc.
Management	Lack of resources (people) to implement or advance Asset Management, reputational risk, data security risk, organization change and staff turnover, loss of institutional knowledge and processes, etc.
Service Delivery	Outdated or unsupported software or hardware failures, power outages, inadequate stakeholder communication/engagement, etc.
Assets (In General)	Security and safety of physical or information assets from theft/vandalism/cyberattacks, inadequate maintenance and rehabilitation programs to preserve asset value and longevity, lack of documentation/records on existing assets, etc.
Hazard & Environmental	Extreme weather events, climate change, improper storage, or usage of hazardous or toxic materials, etc.

7.1.1 Connection between Risk and Levels of Service

The connection between risk and level of service starts with looking at how the potential risk events from each of the 5 categories affect the service commitments made in Section 5 (Levels of Service) and defining a risk outcome (i.e., stating how the risk event would affect the service commitment). For example, how insufficient staff resources (which is a management risk) can affect the reliability and condition of sanitary system infrastructure (which is a service commitment). The risk outcome will be that the lack of resources to maintain the sanitary infrastructure could reduce reliability and condition of the sanitary system.

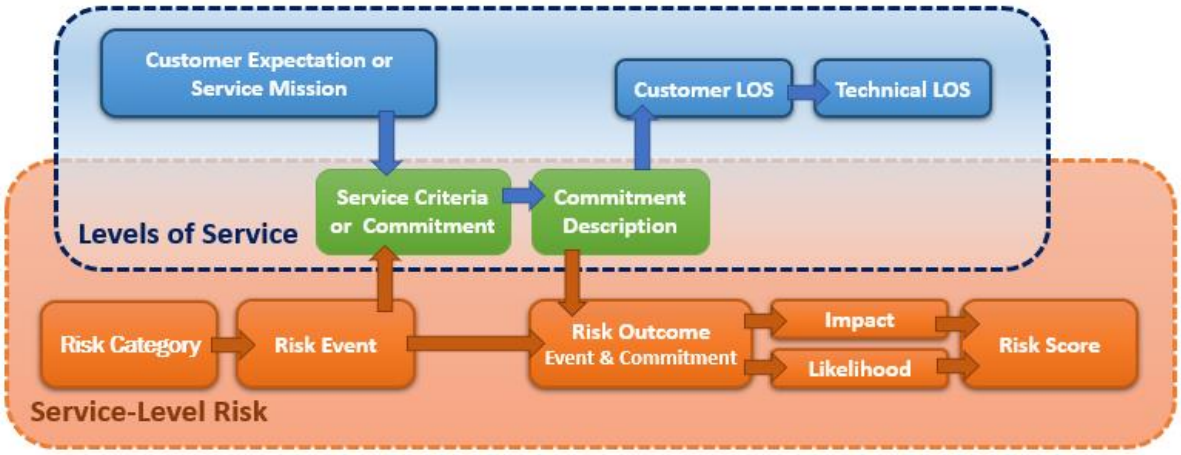


Figure 7-1 Connection between Risk and Levels of Service

The service risks are characterized by the impact to service delivery and the likelihood of that impact event occurring. The District has assessed the service level risks in each risk category that are relevant to the sanitary service and identified an appropriate action for each risk, as shown in Table 25 below.

Table 25 Risk Level and Action

Risk Score / Level		Recommended Action
1-2	Very Low	Accept: These risks can be tolerated. They should be assessed annually to determine whether the level of risk has changed.
3-6	Low	Accept: These risks can be tolerated. They should be assessed annually to determine whether the level of risk has changed.
7-11	Medium	Monitor: These risks require a balanced approach to management. They should be included in future risk mitigation plans and assessed at least annually to determine whether levels of risk have changed.
12-17	High	Mitigate: These risks should be prioritized. Existing mitigation programs and plans should be modified to include these risks, and where new risks are identified, update mitigation programs and plans. An assessment of the effectiveness of the mitigation programs and plans must be conducted annually and updated as appropriate.
18-25	Very High	Take action: These risks cannot be tolerated as they are critical to service delivery. Immediate corrective actions to mitigate risk should be taken. A risk level monitoring program should be developed to reduce or prevent potential reoccurrence of the risk.

7.1.2 Current Service Risk

Table 26 reports the number of risks rated in each category and their respective risk scores (current). The risk ratings are also shown in a graphical format in Figure 7-2 below.

Table 26 Service Level Risk Ratings – Current (Unmitigated)

Risk Category	Very Low	Low	Medium	High	Very High	Count
Planning	2	2	2	3	0	9
Management	0	4	2	2	0	8
Service Delivery	2	2	2	1	0	7
Physical Assets	0	4	1	2	0	7
Hazard - Environmental	0	5	5	3	0	13
Total	**4**	**17**	**12**	**11**	**0**	**44**

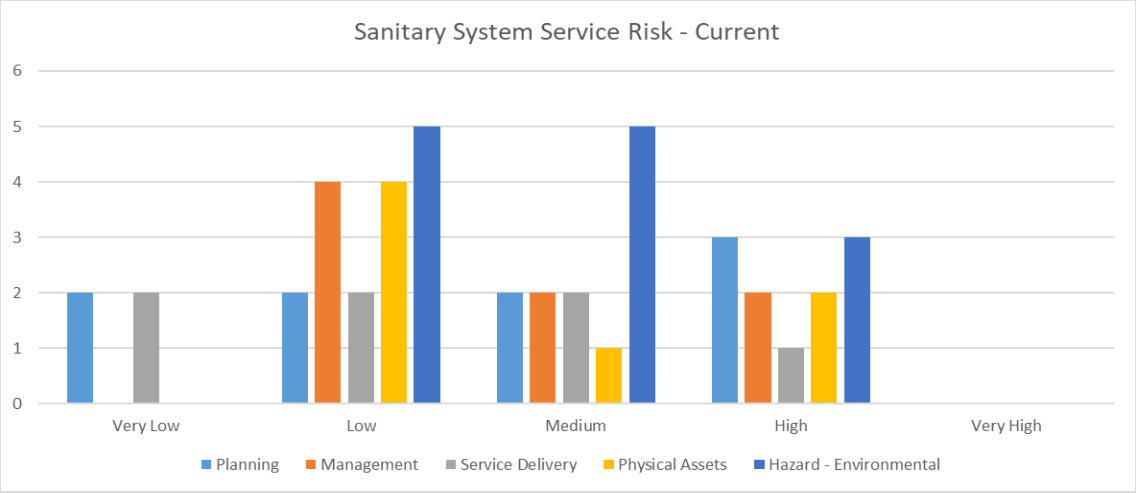


Figure 7-2 Service Level Risks- Current (unmitigated)

7.1.3 Mitigated Service Risk

Table 27 shows the number of risks rated in each category and their respective mitigated risk scores. The results of the mitigated risk ratings are also shown in a graphical format in Figure 7-3 below.

These mitigated risk scores will be realized when the relevant mitigation measures are funded and implemented. Until then, the current risk rating will apply. Details of proposed mitigation measures are given in section 7.1.4.

Table 27 Service Level Risk Ratings - Mitigated

Risk Category	Very Low	Low	Medium	High	Very High	Count
Planning	2	5	2	0	0	9
Management	1	6	1	0	0	8
Service Delivery	2	5	0	0	0	7
Physical Assets	0	6	1	0	0	7
Hazard - Environmental	0	10	3	0	0	13
Total	**5**	**32**	**7**	**0**	**0**	**44**

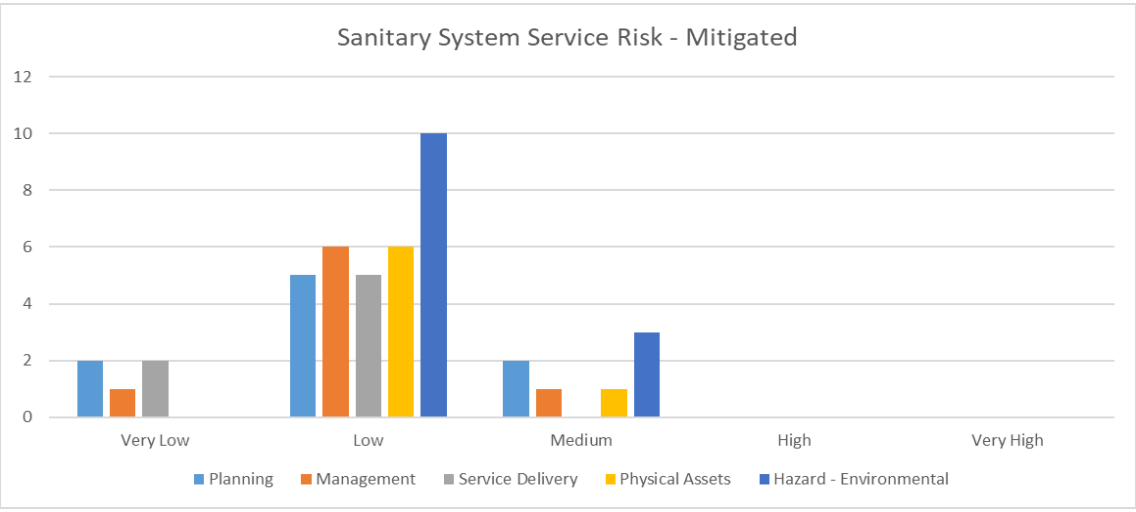


Figure 7-3 Service Level Risks- Mitigated

Current Risk is the risked assessed assuming the current system, processes or resources are in place to manage the event. Mitigated Risk (or Residual Risk) is the risk assessed assuming the additional measures, processes and/or resources associate with treatment options (i.e., mitigation measures) to reduce current risk are in place.

Mitigated risk ratings shown in this section do not represent the District's current exposure to risk events. These ratings will be realized if and only if the relevant mitigation measures (outlined in section) are funded and implemented by the District.

7.1.4 Detailed Service Risk Results

7.1.4.1 Planning Risks

A total of 9 planning risks were identified and rated by the District staff. Out of these, 4 risks were rated as low or very low, 2 risks were rated as medium, and 3 risk was rated as high. Table 28 lists the key planning risks to the sanitary system services with a risk rating of Medium, High, or Very High. The complete list of planning risks is shown in Appendix A Table 3.

Table 28 Key Planning Risks

Risk Event / Outcome	Risk Score	Risk Rating	Mitigation Measures	Mitigated Risk Score	Mitigated Risk Rating
Change in legislation could require more treatment, more inspections, more maintenance, or more management and these will increase the cost of service.	12	High	Reserves to fund WWTP upgrades and potential future increase in operational rates to cover future resource requirements.	9	Medium
New developments or industry could increase quantity of assets and require available resources (money and staff) to do more operations, maintenance, and inspection reducing the overall service reliability that can be achieved (i.e., required to do more with same money means some things will not get done)	9	Medium	Develop and implement process to assess and report lifecycle costs (including operational, maintenance, and inspection costs) as part of development approval process. And increasing OMI budget as necessary to provide agreed LOS.	3	Low
If revenues decrease West Vancouver might not be able to maintain the wastewater infrastructure and service delivery at current levels.	12	High	Annually review and report revenue risks and adjust LOS or budget as necessary.	6	Low
Lifecycle costs for the current level of service might not be sustainable, requiring the wastewater service delivery to be reduced to be affordable.	12	High	Reserve funds to buffer costs on a year-on-year basis. Increase sewer rates based on inheriting new infrastructure.	9	Medium
Insufficient planning for or management of wastewater demands can result in the wastewater system not able to cope with demand, increasing the occurrence of wastewater outages.	9	Medium	Master plan (2019) developed to address I&I issues.	6	Low

Other risks not listed in Table 28 were rated low or very low and relate to organizational staff turnover causing loss of knowledge about the District's assets, lack of data integration and potential to lose crucial information about existing asset inventory, considerable changes to maintenance strategies that may impact asset reliability and overall level of service, and poor-quality procurement that may reduce the useful lives of assets. These events are both unlikely to occur and would have low impact, if they occurred.

7.1.4.2 Management Risks

A total of 8 management risks were identified and rated by the District staff. Out of these, 4 risks were rated as low or very low, 2 risks were rated as medium, and 2 risks were rated as high. Table 29 lists the key management risks to the sanitary system rated by the District staff with a risk rating of Medium, High or Very High. The complete list of management risks is shown in Appendix A Table 4.

Table 29 Key Management Risks

Risk Event / Outcome	Risk Score	Risk Rating	Mitigation Measures	Mitigated Risk Score	Mitigated Risk Rating
Insufficient resources to maintain wastewater infrastructure reducing reliability/condition.	12	High	Develop resource planning model for OMI activities to deliver required LOS and annually update and report outcomes to senior management and adjust LOS or budget as necessary.	6	Low
Insufficient forecasting for capital renewals can reduce service reliability.	8	Medium	Annually review and update asset risk scores and prioritized long term renewal forecast in AMP and include funding requirements for asset renewals in annual budget.	6	Low
Lack of trained resources to maintain wastewater infrastructure.	12	High	Develop resource skills matrix and training requirements to deliver the agreed LOS. Include training costs in budget and annually update matrix.	8	Medium
Inflation or cost of materials/labour affecting capital works.	9	Medium	Annually update replace costs in long term renewal forecast in AMP and update funding requirements in annual budget.	6	Low

Other risks not listed in Table 29 were rated low or very low and relate to ineffective business processes that may impact levels of service, reputation, inability to maintain comparable utility rates, and lack of condition or capacity data. These events are unlikely to occur and, if they do, would have low to medium impact. The development of this AMP addresses these risks and ensure that condition of assets is well-understood and that asset renewals can be sustainably funded.

7.1.4.3 Service Delivery Risks

The District has identified and rated 7 service delivery risks. Of these, 4 were rated as low or very low, 2 risks were rated as medium, and 1 risk was rated as high. Table 30 lists the key risks with a risk rating of Medium, High, or Very High. The complete list of service delivery risks is shown Appendix A Table 5.

Table 30 Key Service Delivery Risks

Risk Event / Outcome	Risk Score	Risk Rating	Mitigation Measures	Mitigated Risk Score	Mitigated Risk Rating
Inadequate service delivery (i.e., not doing appropriate operations, maintenance, or inspections, or tasks taking longer to do) could result in more deterioration of asset condition and/or reducing reliability of the service.	8	Medium	Develop an OMI schedule of tasks and resource needs to deliver the required LOS. Include funding for tasks in annual budget and implement task schedule. Annually review and update OMI task schedule and update budget to maintain LOS.	4	Low

Risk Event / Outcome	Risk Score	Risk Rating	Mitigation Measures	Mitigated Risk Score	Mitigated Risk Rating
Increased service disruptions will reduce reliability of service and increase cost of service.	9	Medium	Annually review condition/age profile of system and update asset replacement forecasts and budgets to maintain minimum LOS and reduce service interruptions.	4	Low
Insufficient service delivery resiliency (i.e., staff numbers, fleet, equipment) can result in delays in completing required operations, maintenance, and inspection activities, leading to reduced asset and/or service reliability.	12	High	Complete (and annually update) a resiliency review (compare staff and equipment capacity with utilization, LOS needs, and measured LOS performance and service interruptions). Also, annually complete a service sustainability assessment. Provide budget for and undertake appropriate action to maintain or improve the overall resiliency and sustainability of the service.	6	Low

Other risks not listed in Table 30 were rated low or very low and relate to insufficient stakeholder consultation, unreliable or lack of IT systems, increased cost of service delivery, and poor design of sanitary infrastructure. The District has robust public engagement procedures for all types of stakeholders; therefore, the possibility of insufficient stakeholder consultation resulting in the District not meeting the customers' expectations is very unlikely. In addition, the District's existing GIS, CMMS, and SCADA systems and after-planning documentation exceed typical requirement for IT systems. While it is possible that service delivery costs may increase over the years, the District has invested in a flusher truck that considerably reduced the previously outsourced services. Finally, the likelihood of poor design of sanitary infrastructure is very low as the District has recently reviewed design criteria and requirement for sanitary infrastructure and has robust procurement procedures in place that guarantee high quality design.

