NEW WESTMINSTER

REPORT

City of New Westminster

Water Asset Management Plan

VERSION 1

MARCH 2021
EDMS #1806554

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EXECUTIVE SUMMARY

Introduction

The City of New Westminster (the "City") has developed this Water Asset Management Plan (Water AMP) with the help of Associated Engineering to serve as a guiding document that will support the ongoing management and long-term stewardship of the City's water assets. This is the City's first Water AMP developed following the 2019 Asset Management Strategy.

Water Service Performance

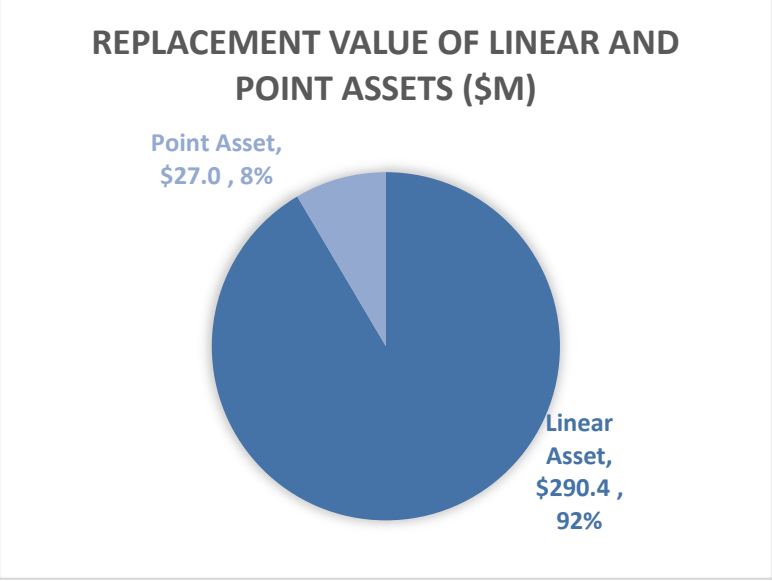
The AMP Working Group developed a list of service outcomes and performance measures for Water Assets. The outcome areas depicted in the graphic to the right were used to determine the Level of Service (LoS).

Key performance indicators (KPIs) have been defined for each area.

Reliability	Provide reliable service and infrastructure	Affordability & Long-Term Sustainability	Ensure long-term sustainment of the water infrastructure and service
Public Health & Safety	Protect public health and safety	Responsiveness, Service & Reputation	Have satisfied and informed customers and protect public/corporate reputation
Productivity, Efficiency & Employee Safety	Meet service and operational requirements with economic efficiency, safety and productivity	Aesthetics & Water Quality	Provide quality water that customers want to drink
Regulatory Compliance	Meet current and anticipate future regulatory requirements	Environment	Protect the environment

Water Assets

The current value of the City's water infrastructure assets amounts to approximately $316M.



Linear Assets

- 206 km Water Mains
- 11,672 Laterals (Services)

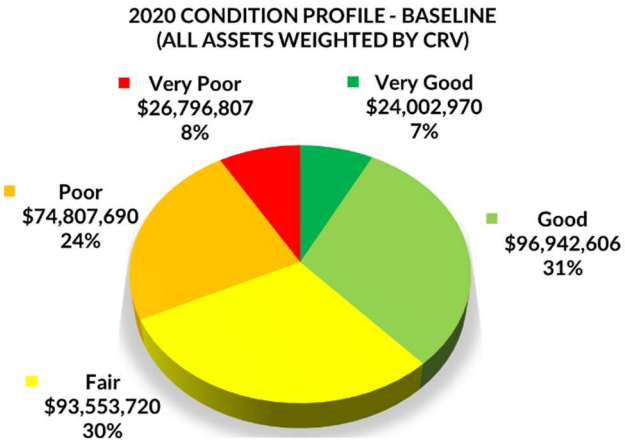
Point Assets

- 45 Fountains
- 912 Hydrants
- 1,024 Meters (Zone & Residential)
- 11 PRVs (1 with 2 valves)
- 20 Sampling Stations
- 3,304 System Valves

Estimated Condition

Condition of the water assets is predominately based on asset age data, as well as break data for a subset of assets. Condition is not defined based on physical or observed condition.

The condition rating is based on the condition scale used in the Canadian Infrastructure Report Card (CIRC).

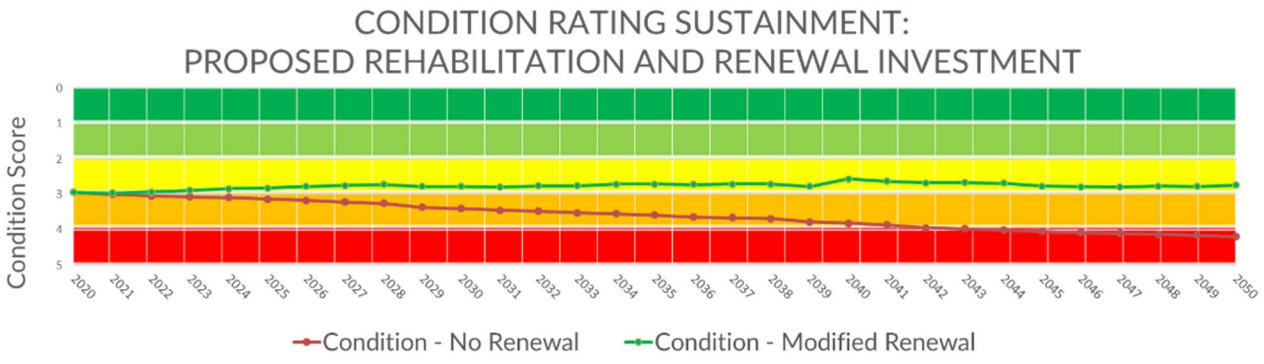


CANADIAN INFRASTRUCTURE REPORT CARD 2019

- **Very poor:** The asset is unfit for sustained service. It is near or beyond its expected service life and shows widespread signs of advanced deterioration. Some assets may be unusable.
- **Poor:** There is an increasing potential for its condition to affect the service it provides. The asset is approaching the end of its service life, the condition is below the standard and a large portion of the system exhibits significant deterioration.
- **Fair:** The asset requires attention. The asset shows signs of deterioration and some elements exhibit deficiencies.
- **Good:** The asset is adequate. It is acceptable and generally within the mid-stage of its expected service life.
- **Very Good:** The asset is fit for the future. It is well maintained, in good condition, new or recently