7.1.4.4 Physical Asset Risks

A total of 7 physical asset risks were identified and rated by the District staff. Out of these, 4 risks were rated as low or very low, 1 risk was rated as medium, and 2 risks were rated as high. Table 31 lists the key physical asset risks to the sanitary system with a risk rating of Medium, High, or Very High. The complete list of physical asset risks is shown in Appendix A Table 6.

Table 31 Key Physical Asset Risks

Risk Event / Outcome	Risk Score	Risk Rating	Mitigation Measures	Mitigated Risk Score	Mitigated Risk Rating
Assets in very poor or failed condition increase risk unplanned wastewater outages.	9	Medium	Annually review and update condition and age profile of assets and asset renewal program. Update budget as appropriate and undertake works to maintain or improve overall condition profile for system.	6	Low
Reduced asset investment can result in insufficient maintenance leading to increased deterioration and poor asset condition with increased risk of failures.	16	High	Development of financial strategy in AMP will inform West Vancouver of budget requirement.	9	Medium

Risk Event / Outcome	Risk Score	Risk Rating	Mitigation Measures	Mitigated Risk Score	Mitigated Risk Rating
Under-designed wastewater assets will increase risk of poor wastewater treatment.	12	High	Undertake periodic review and update of design standards to keep them up to date (i.e., adjust for flow monitoring results and for climate change impacts). Also periodically update hydraulic models for these factors as well and review capacity of existing system according to new trends and information.	6	Low

Other risks not listed in Table 31 were rated low or very low and relate to insufficient protection of assets from potential vandalism and accidental damage, failure to complete operational activities, and potential of asset failure resulting in overall decrease in levels of service. The District has a very good understanding of high-risk areas and reacts to issues quickly to avoid interruptions to service on larger scale. Moreover, the District has robust IT systems and maintenance programs that ensure all operational activities are completed in a timely and efficient manner. Therefore, the likelihood of these risks occurring is very unlikely.

7.1.4.5 Key Hazard-Environmental Risks

The District has identified 13 hazard-environmental risks. Of those, 5 risks were rated as low or very low, 5 risks were rated as medium, and 3 were rated as high. Table 32 lists the key risks with a risk rating of Medium, High, or Very High.

Table 32 Key Hazard-Environmental Risks

Risk Event / Outcome	Risk Score	Risk Rating	Mitigation Measures	Mitigated Risk Score	Mitigated Risk Rating
High winds can impact foreshore service and infrastructure and potentially power to treatment plants and lift stations. Can affect staff safety.	12	High	Implement process to record high-wind events and any asset damage occurring from these events. Periodically review and update high-wind risk rating and implement appropriate mitigation measures.	9	Medium
Extreme wet weather events could cause overflows affecting properties and adjacent water courses.	12	High	Work with Regional government on climate adaptation and increased rainfall events due to climate change and develop mitigative strategies to manage flood risk on a local and regional levels.	9	Medium
Extreme wet weather events could cause overflows affecting properties and adjacent water courses.	12	High	Work with Regional government on climate adaptation and increased rainfall events due to climate change and develop mitigative strategies to manage flood risk on a local and regional levels.	9	Medium
Flood can impact pump stations and potentially cause pump outage.	9	Medium	Work with Regional government on climate adaptation and increased rainfall events due to climate change and develop mitigative strategies to manage flood risk on a local and regional levels.	6	Low
Internal fire could cause damage to assets and treatment facilities reducing capacity and reliability of service.	8	Medium	Continue to work with DWV Fire Department to ensure fire safety and suppression systems	6	Low

Risk Event / Outcome	Risk Score	Risk Rating	Mitigation Measures	Mitigated Risk Score	Mitigated Risk Rating
			are maintained, up to date and in working order.		
Wildfire could cause damage to assets and treatment facilities reducing capacity and reliability of service.	8	Medium	Work with DWV Fire Department on the Wildfire Management Plan.	6	Low
Ladder rungs in wells and railings around stations etc. in poor condition affecting staff safety.	8	Medium	Undertake periodic assessment of ladder rung and rail conditions and update budget and program for asset repairs and replacements.	3	Low
Chemicals, residuals, and fumes affecting safety of staff and equipment damage.	8	Medium	Ensure sufficient maintenance of HVAC and other forms of ventilation systems are maintained and in working order. Ensure staff have adequate training to recognize safety issues to avoid risk to staff and equipment.	3	Low

Other risks not listed in Table 32 were rated low or very low and relate to inadequate HR procedures and lack of safety training resulting in employee injury and damage to property, extreme weather events that may impede access to assets during service disruptions, and legislative non-compliance that may pose health risk to people or loss of revenue to businesses. The likelihood of these events is low and the District's existing operation processes minimize the potential impact, if these events were to occur.

7.2 Asset-Level Risks

Asset level risks are calculated by multiplying the consequence of failure for each asset with the likelihood of that asset failing. For an initial assessment, the likelihood and consequence of failure are based on:

Likelihood of failure: a 1-5 score for remaining life of each asset (based on an age-based condition rating or measured condition state determined from physical condition assessments).

Consequence of failure: a 1-5 criticality score for each asset.

Table 33 summarizes the current risk profile of the District's sanitary system by value. Most assets are rated as low or very low risk, with only 4.2% rated as medium and 0.1% rated as high. Gravity mains and service connections are the only asset categories with high risk-level assets worth $1,034K.

Table 33 Risk Profile, by Replacement Value

Asset Type	Current Replacement Value [$'000] (1)				
	Very Low	Low	Medium	High	Very High
Forcemains	$8,026K	$9,760K	$1,844K	-	-
Gravity Mains	$301,568K	$170,449	$22,602K	$852K	-
Service Connections	$22,274K	$150,724K	$4,522K	$182K	-
Manholes	$51,436K	$10,556K	$630K	-	-
Lift Station: Civil	$18,231K	$294K	-	-	-
Lift Station: Electrical	$2,955	$11,759K	$945K	-	-
Lift Station: Mechanical	$4,890K	$2,273K	$312K	-	-
Lift Station: Pumps	$724K	$826K	$39K	-	-
WWTP-Citrus Wynd			$2,909K		-
Total	$410,105K	$356,641K	$33,803K	$1,034K	-
Percent of Grand Total	51.2%	44.5%	4.2%	0.1%	0%

(1) Replacement values are shown in thousands.

Figure 7-4 illustrates the asset risk profile graphically and subsequent paragraphs provide further detail on the methodology of the risk framework for each asset type.

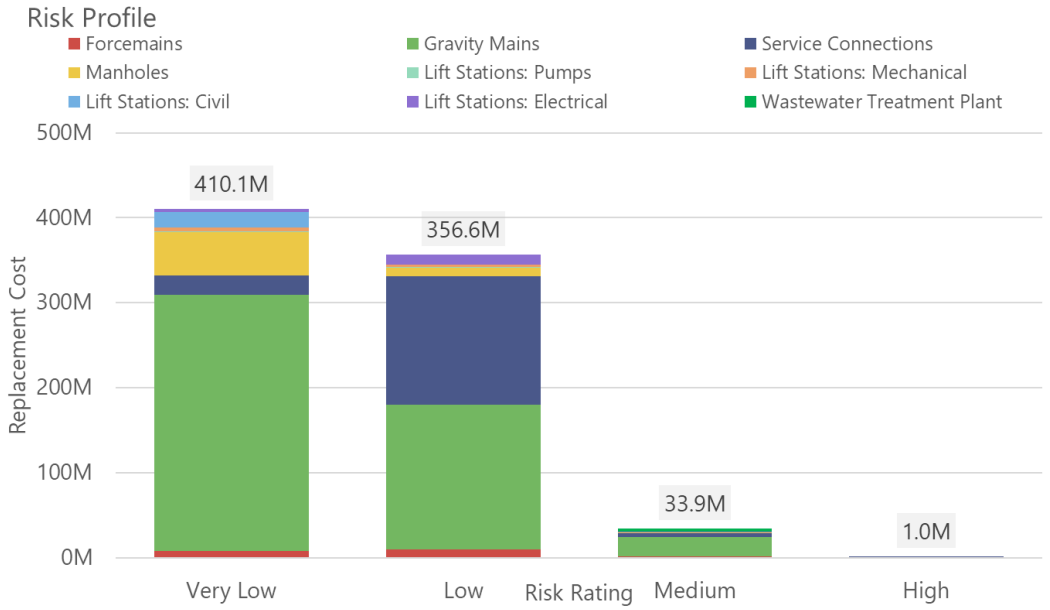


Figure 7-4 Risk Profile, All Assets by Replacement Cost

7.2.1 Gravity Mains

The District's sanitary CCTV inspection program identifies structural deficiencies and potential sources of infiltration for approximately 10,000 m of gravity mains annually (see Table 11 in Chapter 1). Table 34 summarizes the Custom Pipe Rating that is used to evaluate each manhole-to-manhole sewer segment. The 2014 CCTV Program – Sanitary report (OPUS DK, 2014) provides further detail on how the five-point grading system was developed.

Table 34 Custom Pipe Rating and Typical Defects (Likelihood of Failure)

Custom Pipe Rating	Typical Structural Defects	Typical O&M Defects	Implications
5	- Broken/Hole >= 3 Clock Positions - Broken/Hole (with soils or voids visible) - Collapse - Deformed > 10% diameter	- Infiltration Gusher - Deposits > 30% of x-section - Root balls in mainline	Failed or failure imminent
4	- Multiple Fractures - Broken and 1 Clock Position - Hole and 1 Clock Position - Deformed <= 10% diameter	- Infiltration Runner - Deposits <= 30% of x-section - Medium roots in mainline	High likelihood of failure
3	- Multiple Cracks - Longitudinal and Spiral Fractures	- Infiltration Dripper - Deposits <= 20% of x-section - Tap roots in mainline - Medium roots in lateral	Moderate likelihood of failure
2	- Longitudinal Crack, Spiral Crack - Circumferential Fractures - Large Joint Offset or Separation	- Infiltration Weeper - Deposits <= 10% of x-section - Roots fine in mainline - Tap roots in lateral - Defective lateral	Low likelihood of failure
1	- Circumferential Crack - Medium Joint Offset or Separation		Failure is unlikely in the foreseeable future

The CCTV inspection data and assigned custom rating scores were used to benchmark likelihood of failure (LOF) for each inspected gravity sewer. The LOF was assigned based on remaining useful life that is determined based on condition scores from the CCTV inspection reports (i.e., condition-based remaining useful life). While CCTV data has been collected since 2011 (see Table 11 in Chapter 1), condition data recoded within the past 5 years were used to assign LOF ratings.

For gravity sewers that have not been CCTV-inspected within the past 5 years, LOF was assigned based on age-based remaining useful life (see Table 13 in Chapter 1) and extrapolated custom pipe rating shown in Table 35. The use of extrapolated custom pipe rating based on pipe material and soil types was adopted from the District's Sanitary Master Plan (KWL, 2019) and included in this Asset Management Plan for consistency. The overall LOF rating was weighted 75% towards remaining useful life and 25% towards custom material-soil type rating.

Table 35 Extrapolated Custom Pipe Rating (Likelihood of Failure)

Pipe Material	Granitic Rock	Gravel and Sand	Sandstone	Till	Volcanic Rock	Foliated sedimentary and Volcanic rock	Water	Unknown
Concrete	3	3	3	3	3	3	3	3
Vitrified Clay	3	3	3	3	3	3	3	3
PVC, ***before*** 1989	2	2	2	2	2	2	2	2
PVC, ***after*** 1989	1	1	1	1	1	1	1	1
AC	3	3	3	3	3	3	3	3
Other	2	3	2	3	3	3	3	3

The consequence of failure (COF) for each gravity main was estimated based on the method outlined in the District's Sanitary Master Plan (KWL, 2019), where the impact of asset failure was expressed in "Tripple Bottom Line" (TBL) terms (i.e., people, planet, and profit). The COF rating method considers several economical, social, and

environmental factors and weighs them to generate overall COF rating. Table 36 shows the COF rating matrix for each type of factor and Table 37 shows how each factor is classified (i.e., economic cost, social cost, environmental cost) and weighted towards the overall COF rating. The six-point scale rating used in Sanitary Master Plan was normalized to five-points scale in this asset management plan.

Table 36 Consequence of Failure Rating Matrix (1)

CoF	Diameter	Depth	Existing PWWF	Road Class	Distance from Infrastructure
1	< 200 mm	< 1.8 m	< 10	Unpaved	> 45 m
2	200 mm – 250 mm	1.8 – 3 m	11 - 30	Strata	30 – 45m
3	250 mm – 375 mm	3 - 4.3 m	31 - 70	Local	23 -30 m
4	375 mm – 525 mm	4.3 - 5.5 m	71 - 120	Collector	15 - 23 m
5	525 mm – 750 mm	5.5 – 7 m	121 - 150	Arterial	7.5 - 15 m
6	> 750 mm	> 7 m	> 150	Freeway	< 7.5 m

Table 37 Consequence of Failure Weighting Factors, Gravity Mains

Impact Category	Weight (%)	Factors Considered
Social	25%	Diameter Existing PWWF Road Class Distance from School
Economical	25%	Depth Distance from Business Diameter Road Class
Environmental	50%	Distance from Waterway

Figure 7-5 shows risk distribution for gravity sewers, 95% of which are rated as low- or very low-risk assets. The remaining 5% are rated medium or high, representing approximately $23M worth of infrastructure.

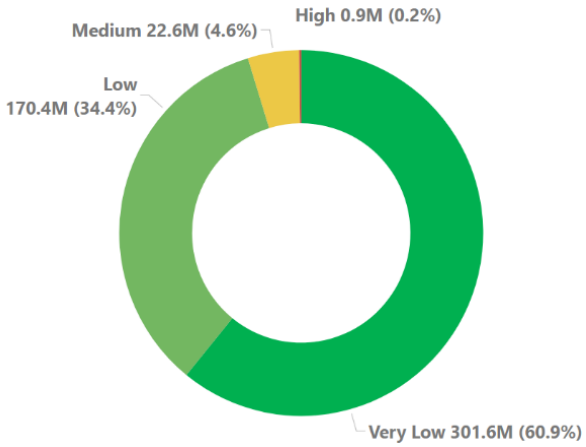


Figure 7-5 Gravity Mains Risk Distribution, by Replacement Cost

7.2.2 Manholes

The condition data included in the District's CMMS are used to benchmark likelihood of failure (LOF) for each inspected manholes. The condition data has been recorded for 3,186 out of 4,473 manholes included in the analysis (see Table 11 in Chapter 1).

Manholes that have not been inspected were assigned LOF ratings based on an age-based remaining useful life. Assumptions on theoretical useful life for Manholes are shown in Table 12 in Chapter 1. The consequence of failure (COF) ratings for all manholes are based on intersecting gravity sewers. The COF for a given manhole is the highest COF of the gravity mains intersecting it.

Figure 7-6 shows risk distribution for manholes, almost 99% of which are rated as low- or very low-risk assets. The remaining 1% are rated medium, representing approximately $0.6M worth of infrastructure.

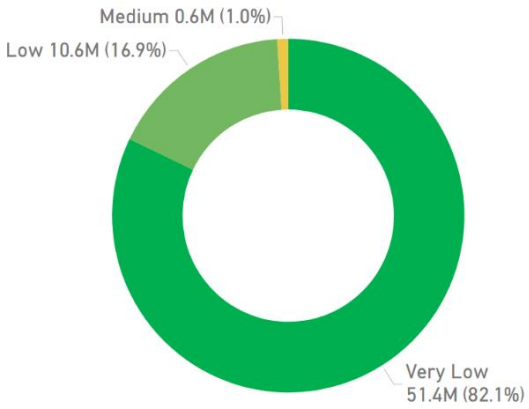


Figure 7-6 Manholes Risk Distribution, by Replacement Cost

7.2.3 Service Connections

The District does not collect condition data for service connections. Therefore, the likelihood of failure (LOF) is based on the remaining useful life and typical deterioration curve (see Table 10 and Figure 4-3 in Chapter 1).

The consequence of failure for service connections is based on type of land use (e.g., hospital, household). A geo-spatial analysis was conducted to match each service connection to a parcel in the District's geo-database. Each parcel type was assigned a criticality based on land use that was used as COF for the corresponding service connection. Table 38 shows and example of land use types and their corresponding criticality / COF rating.

Table 38 CoF Rating for Land Use Types

CoF	Type of Land Use [Examples]
1	Parking lot
2	Residential single dwelling Recreational & cultural buildings Automobile shops Parks and playing fields Storage and Warehouse
3	Schools, Universities, and Colleges Stores and Offices Government Buildings Strata Lot Residential Multifamily Housing
4	Senior Care Seniors Independent & Assisted Living Restaurants
5	Hospitals Police and Fire Stations

Figure 7-7 shows risk distribution for service connections, about 97% of which are rated as low- or very low-risk assets. The remaining 3% are rated medium or high, representing approximately $4.7M worth of infrastructure.

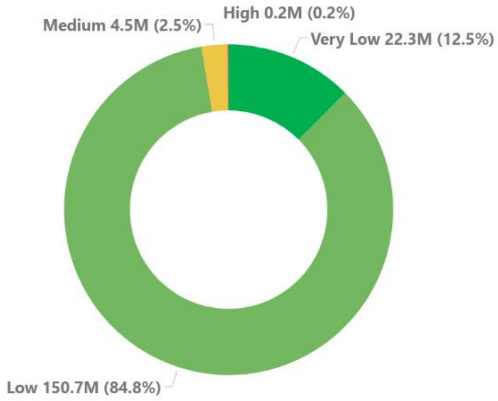


Figure 7-7 Service Connections Risk Distribution, by Replacement Cost

7.2.4 Lift Stations

The likelihood of failure for each of the four components of a typical lift station (i.e., civil, electrical, mechanical, pumps) was estimated based on average condition assessment results provided in the District's Sanitary Pump Station Condition Assessment Report (KWL, 2018). Each pump station was evaluated based on its technical performance, operational performance, reliability, and availability and maintainability. In addition to a combined condition and performance score, the analysis for this asset management plan incorporates remaining service life into the final POF score. Both the condition and performance score, and remaining service life are weighted equally at 50%.

The consequence of failure is calculated for each lift station rather than individual components. This is based on the premise that a catastrophic failure of any of the four components for would have a major impact on the function of the pump station and could render it inoperable. Similar to gravity mains, the COF for lift stations is calculated based on social, economical, and environmental impacts of a failure. Table 39 shows the weighting and criteria for each category.

Table 39 Consequence of Failure Rating Weighting Factors, Lift Stations

Impact	Criteria	Weight
Social	Sewer Backups Service Interruptions	35%
Economical	Sewer Overflow Repairs/Rehabilitation Regulatory Fines Road & Business Closures Compensatory Claims	30%
Environmental	Sewer overflows to sensitive areas	35%
		100%

Although one COF rating is used for all four components of a pump station, the POF score can vary for each component and therefore risk ratings are reported at the component level.

Figure 7-8 shows risk distribution for each component of lift stations. As expected, the civil components of lift stations are rated low risk or very low risk given long useful life and slow condition deterioration rate. Electrical and mechanical components have 6% and 4% of assets rated as medium risk, respectively, with the rest being low or very low risk. Only 2% of pump components are rated as medium risk, while the remaining 98% are low or very low risk. The results indicate that most of the District's lift stations are in a good condition, with a few lift stations requiring attention in the near future to improve overall results and asset reliability.

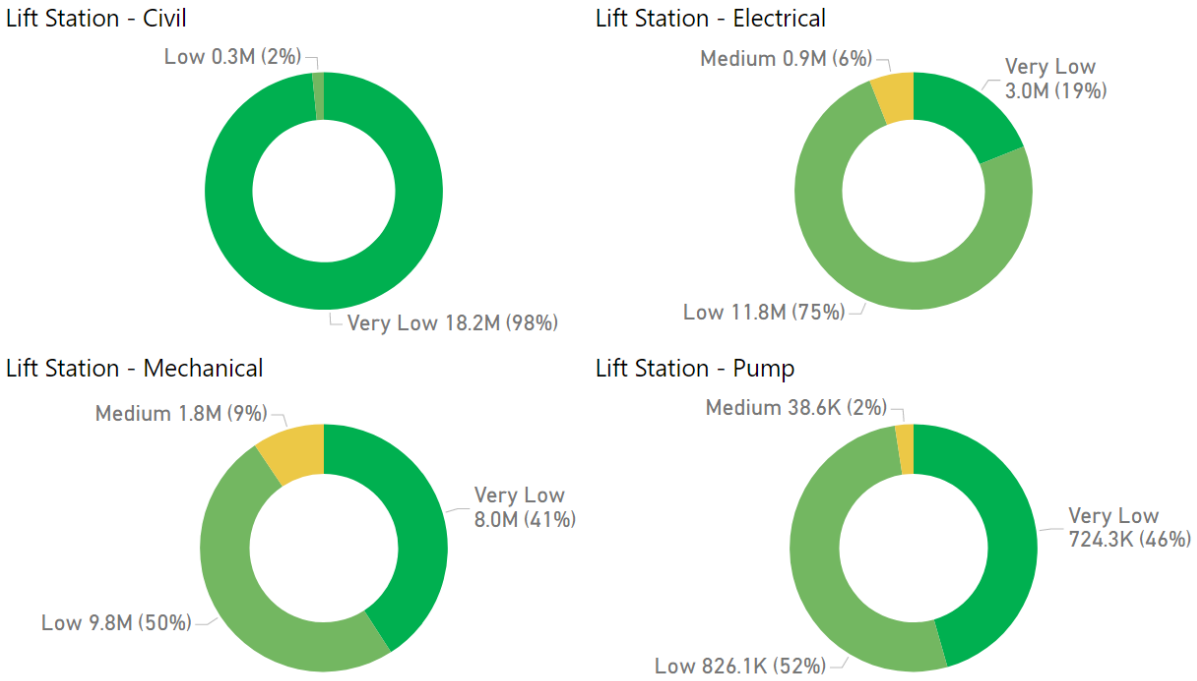


Figure 7-8 Lift Stations Risk Distribution, by Component, by Replacement Cost

7.2.5 Forcemains

The likelihood of failure (LOF) for forcemains is solely based on their remaining useful lives (see Table 13 in Chapter 1). The consequence of failure for each forcemain was scored based on the COF of adjacent lift station. If a forcemain is not in close proximity to any lift station, the highest COF of two intersecting gravity mains is used.

Figure 7-9 shows risk distribution for forcemains, 91% of which are rated as low- or very low-risk assets. The remaining 9% are rated medium, representing approximately $1.8M worth of infrastructure.

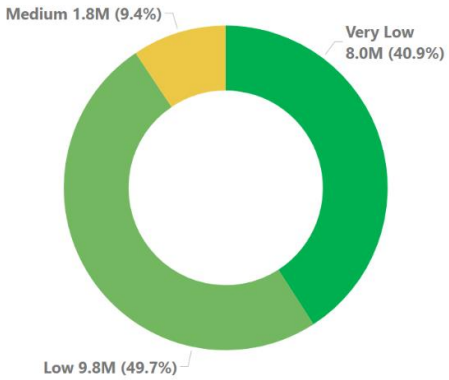


Figure 7-9 Forcemains Risk Distribution, by Replacement Cost

7.2.6 Wastewater Treatment Plant

The likelihood of failure (LOF) for the Citrus Wynd Wastewater Treatment Plant is solely based on its remaining useful life (SEE TABLE XX in SOI Chapter).

Figure 7-10 shows risk distribution for the Citrus Wynd Wastewater Treatment Plant, 100% of which is rated as medium risk asset.

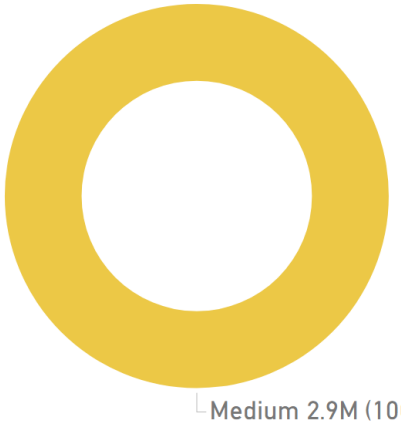


Figure 7-10 Wastewater Treatment Plant Risk Distribution, by Replacement Cost

7.3 Risk Improvement Items

Table 40 lists the improvement actions that will improve risk management asset management practices.

Table 40 Risk Improvement Items

Task No.	Improvement Task Name	Improvement Task Description
7.1	Standardized risk approach	Currently there is not a consistent approach for rating risks across different asset groups. It is recommended to develop standardize risk evaluation frameworks for wastewater, for (1) linear assets and (2) non-linear assets.
7.2	Maintain and refine the Sanitary System risk scores	Maintain and refine the sanitary system risk model inputs, as more condition information becomes available and consequence ratings are refined.
7.3	Capitalize Mitigation Strategies	Capitalize possible mitigation options employed by the District and quantify risk reduction in dollar terms to estimate benefit-cost ratio of various mitigation strategies. Systematically evaluating mitigation options / risk reduction strategies will help the District better understand their risk appetite and ensure better value for money.

8 Financial Forecast

The following sections present the District's foundation financial information to inform a funding strategy, including current expenditures, forecasted costs to renew and upgrade existing infrastructure as required over the planning horizon, and the estimated annual investment requirements over the 100-year planning horizon.

The District's Sewer Utility and its financial plans include the regional sewage treatment levy from Metro Vancouver (MV), the Greater Vancouver Sewerage and Drainage District. The regional wastewater treatment levy reflects the District's actual costs of treatment, but also embedded in the levy are the District's share of regional capital asset renewal costs for treatment infrastructure. In the interest of transparency for rate payers, the District's sewer rate is structured to separately reflect the proportional regional levy from the local revenues and expenses. The costs associated with the new North Shore Wastewater Treatment Plant (NSWWTP) are captured based on the best available information at the time of this study. The projections associated with the NSWWTP are subject to change once the final construction costs are realized and may also be influenced by fluctuations in the cost of sewage treatment operations by MV.

The regional capital renewal costs are expected to rise as regional infrastructure reaches end-of-life. The District has limited control over regional asset renewal schedules, but has been taking steps to build up a Reserve fund and smooth future rate impacts for rate payers in anticipation of regional cost increases.

SSAMP Update – the first SSAMP in 2010 did not include information on operations and maintenance activities and related costs. This 2021 version of the SSAMP now includes information on the District's operating and maintenance costs and expectations for future needs in this area.

8.1 Key Assumptions and Forecast Parameters

Key financial planning assumptions and parameters used to develop the financial forecasts are as follows:

- The planning horizon for financial forecast is 100 years. This meets or exceeds the expected useful life of all sanitary system assets.
- Capital improvement projects are identified for the next 20 years, based on the District's Sanitary Master Plan (KWL, 2019). This report lists improvement costs for linear assets (i.e., gravity mains and forcemains). These costs have been updated based on unit rates used in this Asset Management Plan. Upgrade costs for lift stations were also sourced from the Master Plan and converted to $2021. The Master Plan provides more detail on the required upgrades and expansion of the sanitary system to address capacity issues within the next 20-yr period, only the values are reported in this section for the financial forecast.
- The long-term financial plan is developed based on average values for two key input parameters - unit costs and expected useful lives of assets.
    - The unit costs were assumed based on historic data and the District's staff expertise. These costs may vary from project-to-project depending on various project-specific factors such as geographic location and physical constrains, macro- and micro-economic factors such as scarcity of resources, highly concentrated construction market, and regulations, as well as environmental factors such as climate change and natural disasters. However, using average costs in the long-term tends to balance out occasional high-cost and low-cost projects.
    - To address uncertainty related to expected useful lives of assets, the financial forecast was developed for 3 scenarios (estimated most likely lifespan and +15% and -15% lifespan values).
    - Unit rates are shown in the Appendix B Table 8 and Appendix B Table 9.
- All costs and budgets are reported in $2021 unless stated otherwise. Where required, historic costs and available budgets were converted to $2021 dollars using ENR Cost Index (Note ENR Construction Cost Index used due to discontinuation of Statistics Canada's Infrastructure Construction Price Index in 2019).

- No inflation has been included in the forecasted costs.

8.2 Historical Costs

8.2.1 Operating and Maintenance Costs (excluding Treatment Levy)

Budget

Table 41 summarizes the District's 3-year average Sanitary System Operation and Maintenance Budget (2019-2021), by business unit and expenditure type. The available data between 2019 and 2021 was aggregated to generate average expenditures per annum. The budget is only for operations and maintenance expenditures including, but not limited to, asset inspection programs, material and tools supply, labor costs, and wastewater treatment operation costs. Metro Vancouver Sewage Treatment Levy is detailed in section 8.2.2 and Capital renewals, upgrades, and expansions are detailed in section 8.3.

Table 41 Sanitary System Budget OMI (2019-2021 3-Year Average)

Business Unit	Expenditure Type [$2021 Dollars] (1)				
	Inspections	**O & M**	**Overhead**	**Shop/Tools**	**Total**
General Operations	-	-	$525,481	$43,747	$569,228
Operations Centre & Administration	-	-	$542,875	-	$542,875
Sewer Collection System	$85,980	$195,498	$54,356	-	$335,834
Sewer Pumps	$74,966	$421,778	$87,949	-	$584,693
WWTP-Cytrus Wynd	-	$227,941	-	-	$227,941
Total	$160,946	$845,217	$1,210,661	$43,747	$2,260,571

(1) All values were converted to $2021 dollars using ENR index.

Expenditure

Table 42 shows the District's 3-year average expenditures (2019-2021), by business unit and expenditure type. On average, the district has exceeded their planned budget for shop maintenance and construction tools and inspection programs.

Table 42 Sanitary System Actual Expenditures OMI (2019 – 2021 3-Year Average)

Business Unit	Expenditure Type [$2021 Dollars] (1)				
	Inspections	O & M	Overhead	Shop/Tools	Total
General Operations	-	-	$486,980	$76,639	$563,619
Operations Centre & Administration	-	-	541,997	-	$541,997
Sewer Collection System	$82,715	$246,669	$42,761	-	$372,145
Sewer Pumps	$119,240	$315,462	$55,838	-	$490,540
WWTP-Cytrus Wynd		$162,902			$162,902
Total	$201,955	$725,033	$1,127,576	$76,639	$2,131,203

(1) All values were converted to $2021 dollars using ENR index.
(2) Expenditures that exceed the budget are highlighted in red, and expenditures that are below the budget are highlighted in green.

8.2.2 Operating Costs (Metro Vancouver Treatment Levy)

Table 43 summarizes the District's 3-year average Metro Vancouver Treatment Levy Budget and Actual Expenditure (2019-2021), for treating the District's sanitary sewage.

Table 43 Sanitary System Budget – Metro Vancouver Levy (2019-2021 3-Year Average)

Business Unit	Expenditure Type [$2021 Dollars] (1)			
	Levy Budget (2019-2021)	Budget Total	Expenditure (2019-2021)	Expenditure Total
Metro Vancouver Sewage Treatment Levy	$8,598,400	$8,598,400	$7,922,836	$7,922,836
Total	$8,598,400	$8,598,400	$7,922,836	$7,922,836

(1) All values were converted to $2021 dollars using ENR index.
(2) Expenditures that exceed the budget are highlighted in red, and expenditures that are below the budget are highlighted in green.

8.2.3 Total Operating and Maintenance Costs (including Treatment Levy)

Figure 8-1 shows the District's total operating and maintenance budget (including treatment levy) over the period of 3 years from 2019 to 2021, compared to actual expenditure. In all 3 periods, the District has stayed within the allowable budget, with average actual expenditure being 93% of budget.

The District also maintains a reserve balance set aside for fiscal emergencies that can result from emergency repairs, natural disasters, and unforeseen economic influences. One of the most common metrics used in determining operating reserve levels is a specified number of days or months of operating expenses. The District's emergency operating reserve level is 90 days worth of operational and maintenance costs. The reserve level depends on stability and predictability of revenues and expenses and, therefore, varies from organization to organization. The reserve balance is reviewed annually during the budgeting process to ensure adequate reserve level and promote sustainable financial management.

The District's Sanitary System Operation and Maintenance Budget is currently providing sufficient resources to manage the system in its current condition. However, this may not be sufficient as the assets age and as more assets are added over time. The State of Infrastructure chapter (Chapter 1) of this SSAMP identifies that more than 60% of assets are currently in good or very good physical condition being at or just above half their expected useful lives on average. Operation and maintenance budget needs will change over time due to changing state of infrastructure (e.g., aging assets), economic situation (e.g., inflation rate), and environmental factors (e.g., climate change and natural disasters). This reality warrants re-assessment of operation and budget needs on a regular basis (ideally, annually).

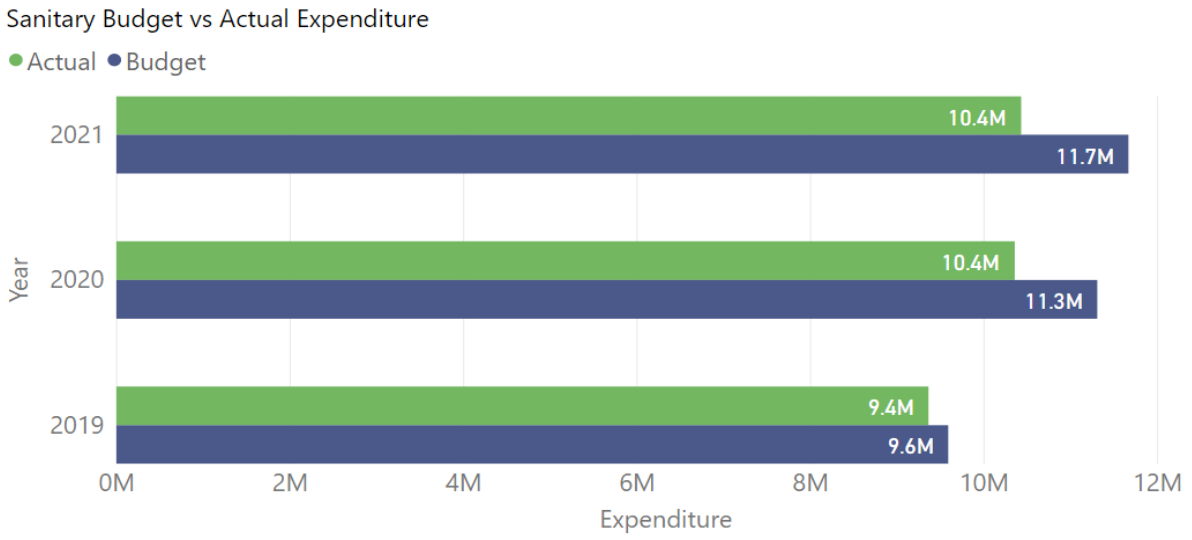


Figure 8-1 Sanitary Budget vs Actual Expenditure, 2019-2021 (including Treatment Levy)

Table 44 compares the annual OMI budget increase between 2019 to 2021 to inflation rate, measured using ENR Cost Index (Note ENR Cost Index used due to discontinuation of Statistics Canada's Infrastructure Construction Index in 2019). Metro Vancouver sewage treatment levies are excluded from this comparison. Note that the annual OMI

budget increase has barely exceeded the inflation rate by only 0.02% in 2020 and was approximately 4% lower than the inflation rate in 2021.

Table 44 Comparison of OMI Budget Increase to Inflation Rate (excluding Treatment Levy)

Year	Budget, excluding MV Levy [1]	Budget, Annual Percent Increase	ENR Index, Annual Percent Increase	Difference
2019	$2,130,444	-	-	-
2020	$2,165,653	1.65%	1.63%	0.02%
2021	$2,201,600	1.66%	5.75%	-4.09%

(1) Budget, excluding Metro Vancouver sewage treatment levy.

The recommended detailed review of annual budget will seek to ensure sufficient funds are provided to maintain and operate the sanitary infrastructure assets, considering inflation, aging assets, and the other factors mentioned above. The review should also identify how the annual budget is distributed by expenditure type. Future review should address the above-mentioned gap and issues in operations and maintenance budget forecasts and planning.

8.3 Forecast Costs

8.3.1 Forecast Treatment Levy

The Metro Vancouver Treatment Levy is part of the overall cost of service for West Vancouver's sanitary sewer system. The Treatment Levy budget includes allowance for rate smoothing to mitigate the impact of expected future rate increases.

Table 45 Treatment Levy Forecast

Year	Metro Vancouver Treatment Levy			
	Levy Budget	Levy Paid	Levy Rate Smoothing	Forecast
2019	$ 6,795,400	$ 6,768,895	$ 1,300,000	
2020	$ 8,530,800	$ 7,672,738	$ 500,000	
2021	$ 9,469,700	$ 8,378,930	$ 550,000	
2022			$ 1,000,000	$ 10,000,000
2023				$ 10,000,000
2024				$ 10,000,000
Average	**$ 8,265,300**	**$ 7,606,854**	**$ 837,500**	**$ 10,000,000**

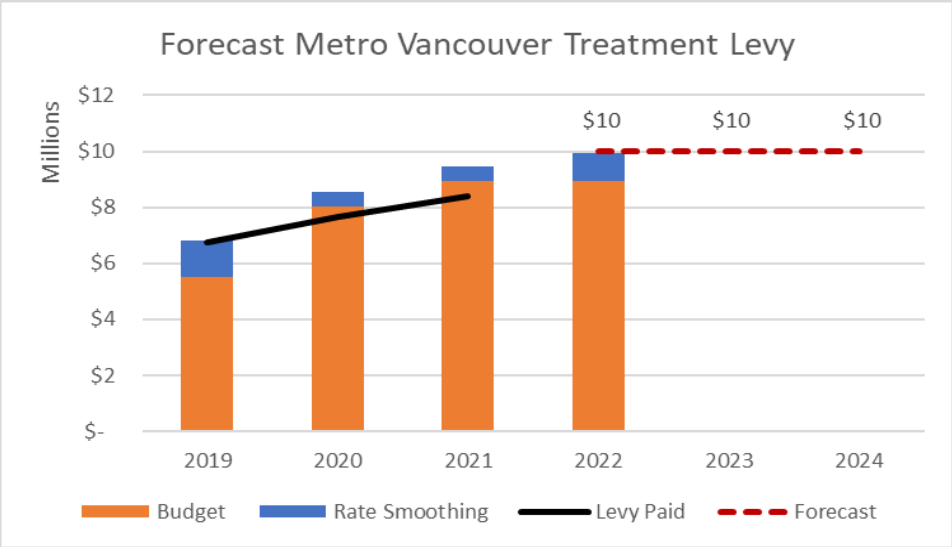


Figure 8-2 Treatment Levy Budget vs Actual Expenditure and 3-Year Forecast

8.3.2 Forecast Total Operations and Maintenance (including Treatment Levy)

A long-term financial forecast for operations and maintenance costs has not been developed. However, the available information provides a short-term indication based on average actual expenditure from the past 3-years (see Table 42).

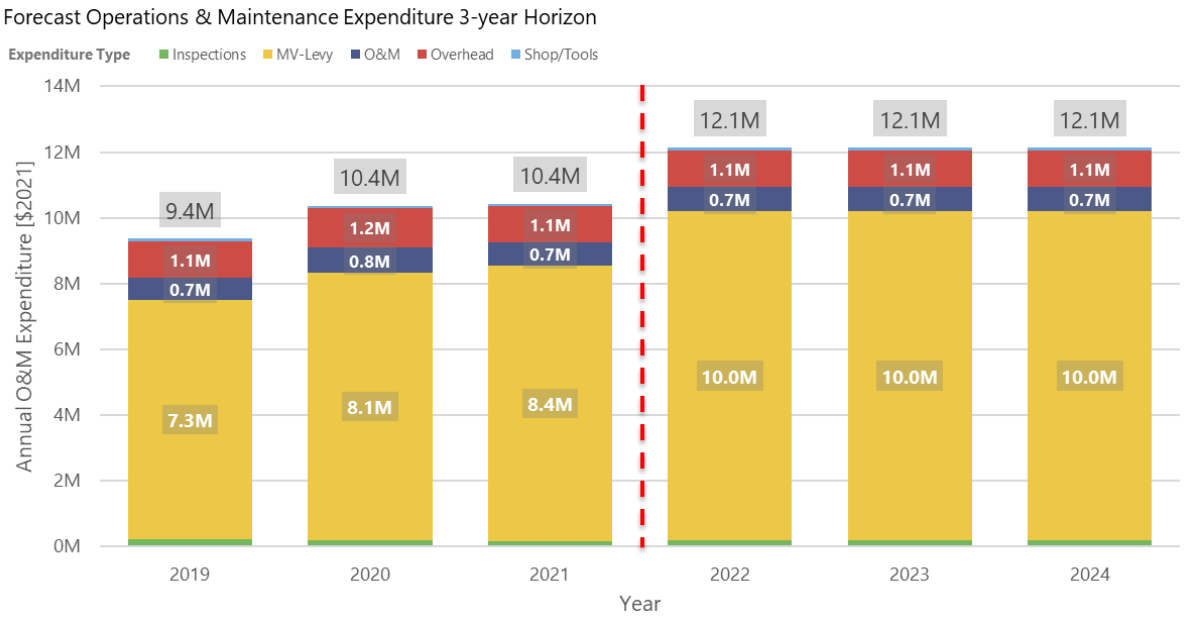


Figure 8-3 Forecast Operations and Maintenance Expenditure 3-year Horizon

Note that the forecast in Figure 8-3 is based on average actual costs from the last 3 years for inspections, overheads, shop/tools, and O&M, but the forecast for the MV Treatment Levy includes a forecast rate smoothing allowance. This forecast (other than the Treatment Levy) may or may not be sufficient to maintain the existing sanitary system assets as they age over time, and to reliably operate the assets to meet the required level of service targets in the longer-term. Current level of service is defined at the service-level (service delivered to customers). A detailed analysis at an activity-level identifying the individual operations, maintenance, and inspection activities needed to support level of service delivery, and the frequency and cost of these activities, will generate a robust (needs-based) forecast. This detailed activity-level analysis is recommended as an improvement task.

8.3.3 Forecast Capital Renewal Costs

The Capital Renewal Costs are allocated for the strategic replacement of aging infrastructure to address issues with service or poor performance. The Capital Renewal Costs are separate and distinct from Capital New and Upgrade costs. The Capital New and Upgrade Costs are detailed in Section 8.3.4. Capital renewal costs are limited to replacement of existing assets and meeting current levels of service.

Figure 8-4 summarizes the replacement unit rates used for linear sanitary assets. Detailed unit rates for each material type and pipe size are shown in Appendix B Table 8. Forcemain and sanitary main replacement costs vary by size and length of an asset. While the cost of each service connection will vary by size, length, and pipe material type as well as depth of construction and complexity of reinstatement, the analysis in this AMP assumes an average rate of $14,000 per service connection.

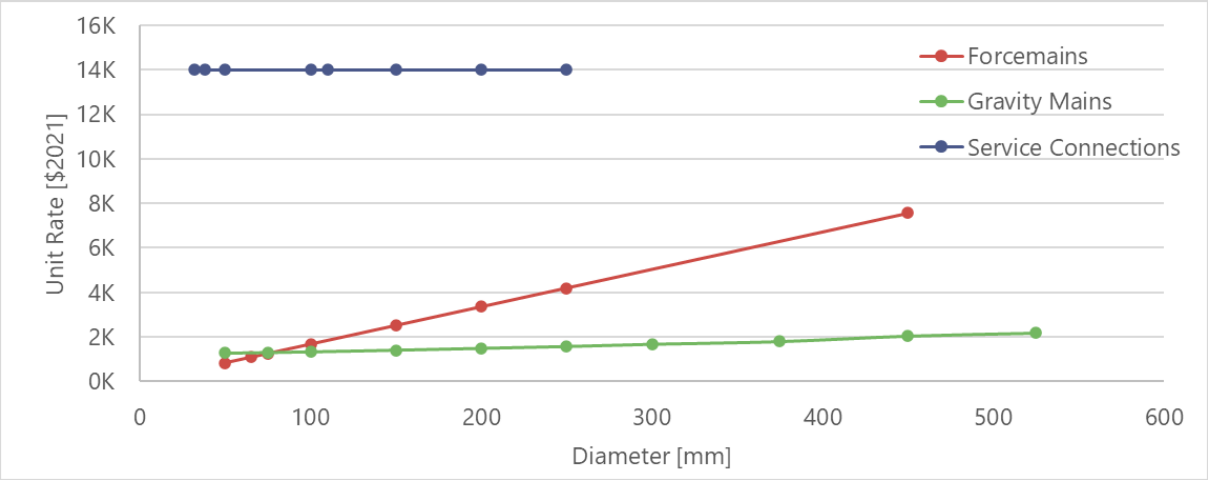


Figure 8-4 Unit Rates for Renewals – Linear Assets

Note: Unit Rates for Forcemains and Gravity Mains are per meter of pipe. Unit Rate for Service Connection is per service connection. Unit Rates include both engineering O/H or contingency.

Table 46 summarizes the replacement unit rates used for non-linear sanitary assets. While replacement costs for manholes varies based on size, depth, as well as other factors such physical constraints, the analysis in this AMP assumes an average rate of $14,000 per manhole The replacement cost for the Citrus Wynd Wastewater Treatment Plant was estimated to be approximately $2,910,000. Current granularity of data on the Citrus Wynd WWTP does not allow for a more detailed cost breakdown by each component. The replacement costs for lift stations and their components have been estimated and summarized in the District's Sanitary Pump Station Condition Assessment Report (KWL, 2018). Appendix B Table 10 contains replacement cost estimates for each lift station by component (i.e., civil, electrical, mechanical, pump).

Table 46 Unit Rates for Renewals – Non-Linear Assets

Asset Type	Unit of Measure	Construction Rate [$2021 Dollars] (1)	Unit Rate [$2021] (1), (2)
Manhole	Per Manhole	$10,000	**$14,000**
WWTP-Citrus Wynd	Per WWTP	$2,080,000	**$2,910,000**
Lift Station	Per Lift Station Component	Various (3)	Various (3)

(1) All values were converted to $2021 dollars using ENR index.
(2) Unit Rates include 15% engineering O/H & 25% contingency.
(3) See Appendix B Table 10 for detailed costing for lift stations.

8.3.4 Forecast Capital New and Upgrade Costs

Capital New and Upgrade Costs represent the District's planned expenditures required to service new developments and growing demand, meet increased sanitary service levels, or provide for new design requirements. The District's Sanitary Master Planning Study (KWL, 2019) prioritised capital upgrade projects based on a hydraulic analysis of the system performance under existing and future development scenarios. The capital improvement projects identified in the M Refers to Citrus Wynd Wastewater Treatment Plant Master Plan are classified as Capital New and Upgrade Costs in this Asset Management Plan.

Table 47 summarizes the total new and upgrade costs for each asset type.

Table 47 Capital New and Upgrade Costs Summary

Asset Type	Quantity/Length	Total New & Upgrade Cost [$2021] (1), (2), (3)
Forcemains	136 m	$342,657
Gravity Mains	8,535 m	$14,416,516
Lift (Pump) Stations:		
Electrical Component	5	$3,043,734
Mechanical Component	5	$1,121,883
Pump Component	5	$357,584
Total:		**$19,282,375**

(1) All values were converted to $2021 dollars using ENR index.
(2) Costs include engineering O/H & contingency.
(3) Total costs are calculated using unit rates used in this Asset Management Plan and, therefore, do not necessarily match total costs in the Master Plan.

8.3.5 Forecast Total Capital Renewal and Capital New and Upgrade

The financial forecast has been developed for a 100-year horizon in accordance with key assumptions and parameters outlined in section 8.1. Note that the total includes 100-year forecast for capital renewal costs but only the available 20-year forecast for capital new and upgrade costs. Table 48 and Figure 8-5 show the total forecast capital expenditure for the 100-year analysis period by asset type.

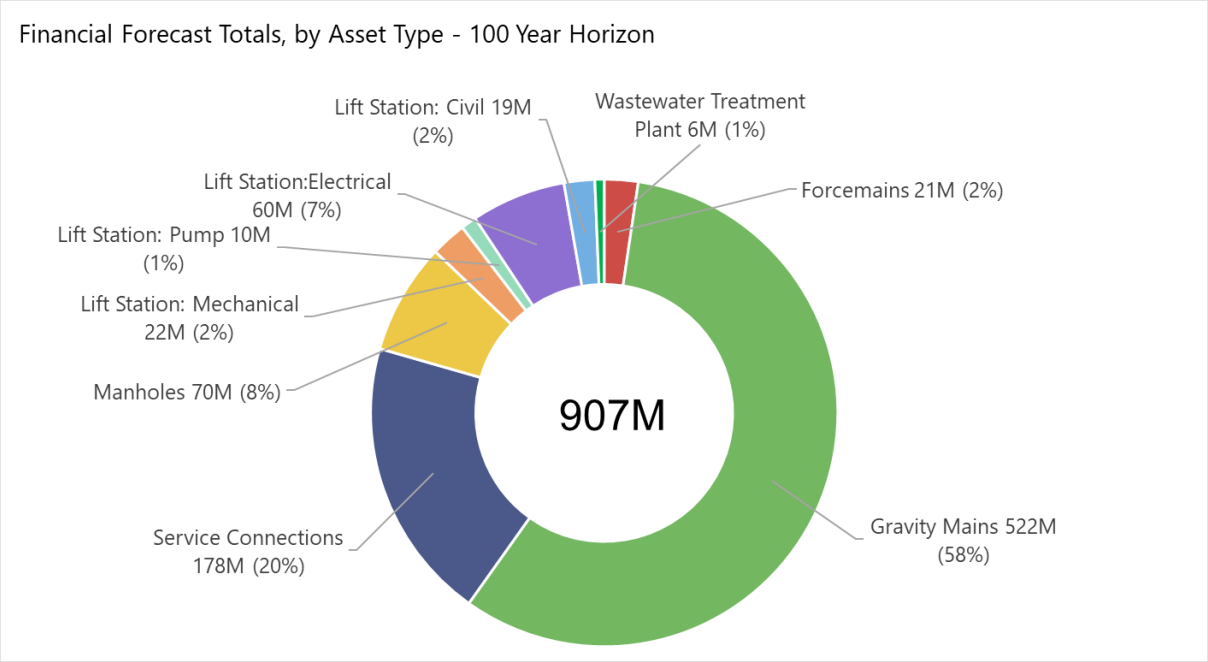


Figure 8-5 Total Forecast Capital Expenditure – 100-Year Horizon, By Asset Type

Table 48 Total Forecast Capital Expenditure 100-Year Horizon, By Asset Type

Asset Type	100-year Total Capital Expenditure [$2021]	Percent of Total
Forcemains	$21.2M	2%
Gravity sewer mains	$521.6M	57%
Service connections	$177.8M	20%
Manholes	$69.8M	8%
Lift Station Mechanical Components	$22.4M	2%
Lift Station Pump Components	$9.7M	1%
Lift Station Electrical Components	$59.8M	7%
Lift Station Civil Components	$19.2M	2%
WWTP-Citrus Wynd	$5.8M	1%

Table 49 shows a detailed breakdown of the forecast capital expenditure within the next 20-year period between 2023 and 2043. The analysis shows that the District will require $96.5M in the next 20 years (or $5.8M per year) for capital expenditures. Out of $96.5M, about 17% ($19.3M) is for expansion of the existing system.

Table 49 Sanitary System 20-Year Financial Forecast, By Asset Type and By Expenditure Type

Asset Type	Total 20-Year Expenditures	Total 20-Year New & Upgrade Expenditures	Total 20-Year Renewal Expenditures	20-Year Average Per Annum
Forcemains	$4,616K	$343K	$4,273K	$231K
Gravity sewer mains	$91,132K	$14,417K	$76,716K	$4557K
Service connections	$56K	-	$56K	$3K
Manholes	$3,696K	-	$3,696K	$185K
Lift Station: Mechanical	$1,927K	$1,122K	$805K	$96K
Lift Station: Pump	$1,322K	$358K	$964K	$66K
Lift Station: Electrical	$12,984K	$3,044K	$9,940K	$649K
Lift Station: Civil	$125K	-	$125K	$6K
WWTP-Citrus Wynd	-	-	-	-
Total	$115,858K	$19,282K	$96,576K	$5,793K

Figure 8-6 shows the long-term 100-year financial forecast for capital renewals and includes capital upgrades and new capital creation forecast to occur within the next 20-year period. Capital improvement needs beyond the 20-year horizon are not currently known.

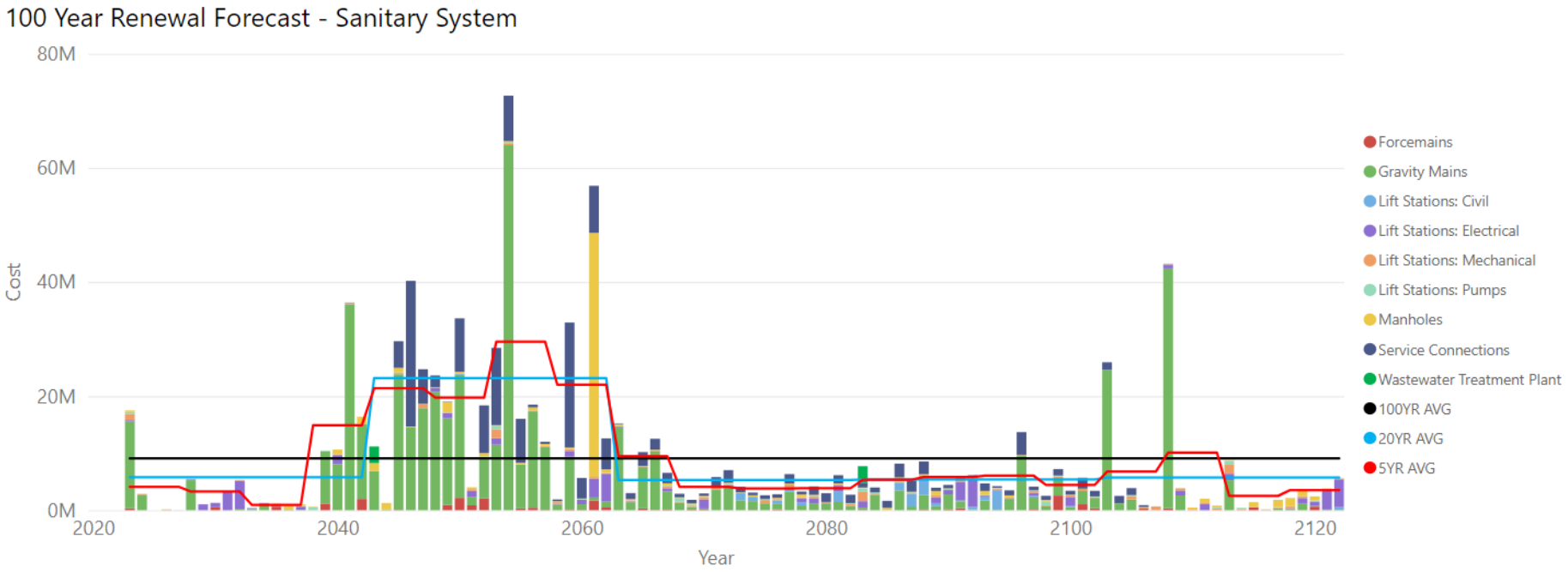


Figure 8-6 Sanitary System 100-year Financial Forecast, by Asset Type

8.4 Sensitivity Analysis

The financial forecast (for capital renewals and capital new and upgrades), was estimated for 3 scenarios to provide a better understanding of the relationship between costs and assumed estimated useful lives (EUL) of assets. The Most Likely scenario has been presented in the previous section (Section 8.3.5) and uses the estimated useful lives provided in Table 12 and Table 13 in the SOI Chapter 1.

Two other cost scenarios were calculated for comparison with the most-likely scenario. These were Best-Case and Worst-Case scenarios based on increasing and reducing the most-likely estimated useful lives by 15%, respectively.

Figure 8-7 and Figure 8-8 show the long-term financial forecast for the Best-Case and Worst-Case scenarios. In the short-term there are only minor variances between the financial forecast scenarios. However, in the longer-term, the scenarios show that additional renewals are required towards the end of the 100-yr period for the Worst-Case scenario due to shorter estimated useful lives. The longer estimated useful lives in the Best-Case scenario show a reduced number of asset renewals and therefore a lower 100-year cost compared to both the Worst-Case (Figure 8-8) and the Most Likely scenarios (Figure 8-6).

Table 50 reports total, 100-year average, as well as peak 5-year and 20-year averages for capital expenditure for each scenario.

Table 50 Sensitivity Analysis Summary – Capital Expenditure Forecast [in $2021]

Planning Period	Worst Case [-15% EUL(1)]	Most Likely [EUL(1)]	Best Case [+15% EUL(1)]
Peak 5 Year Average per Annum Total Capital Expenditures	**$33.9M**	**$29.5M**	**$29.1M**
Peak 20 Year Average Per Annum Total Capital Expenditures	**$23.4M**	**$23.2M**	**$17.2M**
Total 100 Year Average Per Annum Total Capital Expenditures	**$14.3M**	**$9.1M**	**$8.7M**
100 Year Total Capital Expenditures	**$1,426.2M**	**$907.4M**	**$871.9M**

(1) EUL = Estimated Useful Life

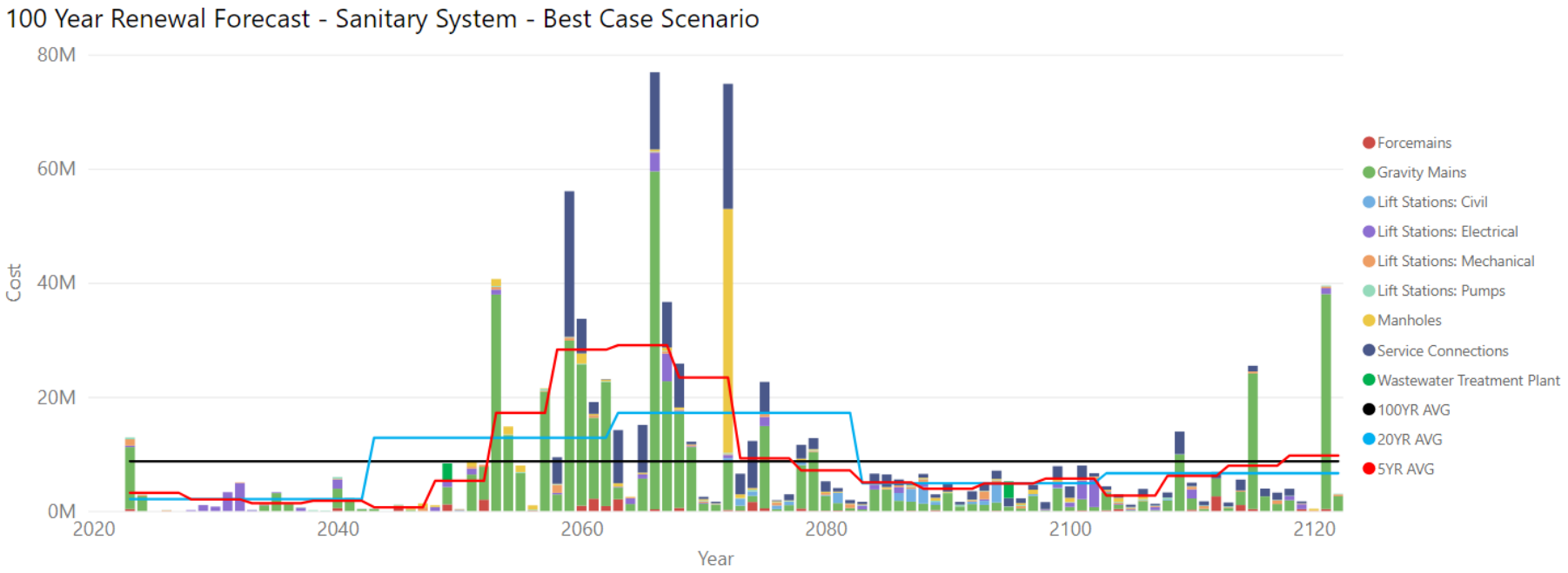


Figure 8-7 Sanitary System 100-year Financial Forecast, by Asset Type – Best Case Scenario

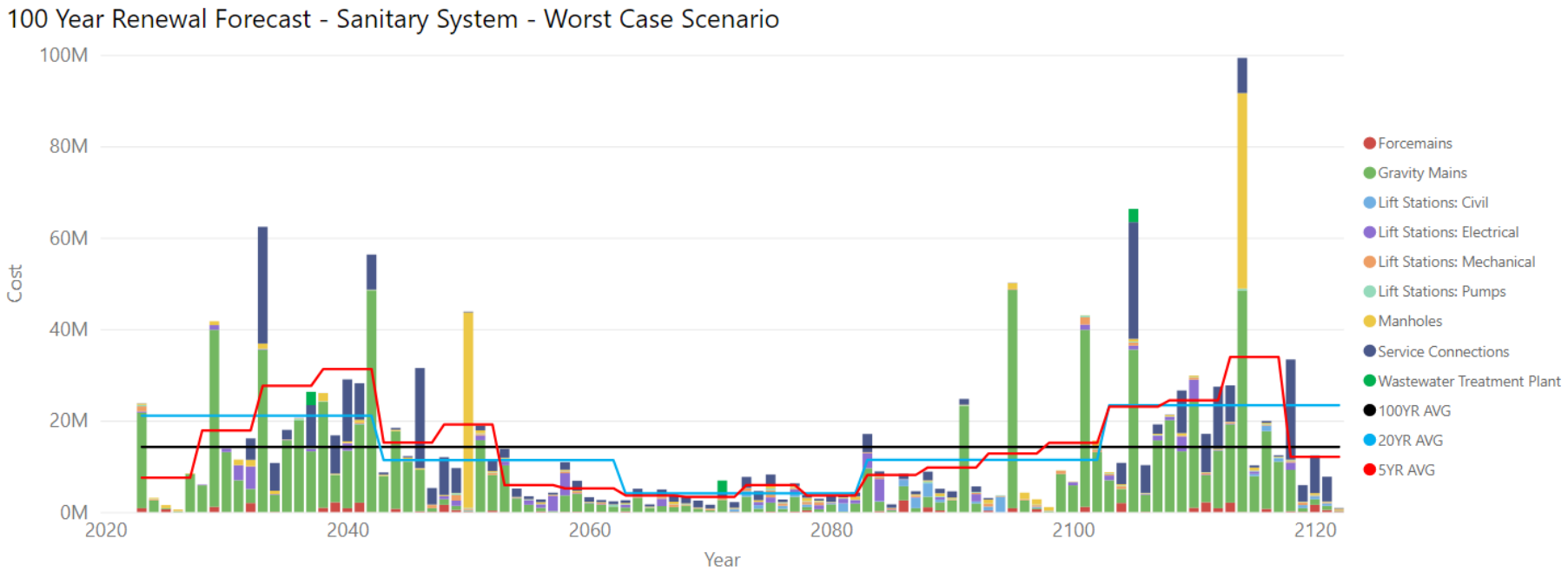


Figure 8-8 Sanitary System 100-year Financial Forecast, by Asset Type – Worst Case Scenario

8.5 Revenues, Reserve Funds, and Alternative Measures for Funding Strategy

The District has several revenue streams to support the future investment in service delivery to the community:

- Property taxes and utility fees paid by residents of the community
- Regular grants and other revenue streams from other levels of government (e.g., Federal Gas Tax Funding)
- Development cost sharing arrangements
- Operating fund surplus reserves
- Capital fund surplus reserves
- Capital replacement reserves
- Debt funding (loans)

A detailed review of forecasted revenues should be undertaken and compared with forecasted expenditures to identify any potential funding gaps. Considerations towards grant funding, debt servicing, DCC's, and any other possible funding mechanisms should also be considered for the development of the District's funding strategy.

8.6 Data Reliability and Confidence

The condition, valuation, and forecast renewals in this Plan are based on the best available data at the time of analysis. This data review section provides a grade of reliability for the data used for the state of infrastructure analysis and financial forecasts. Up-to-date and accurate asset data is critical to effective asset management, accurate financial forecasts, and informed (evidence-based) decision-making.

Understanding the accuracy and reliability of information is highly crucial. While data may not be accurate, it can deliver value to decision-makers provided the accuracy is known and considered in the decision-making processes. Therefore, the data used in this Asset Management Plan has been evaluated for reliability. A grade from A – Highly Reliable to E – Unknown was used for this purpose. Detailed descriptions for each data confidence grade are shown in Table 51 below.

Table 51 Data Confidence Grading

Confidence Grade	Description
A – Highly Reliable	Data based on sound records, procedures, investigations, and analysis, documented properly, and agreed as the best method of assessment. Dataset is complete and estimated to be highly accurate.
B - Reliable	Data based on sound records, procedures, investigations, and analysis, documented properly but has some minor shortcomings, for example some of the data is old, some documentation is missing and/or reliance is placed on unconfirmed reports or some extrapolation. Dataset is complete and estimated to be reasonably accurate.
C – Uncertain	Data based on sound records, procedures, investigations, and analysis which are incomplete or unsupported, or extrapolated from a limited sample for which Grade A or B are available. Dataset is substantially complete but up to 50% is extrapolated data and accuracy
D – Very Uncertain	Data is based on unconfirmed verbal reports and/or cursory inspections and analysis. Dataset may not be fully complete, and most data is estimated or extrapolated.
E – Unknown	None or very little data held.

Table 52 provides a summary of the data confidence and reliability for each asset type.

Table 52 Sanitary System Data Confidence, By Asset Type

Asset Type	Inventory	Condition	Remaining Useful Life	Upgrade Needs	Cost Estimates	Comments
Forcemains	B	D	B	B	B	GIS data for forcemains appears to be maintained and updated regularly with the most recent information. Upgrade needs are based on Sanitary Master Plan and are considered accurate. Condition for forcemains is not measured due to physical limitations for access to mains and cost of non-invasive investigation processes. However, condition can be deduced from age as an indicator.
Gravity Mains	B	C	B	B	B	Inventory data for gravity mains varies and exists in multiple sources (CCTV tables vs GIS data). Condition data is collected for approximately 10km (out of 340km) per annum. Upgrade needs are based on Sanitary Master Plan and are considered accurate.
Service Connections	B	E	B	D	B	GIS data for service connections appears to be maintained and updated regularly with the most recent information. Condition and upgrade needs for service connections are assessed on a case-by-case basis as and when needed. Condition ratings are not currently assigned to connections.
Manhole	C	C	C	C	B	GIS data for manholes is incomplete. Installation years have been assumed. The existing GIS data does not specify when condition information was collected. Upgrade needs are uncertain due to lack of confidence in condition data.
Lift Stations	B	A	A	A	A	Existing data shows minor inventory non-consistencies across data sources. Recent Pump Station Condition Assessment Reports and Sanitary Master Plan provide very detailed information on condition, upgrade needs, and cost estimates for all components of lift station.
WWTP-Citrus Wynd	D	D	D	D	D	The District has most records on the Citrus Wynd WWTP but they have not yet been uploaded to the MC database. All information used in the analysis was estimated based on age and or extrapolated from other indicators.

8.7 Financial Forecast Improvement Items

Table 53 lists several improvement recommendations that were identified through the development of the sanitary system financial forecast.

Table 53 Financial Forecast Improvement Items

Task No.	Improvement Task Name	Improvement Task Description
8.1	Operations and Maintenance Forecast	Include operations and maintenance activities and their costs in the financial forecast. Develop a detailed needs-based budget at the activity-level for operations, maintenance, and inspection activities, necessary to deliver and maintain the required level of service as assets age, population increases, assets are upgraded, and development assets and other new assets are added. Currently the operations budget is generally based on previous years budget with a percent increase for cost increases and added assets. This improvement task will provide a more robust forecast based on level of service.
8.2	Funding Strategies	Continue to improve the framework that identifies existing revenue streams and evaluates other revenue opportunities and develop both short- and long-term available budget forecasts. A well-defined framework will help the District to determine and measure budget deficit or surplus more accurately and adjust the financial management plan accordingly.
8.3	Continuously Improve Inventory and Condition data	Continue to improve asset condition forecasting and, consequently, timeliness of renewals and/or upgrades and their incurred lifecycle costs, the inventory and condition data should be continuously maintained and improved.
8.4	Price Index	Revise price index to be used in the future updates of the AMP. Similar to the District's Water AMP, this AMP uses ENR Construction Cost Index due to discontinuation of Statistics Canada's Infrastructure Construction Price Index in 2019. ENR Index is based on 20 large U.S. cities and may not accurately represent price increase in the District of West Vancouver. Therefore, future revisions of this AMP should use a more appropriate price index, if available.

9 Continuous Improvement Plan

9.1 Overview

The intended outcome of this SSAMP and supporting analysis is to provide a roadmap to manage the wastewater utility and service delivery in a way that balances costs, risks, and benefits appropriately to promote a sustainable service.

Therefore, in addition to documenting current state and business practices to guide the management of the wastewater utility, this section of the Plan provides recommended improvement tasks collated from each section of the document. These recommended improvement tasks will:

- Increase the level of understanding of the assets and services provided
- Improve the accuracy of financial forecasts and risk assessments
- Provide decision-makers with accurate and complete information in an easy-to-understand format to assist them with making evidence-informed decisions for the best use of available funding and the best interests of the community, customers, and stakeholders.
- Provide an integrated approach to service delivery, operations activities, risk, asset lifecycle strategies, and funding
- Maintain information up to date
- Implement and improve asset management practices necessary to support sustainable service delivery

9.2 Improvement Task List

Improvement plan tasks have been identified at the end of each section throughout this Plan. These improvement tasks form the basis of the Asset Management Improvement Plan as shown in Table 54.

Table 54 Asset Management Improvement Plan

Task No.	Improvement Task Name	Improvement Task Description	Priority
3.1	Asset Management Policy & Procedure	Review and revise draft Capital Asset Management Policy (#0054) and Procedure (#0055).	M
3.2	Roles and Responsibilities	Review key asset management roles and responsibilities and identify who will fulfill these.	M
3.3	Resource Plan	Develop a Resource Plan to identify resource needs for completing asset management improvement tasks.	H
3.4	Asset Management Goals	Document departmental asset management goals.	H
3.5	Asset Management Training	Establish an asset management education and training program to support staff in learning key asset management principles and applying these to their everyday work.	M
4.1	Review asset hierarchy for lift stations and improve asset attribute data for lift station components	Currently, lift stations GIS data contains a mix of information for all four components (i.e., pumps, mechanical, civil, electrical). Asset attribute data within the database does not consistently record critical information (e.g., year renewed, condition) for each separate component. This limits analysis of the data and usefulness for reliable reporting and to support evidence-based decision-making. It is recommended that the District implements consistent componentization of lift stations and maintains asset attribute data at the component level.	M
4.2	Data Updating	Design, document and implement procedure for returning field information to asset register and GIS when work is undertaken on	M

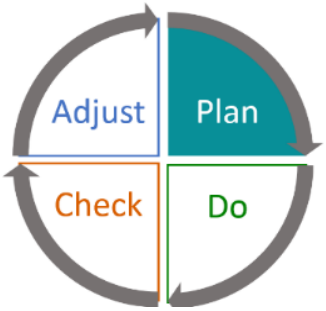
Task No.	Improvement Task Name	Improvement Task Description	Priority
		any asset, or when missing or default information is verified, for example the year when condition was assessed and install year of manholes.	
5.1	Performance Measures Data Sources and Collection Methods Identification	Conduct workshops to identify data sources and collection methods for all performance measures. Where significant data gaps exist, develop, and implement data collection strategies that will provide the necessary support to inform performance measures and decision-making.	M
5.2	Performance Targets Identification	Identify performance targets for each performance measure. It is recommended to set targets after at least one year of measured performance values are available to confirm the current level of service being achieved.	M
5.3	Levels of Service Sustainability	Review the relationship between cost of service, level of service and risk, to establish if current levels of service are sustainable into the future.	M
5.4	Stakeholder Consultation	Consult with stakeholders to confirm the levels of service and performance measures. LOS, cost of service options, and measured performance results must be available prior to consultation, to support this task and inform both the District and the Stakeholders.	L
5.5	Levels of Service Statements Updates	Regularly review LOS statements to ensure their alignment with the District's strategic and corporate objectives as well as stakeholder expectations.	M
6.1	Document existing lifecycle strategies	Investigate and capture any existing lifecycle strategies that staff are currently implementing. Formalize and document these strategies in this plan to ensure these are also documented outside of Maintenance Connection.	M
6.2	Maintenance strategies	Document information regarding roles and responsibilities; maintenance goals; typical maintenance options, methods, and protocols; decision criteria and rules for evaluating maintenance options; what maintenance performance indicators are to be tracked and reported; when to flag an asset for renewal.	M
6.3	Asset Valuations	Continue to review and update unit rate tables and asset lifespans, update replacement cost estimates for all assets.	H
6.4	Update 20-year capital works plan	Based on the asset valuation, inventory data established, and capital planning and risk-based planning exercises conducted, update and prioritize a list of high impact projects.	H
7.1	Standardized risk approach	Currently there is not a consistent approach for rating risks across different asset groups. It is recommended to develop standardize risk evaluation frameworks for wastewater, for (1) linear assets and (2) non-linear assets.	H
7.2	Maintain and refine the Sanitary System risk scores	Maintain and refine the sanitary system risk model inputs, as more condition information becomes available and consequence ratings are refined.	M
7.3	Capitalize Mitigation Strategies	Capitalize possible mitigation options employed by the District and quantify risk reduction in dollar terms to estimate benefit-cost ratio of various mitigation strategies. Systematically evaluating mitigation options / risk reduction strategies will help the District better understand their risk appetite and ensure better value for money.	M
8.1	Operations and Maintenance Forecast	Include operations and maintenance activities and their costs in the financial forecast. Develop a needs-based budget for operations, maintenance, and inspection activities, necessary to deliver and maintain the required	H

Task No.	Improvement Task Name	Improvement Task Description	Priority
		level of service as assets age, population increases, assets are upgraded, and development assets and other new assets are added.	
8.2	Funding Strategies	Continue to improve the framework that identifies existing revenue streams and evaluates other revenue opportunities and develop both short- and long-term available budget forecasts. A well-defined framework will help the District to determine and measure budget deficit or surplus more accurately and adjust the financial management plan accordingly.	H
8.3	Continuously Improve Inventory and Condition data	Continue to improve asset condition forecasting and, consequently, timeliness of renewals and/or upgrades and their incurred lifecycle costs, the inventory and condition data should be continuously maintained and improved.	H
8.4	Price Index	Revise price index to be used in the future updates of the AMP. Similar to the District's Water AMP, this AMP uses ENR Construction Cost Index due to discontinuation of Statistics Canada's Infrastructure Construction Price Index in 2019. ENR Index is based on 20 large U.S. cities and may not accurately represent price increase in the District of West Vancouver. Therefore, future revisions of this AMP should use a more appropriate price index, if available.	M

9.3 Review of this plan

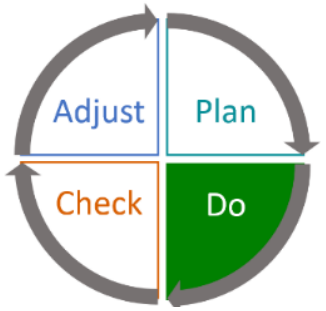
This Asset Management Plan (SSAMP) is intended to be a "living" document, and as such all components of the Plan including the Improvement Task List, should be reviewed regularly, and amended to recognize any material changes in or understanding of service levels and/or resources available to provide those services, changes resulting from budget decisions, or other factors influencing service delivery, and for improvement tasks completed.

To provide consistent relevant guidance and up to date information to decision makers, it is important that a continuous improvement approach is implemented for the Plan. This approach includes a process of regular review and adjustment to keep the SSAMP up to date with the latest information, understanding, and forecasts.



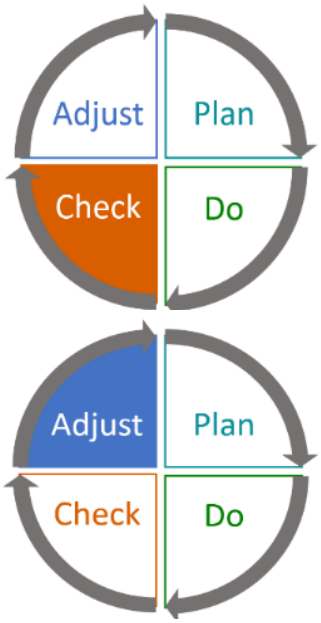
PLAN

- Collate available data and analysis results
- Consider data and analysis results in relation to objectives
- Document outcomes and recommendations
- Update assessment of limitations and assumptions
- Update AMP, consult and confirm for implementation



DO

- Schedule, fund, and complete improvement tasks
- Improve asset and cost data
- Monitor, manage, and mitigate risk
- Manage assets and deliver required service
- Measure and record performance



CHECK

- Review performance results
- Analyze asset and cost data
- Re-assess state of infrastructure and risk ratings
- Re-assess state of asset management practice
- Report achievements

ADJUST

- Update improvement tasks and plan
- Adjust lifecycle strategies
- Adjust priorities and targets
- Update forecasts

Figure 9-1 SSDP Implementation – Continuous Improvement Model

The process has four phases named 'Plan, Do, Check, Adjust,' (based on the Deming Cycle). This process is designed to generate appropriate and relevant iterative improvements to the SSAMP and where needed, to the business processes to manage the assets and deliver the service, and to facilitate responsible adaptation to change.

Each phase of the four-step process is described in Figure 9-1. The development of this SSAMP is the current iteration of the 'Plan' phase. The next phase is the 'Do' phase which is the implementation of this SSAMP.

The review cycle for implementing and updating the SSAMP is best completed annually to capture work completed in the year and update financial forecasts, risks, track the state of infrastructure, and review and re-prioritize improvement tasks. Completing small edits each year will maintain the SSAMP up to date for least effort and cost. However, where little change has occurred the review and update could be done every two years.

The timing for the SSAMP update is preferably prior to the annual budget process. This will facilitate consideration of outcomes and inclusion of updated forecasts into the financial planning process.

9.4 Improvement Program and Schedule

The improvement program will be a subset of the improvement tasks listed in Table 54. This is recommended because when an improvement task is completed, knowledge is gained, and this can change the priority of remaining tasks, the sequence or order of tasks, and identify new tasks. The improvement program should therefore be reviewed and updated annually. For this reason, a 3-year planning period is recommended for the improvement program and schedule.

The improvement tasks to be included in the 3-year improvement program are selected from the list in in Table 54, based on priority, dependencies, efficient coordination, and limited to what is practical and achievable in a 3-year period.

Selecting tasks for the SSAMP 3-year improvement program and schedule should be the highest priority task to complete next, followed by documenting the program and schedule, securing funding, and implementing the improvements.

In the annual review of this Plan (see section 9.3), the 3-year improvement program and schedule would be updated for completed tasks, adjusted for latest priorities, new issues, and new tasks, and funding requirements reassessed.

Appendix A – Detailed Service Level Scoring Framework

Table A.1 Service Commitment Criteria

Appendix A Table 1 Service Commitment Criteria

Service Commitment Criteria	Description of Service Commitment for Criteria
Service Reliability	Mitigate/reduce the risk to people, businesses, and property from wastewater service failure.
Asset Reliability	Maintain wastewater infrastructure condition in state of good repair to minimize unplanned disruption of service from asset failure.
Quality of Service	Manage wastewater service to meet wastewater standards
Cost of Service	Manage the resources and budgets to deliver required level of service
Service Responsiveness	Manage wastewater service to provide quick reinstatement of unplanned shutdowns
Environmental Responsibility	Manage wastewater service to mitigate/reduce risk to environment from all service-related activities.
Safety	Manage wastewater service in a responsible way to protect safety of staff, public, and property
N/A	Not Applicable

Appendix A Table 2 Service-Level Risk Scoring Matrix

		Impact				
		1 - Very Low	2 - Low	3 - Medium	4 - High	5 - Very High
Likelihood	1 - Rare	Very Low	Very Low	Low	Low	Low
	2 - Unlikely	Very Low	Low	Low	Medium	Medium
	3 - Possible	Low	Low	Medium	High	High
	4 - Likely	Low	Medium	High	High	Very High
	5 - Almost Certain	Low	Medium	High	Very High	Very High

Appendix A Table 3 Planning Risk Matrix

Event	Service Commitment	Risk Event Outcome	Impact	Likelihood	Risk Score	Risk Rating	Mitigation Measures	Mitigated Impact	Mitigated Likelihood	Mitigated Risk Score	Mitigated Risk Rating
Change in Legislation	Cost of Service	Change in legislation could require more treatment, more inspections, more maintenance, or more management and these will increase the cost of service	3 - Medium	4 - Likely	12	High	Reserves to fund WWTP upgrades and potential future increase operational rates to cover resource requirements.	3 - Medium	3 - Possible	9	Medium
Developments and Industry Demand	Service Reliability	New developments or industry could increase quantity of assets and require available resources (money and staff) to do more operations, maintenance, and inspection reducing the overall service reliability that can be achieved (i.e. required to do more with same money means some things will not get done)	3 - Medium	3 - Possible	9	Medium	Develop and implement process to assess and report lifecycle costs (including operational, maintenance, and inspection costs) as part of development approval process. And increasing OMI budget as necessary to provide agreed LOS.	3 - Medium	1 - Rare	3	Low
Decreasing Revenues	Service Reliability	If revenues decrease West Vancouver might not be able to maintain the wastewater	4 - High	3 - Possible	12	High	Annually review and report revenue risks and adjust LOS or budget as necessary	3 - Medium	2 - Unlikely	6	Low

Event	Service Commitment	Risk Event Outcome	Impact	Likelihood	Risk Score	Risk Rating	Mitigation Measures	Mitigated Impact	Mitigated Likelihood	Mitigated Risk Score	Mitigated Risk Rating
		infrastructure and service delivery at current levels									
Procurement Strategies	Service Reliability	Poor procurement strategy may result in poor quality materials or maintenance outcomes reducing the life of the assets and/or the reliability of service delivery	1 - Very Low	2 - Unlikely	2	Very Low					Very Low
Lifecycle Cost of Asset Ownership	Service Reliability	Lifecycle costs for the current level of service might not be sustainable, requiring the wastewater service delivery to be reduced to be affordable	3 - Medium	4 - Likely	12	High	Reserve funds to buffer costs on a year-on-year basis. Increase sewer rates based on inheriting new infrastructure.	3 - Medium	3 - Possible	9	Medium
Data Integration	Service Reliability	No linkage between asset data and preventative maintenance program can result in missed treatments causing increased deterioration and reduced wastewater service reliability	2 - Low	2 - Unlikely	4	Low					Low

Event	Service Commitment	Risk Event Outcome	Impact	Likelihood	Risk Score	Risk Rating	Mitigation Measures	Mitigated Impact	Mitigated Likelihood	Mitigated Risk Score	Mitigated Risk Rating
Changing Strategies	Asset Reliability	Changes to maintenance strategies could reduce asset reliability or require available resources (money and staff) to do more activities, reducing the overall service reliability that can be achieved	1 - Very Low	2 - Unlikely	2	Very Low					Very Low
Organizational Staff Turnover	Asset Reliability	High staff turnover or staff retirements can cause loss of important knowledge about the assets, operations programs, risks, and emergency management procedures if there is insufficient data recorded about these	2 - Low	2 - Unlikely	4	Low					Low
Demand Management	Service Reliability	Insufficient planning for or management of wastewater demands can result in the wastewater system not able to cope with demand, increasing the occurrence of wastewater outages.	3 - Medium	3 - Possible	9	Medium	Master plan (2019) developed to address I&I issues etc.	3 - Medium	2 - Unlikely	6	Low

Appendix A Table 4 Management Risks

Event	Service Commitment	Outcome	Impact	Likelihood	Risk Score	Risk Rating	Mitigation Measures	Mitigated Impact	Mitigated Likelihood	Mitigated Risk Score	Mitigated Risk Rating
Staff Resources	Service Reliability	Insufficient resources to maintain wastewater infrastructure reducing reliability/condition	4 - High	3 - Possible	12	High	Develop resource planning model for OMI activities to deliver required LOS and annually update and report outcomes to senior management and adjust LOS or budget as necessary	3 - Medium	2 - Unlikely	6	Low
Forecasts	Service Reliability	Insufficient forecasting for capital renewals can reduce service reliability	4 - High	2 - Unlikely	8	Medium	Annually review and update asset risk scores and prioritized long term renewal forecast in AMP and include funding requirements for asset renewals in annual budget	3 - Medium	2 - Unlikely	6	Low
Business processes	Service Reliability	Lack of processes to deliver service effectively or consistently (i.e. different staff do different things in different ways),	2 - Low	2 - Unlikely	4	Low					Low

Event	Service Commitment	Outcome	Impact	Likelihood	Risk Score	Risk Rating	Mitigation Measures	Mitigated Impact	Mitigated Likelihood	Mitigated Risk Score	Mitigated Risk Rating
		reducing service reliability									
Staff Training	Service Reliability	Lack of trained resources to maintain wastewater infrastructure	4 - High	3 - Possible	12	High	Develop resource skills matrix and training requirements to deliver the agreed LOS. Include training costs in budget and annually update matrix.	4 - High	2 - Unlikely	8	Medium
Data	Asset Reliability	Condition or capacity of wastewater assets unknown therefore appropriate preventative maintenance or capital upgrades not programmed and asset reliability and/or service reliability deteriorates	2 - Low	2 - Unlikely	4	Low					Low
Reputation	Service Reliability	Perception that West Vancouver cannot maintain wastewater	2 - Low	2 - Unlikely	4	Low					Low

Event	Service Commitment	Outcome	Impact	Likelihood	Risk Score	Risk Rating	Mitigation Measures	Mitigated Impact	Mitigated Likelihood	Mitigated Risk Score	Mitigated Risk Rating
		service to level of service desired by public and/or key stakeholder groups									
Inflation	Cost of Service	Inflation or cost of materials/labour affecting capital works	3 - Medium	3 - Possible	9	Medium	Annually update replace costs in long term renewal forecast in AMP and update funding requirements in annual budget.	3 - Medium	2 - Unlikely	6	Low
Value for Money	Cost of Service	Are West Vancouver utility rates competitive or provide sustainable service?	3 - Medium	2 - Unlikely	6	Low					Low

Appendix A Table 5 Service Delivery Risks

Event	Service Commitment	Risk Event Outcome	Impact	Likelihood	Risk Score	Risk Rating	Mitigation Measures	Mitigated Impact	Mitigated Likelihood	Mitigated Risk Score	Mitigated Risk Rating
Service Delivery	Service Reliability	Poor service delivery (i.e., not doing appropriate operations, maintenance, or inspections, or tasks taking longer to do) could result in more deterioration of asset condition and/or reducing reliability of the service	4 - High	2 - Unlikely	8	Medium	Develop an OMI schedule of tasks and resource needs to deliver the required LOS. Include funding for tasks in annual budget and implement task schedule. Annually review and update OMI task schedule and update budget to maintain LOS.	4 - High	1 - Rare	4	Low
Stakeholder Consultation	Service Reliability	Insufficient stakeholder consultation could result in not meeting expectations for wastewater services	1 - Very Low	2 - Unlikely	2	Very Low					Very Low
IT Systems	Service Reliability	Unreliable IT systems or lack of IT systems could result in poor information about assets being recorded, leading to missed preventative maintenance or	1 - Very Low	2 - Unlikely	2	Very Low					Very Low

Event	Service Commitment	Risk Event Outcome	Impact	Likelihood	Risk Score	Risk Rating	Mitigation Measures	Mitigated Impact	Mitigated Likelihood	Mitigated Risk Score	Mitigated Risk Rating
		operational work reducing service reliability.									
Service Disruptions	Service Reliability	Increased service disruptions will reduce reliability of service and increase cost of service	3 - Medium	3 - Possible	9	Medium	Annually review condition/age profile of system and update asset replacement forecasts and budgets to maintain minimum LOS and reduce service interruptions.	2 - Low	2 - Unlikely	4	Low
Service Delivery Costs	Asset Reliability	Increased service delivery costs will impact the total cost of service and reduce the amount of work that can be completed with existing budgets, leading to reduced asset condition and/or service reliability.	2 - Low	3 - Possible	6	Low					Low

Event	Service Commitment	Risk Event Outcome	Impact	Likelihood	Risk Score	Risk Rating	Mitigation Measures	Mitigated Impact	Mitigated Likelihood	Mitigated Risk Score	Mitigated Risk Rating
Asset Design	Service Reliability	Poor wastewater design can lead to wastewater services not meeting stakeholder expectations for level of service.	2 - Low	2 - Unlikely	4	Low					Low
Service Delivery Resiliency	Service Reliability	Insufficient service delivery resiliency (i.e. staff numbers, fleet, equipment) can result in delays in completing required operations, maintenance, and inspection activities, leading to reduced asset and/or service reliability.	3 - Medium	4 - Likely	12	High	Complete (and annually update) a resiliency review (compare staff and equipment capacity with utilization, LOS needs, and measured LOS performance and service interruptions). Also, annually complete a service sustainability assessment. Provide budget for and undertake appropriate action to maintain or improve the overall resiliency	3 - Medium	2 - Unlikely	6	Low

Event	Service Commitment	Risk Event Outcome	Impact	Likelihood	Risk Score	Risk Rating	Mitigation Measures	Mitigated Impact	Mitigated Likelihood	Mitigated Risk Score	Mitigated Risk Rating
							and sustainability of the service.				

Appendix A Table 6 Physical Asset Risks

Event	Service Commitment	Risk Event Outcome	Impact	Likelihood	Risk Score	Risk Rating	Mitigation Measures	Mitigated Impact	Mitigated Likelihood	Mitigated Risk Score	Mitigated Risk Rating
Operations Failure	Asset Reliability	Failure to complete operational activities (valve exercising, inspections, servicing, cleaning etc.) could reduce reliability of service	3 - Medium	2 - Unlikely	6	Low					Low
Asset Failures	Service Reliability	Assets in very poor or failed condition increase risk	3 - Medium	3 - Possible	9	Medium	Annually review and update condition and age profile of	3 - Medium	2 - Unlikely	6	Low

Event	Service Commitment	Risk Event Outcome	Impact	Likelihood	Risk Score	Risk Rating	Mitigation Measures	Mitigated Impact	Mitigated Likelihood	Mitigated Risk Score	Mitigated Risk Rating
		unplanned wastewater outages.					assets and asset renewal program. Update budget as appropriate and undertake works to maintain or improve overall condition profile for system				
Critical Asset Investment	Asset Reliability	Reduced asset investment can result in insufficient maintenance leading to increased deterioration and poor asset condition with increased risk of failures	4 - High	4 - Likely	16	High	Development of financial strategy in AMP will inform West Vancouver of budget requirement.	3 - Medium	3 - Possible	9	Medium
Protection of Assets	Asset Reliability	Insufficient protection of assets or insufficient inspections could increase possibility of vandalism and accidental damage reducing the quality of assets and reliability of service	2 - Low	2 - Unlikely	4	Low					Low
Asset Data Protection	Service Reliability	I.T. Systems backed up or lack of cyber	2 - Low	2 - Unlikely	4	Low					Low

Event	Service Commitment	Risk Event Outcome	Impact	Likelihood	Risk Score	Risk Rating	Mitigation Measures	Mitigated Impact	Mitigated Likelihood	Mitigated Risk Score	Mitigated Risk Rating
		security could affect service delivery									
Asset Risk Mitigation	Service Reliability	Failure to mitigate high risks can result in asset failures and reduced safety and reliability of the service	2 - Low	2 - Unlikely	4	Low					Low
Asset Fit for Purpose (Over/Under designed)	Quality of Service	Under-designed wastewater assets will increase risk of sewer overflows and/or poor wastewater treatment	4 - High	3 - Possible	12	High	Undertake periodic review and update of design standards to keep them up to date (i.e., adjust for flow monitoring results and for climate change impacts). Also periodically update hydraulic models for these factors as well and review capacity of existing system according to new trends and information.	3 - Medium	2 - Unlikely	6	Low

Appendix A Table 7 Hazard-Environmental Risks

Event	Service Commitment	Outcome	Impact	Likelihood	Risk Score	Risk Rating	Mitigation Measures	Mitigated Impact	Mitigated Likelihood	Mitigated Risk Score	Mitigated Risk Rating
Extreme weather events - high winds	Service Reliability	High winds can impact foreshore service and infrastructure and potentially power to treatment plants and lift stations. Can affect staff safety	4 - High	3 - Possible	12	High	Implement process to record high-wind events and any asset damage occurring from these events. Periodically review and update high-wind risk rating and implement appropriate mitigation measures.	3 - Medium	3 - Possible	9	Medium
Extreme weather events - extreme precipitation events	Environmental Responsibility	Extreme wet weather events could cause overflows affecting properties and adjacent water courses.	3 - Medium	4 - Likely	12	High	Work with Regional government on climate adaptation and increased rainfall events due to climate change and develop mitigative strategies to manage flood risk on a local and regional levels.	3 - Medium	3 - Possible	9	Medium

Event	Service Commitment	Outcome	Impact	Likelihood	Risk Score	Risk Rating	Mitigation Measures	Mitigated Impact	Mitigated Likelihood	Mitigated Risk Score	Mitigated Risk Rating
Extreme weather events - extreme precipitation events	Service Reliability	Extreme wet weather events could cause overflows affecting properties and adjacent water courses.	3 - Medium	4 - Likely	12	High	Work with Regional government on climate adaptation and increased rainfall events due to climate change and develop mitigative strategies to manage flood risk on a local and regional levels.	3 - Medium	3 - Possible	9	Medium
Extreme weather events - snowfall	Service Responsiveness	Extreme snow events can cause an extended period of limited access to attend to service disruptions and risk of power outage and difficulty accessing generators to keep fuelled etc.	2 - Low	3 - Possible	6	Low					Low
Extreme weather events - snowfall	Cost of Service	Extreme snow events can cause an extended period of limited access to attend to service	2 - Low	3 - Possible	6	Low					Low

Event	Service Commitment	Outcome	Impact	Likelihood	Risk Score	Risk Rating	Mitigation Measures	Mitigated Impact	Mitigated Likelihood	Mitigated Risk Score	Mitigated Risk Rating
		disruptions and risk of power outage and difficulty accessing generators to keep fuelled etc.									
Flooding	Service Reliability	Flood events can impact pump stations and potentially cause pump outage	3 - Medium	3 - Possible	9	Medium	Work with Regional government on climate adaptation and increased rainfall events due to climate change and develop mitigative strategies to manage flood risk on a local and regional levels.	3 - Medium	2 - Unlikely	6	Low
Fire	Service Reliability	Internal fire could cause damage to assets and treatment facilities reducing capacity and reliability of service	4 - High	2 - Unlikely	8	Medium	Continue to work with DWV Fire Department to ensure fire safety and suppression systems are maintained, up to date and in working order	3 - Medium	2 - Unlikely	6	Low

Event	Service Commitment	Outcome	Impact	Likelihood	Risk Score	Risk Rating	Mitigation Measures	Mitigated Impact	Mitigated Likelihood	Mitigated Risk Score	Mitigated Risk Rating
Fire	Service Reliability	Wildfire could cause damage to assets and treatment facilities reducing capacity and reliability of service.	4 - High	2 - Unlikely	8	Medium	Work with DWV Fire Department on the Wildfire Management Plan	3 - Medium	2 - Unlikely	6	Low
Accident hazards to staff or public from unsafe infrastructure	Safety	Ladder rungs in wells and railings around stations etc. in poor condition affecting staff safety.	4 - High	2 - Unlikely	8	Medium	Undertake periodic assessment of ladder rung and rail conditions and update budget and program for asset repairs and replacements	3 - Medium	1 - Rare	3	Low
Employee safety	Safety	Inadequate safety training and procedures could result in injury	4 - High	1 - Rare	4	Low					Low
Drugs or alcohol	Safety	Inadequate HR procedures to ensure staff do not work while under the influence of drugs or alcohol could result in safety	3 - Medium	1 - Rare	3	Low					Low

Event	Service Commitment	Outcome	Impact	Likelihood	Risk Score	Risk Rating	Mitigation Measures	Mitigated Impact	Mitigated Likelihood	Mitigated Risk Score	Mitigated Risk Rating
		risks to people and property (particularly call out staff for emergency events)									
Waste toxicity	Safety	Chemicals, residuals, and fumes affecting safety of staff and equipment damage	4 - High	2 - Unlikely	8	Medium	Ensure sufficient maintenance of HVAC and other forms of ventilation systems are maintained and in working order. Ensure staff have adequate training to recognize safety issues to avoid risk to staff and equipment	3 - Medium	1 - Rare	3	Low
Incidence of non-compliance or contravention	Quality of Service	A regulatory/ legislative non-compliance event could generate a health risk to people or loss of revenue to commercial businesses	3 - Medium	2 - Unlikely	6	Low					Low

Appendix B – Unit Rates and Cost Breakdown of Assets

Appendix B Table 8 Unit Rates – Linear Assets

Asset Group	Material	Size	Unit of Measure	Construction Rate [$2021] (1)	Unit Rate [$2021] (2)
Forcemain	HDPE	50	Per Meter	$600	$840
Forcemain	HDPE	65	Per Meter	$780	$1,092
Forcemain	HDPE	75	Per Meter	$900	$1,260
Forcemain	HDPE	100	Per Meter	$1,200	$1,680
Forcemain	HDPE	150	Per Meter	$1,800	$2,520
Forcemain	HDPE	200	Per Meter	$2,400	$3,360
Forcemain	HDPE	250	Per Meter	$3,000	$4,200
Forcemain	HDPE	450	Per Meter	$5,400	$7,560
Sanitary Main	PVC	50	Per Meter	$909	$1,273
Sanitary Main	PVC	75	Per Meter	$931	$1,303
Sanitary Main	PVC	100	Per Meter	$954	$1,336
Sanitary Main	PVC	150	Per Meter	$1,008	$1,411
Sanitary Main	PVC	200	Per Meter	$1,068	$1,495
Sanitary Main	PVC	250	Per Meter	$1,128	$1,579
Sanitary Main	PVC	300	Per Meter	$1,200	$1,680
Sanitary Main	PVC	375	Per Meter	$1,287	$1,802
Sanitary Main	PVC	450	Per Meter	$1,464	$2,050
Sanitary Main	PVC	525	Per Meter	$1,560	$2,184
Service Connection	PVC	Various (3)	Per Service Connection	$10,000	$14,000

1. All values were converted to $2021 dollars using ENR index
2. Unit rates include 15% Engineering O/H & 25% Contingency
3. The analysis in this AMP assumes an average rate of $10,000 per connection, despite of length and size

Appendix B Table 9 Unit Rates – Non-Linear Assets

Asset Group	Material	Unit of Measure	Construction Rate [$2021] (1)	Unit Rate[$2021] (2)
Manhole	Concrete	Per Manhole	$10,000 per manhole	$14,000
WWTP-Citrus Wynd (3)	n/a	Per WWTP	2,080,000	$2,910,000

1. All values were converted to $2021 dollars using ENR index
2. Unit rates include 15% Engineering O/H & 25% Contingency
3. Cost for WWTP-Citrus Wynd was provided by the District

Appendix B Table 10 Replacement Cost – Lift Stations

Lift station	Lift Station Component Replacement Cost [$2021] (1), (2)				
	Civil	Electrical	Mechanical	Pump	Total
15th & Argyle	$545,442	$149,076	$163,106	$10,523	$868,147
23rd	$470,027	$156,091	$115,753	$10,523	$752,394
24th	$568,242	$296,398	$161,353	$26,307	$1,052,300
25th	$564,734	$220,983	$117,507	$10,523	$913,747
28th	$470,027	$350,767	$161,353	$38,584	$1,020,731
28th & Palmerston	$299,905	$259,567	$112,245	$15,784	$687,503
3026 Marine	$299,905	$156,091	$112,245	$10,523	$578,765
3200 Marine	$564,734	$350,767	$178,891	$38,584	$1,132,976
Bedora	$168,368	$149,076	$108,738	$10,523	$436,704
Blink Bonnie	$299,905	$220,983	$112,245	$10,523	$643,657
Bluebell	$89,445	$149,076	$106,984	$10,523	$356,028
Caulfield Court	$219,229	$199,937	$147,322	$10,523	$577,011
Copper	$375,320	$471,781	$156,091	$61,384	$1,064,577
Cotton A	$375,320	$350,767	$112,245	$38,584	$876,917
Cotton B	$375,320	$350,767	$156,091	$38,584	$920,762
Cove	$470,027	$564,734	$161,353	$75,415	$1,271,529
Cypress Glen	$470,027	$215,721	$161,353	$10,523	$857,624
Dufferin A	$657,687	$471,781	$170,122	$61,384	$1,360,974
Dufferin B	$470,027	$633,134	$161,353	$84,184	$1,348,698
Eagle Island	$545,442	$161,353	$121,014	$10,523	$838,332
Eastmont	$299,905	$296,398	$156,091	$26,307	$778,702
Ferndale	$675,226	$850,609	$203,445	$105,230	$1,834,509
Foot of 31st	$626,118	$259,567	$119,261	$15,784	$1,020,731
Garrow	$168,368	$149,076	$108,738	$10,523	$436,704
Gleneagles	$219,229	$149,076	$108,738	$10,523	$487,566
Gleneagles Place	$305,167	$413,905	$156,091	$50,861	$926,024
Glenwynd	$168,368	$149,076	$147,322	$10,523	$475,289
Gulf East	$168,368	$149,076	$108,738	$10,523	$436,704
Gulf West	$168,368	$149,076	$108,738	$10,523	$436,704
Happy Valley	$375,320	$396,366	$112,245	$47,353	$931,285
Imperial	$299,905	$471,781	$156,091	$61,384	$989,162
Isleview	$168,368	$149,076	$108,738	$10,523	$436,704
Kew	$375,320	$350,767	$112,245	$38,584	$876,917
Klahanie	$299,905	$149,076	$152,583	$10,523	$612,088
Park Lane	$299,905	$259,567	$112,245	$15,784	$687,503
Parthenon	$299,905	$350,767	$112,245	$38,584	$801,502
Picadilly	$375,320	$533,165	$156,091	$70,153	$1,134,730
Pilot House Rd	$98,215	$149,076	$106,984	$10,523	$364,797
Pitcairn	$168,368	$149,076	$108,738	$10,523	$436,704
Radcliffe #1	$464,766	$350,767	$166,614	$38,584	$1,020,731
Radcliffe #2	$125,149	$262,814	$200,239	$38,584	$626,786
Radcliffe #3	$299,905	$349,013	$156,091	$38,584	$843,594
Rockend	$168,368	$149,076	$108,738	$10,523	$436,704
Saint Georges	$299,905	$471,781	$156,091	$61,384	$989,162
Seaside	$380,582	$296,398	$156,091	$26,307	$859,378
Seawalk Gardens	$299,905	$208,706	$156,091	$10,523	$675,226
South Oxley	$168,368	$110,491	$108,738	$10,523	$398,120
Stone Crescent	$98,215	$149,076	$106,984	$10,523	$364,797
Suicide Bend	$375,320	$533,165	$156,091	$70,153	$1,134,730
Taylor	$299,905	$350,767	$112,245	$38,584	$801,502
The Glen	$299,905	$296,398	$156,091	$26,307	$778,702
Travers	$464,766	$177,137	$159,599	$10,523	$812,025
Westhaven	$752,394	$350,767	$175,383	$38,584	$1,317,129
Wood Valley	$168,368	$199,937	$147,322	$10,523	$526,150
	18,524,612	$15,659,714	$7,475,139	$1,588,973	$43,248,437

1. All values were converted to $2021 dollars using ENR index.
2. All values include 20% Engineering O/H and 40% Contingency.

Appendix B Table 11 Replacement Cost, with Upgrade – Lift Stations

Lift Station	Lift Station Component Replacement Cost, with Upgrade [$2021] (1), (2)				
	Civil	Electrical	Mechanical	Pump	Total
Dufferin B	$470,027	$748,229	$190,685	$99,488	**$1,508,429**
Eastmont	$299,905	$576,458	$303,578	$51,165	**$1,231,106**
Picadilly	$375,320	$653,776	$191,402	$86,022	**$1,306,520**
The Glen	$299,905	$427,886	$225,336	$37,978	**$991,105**
Saint Georges	$299,905	$637,386	$210,883	$82,931	**$1,231,105**
	$1,745,062	**$3,043,735**	**$1,121,884**	**$357,584**	**$6,268,265**

1. All values were converted to $2021 dollars using ENR index.
2. Costs include 20% Engineering O/H and 40% Contingency.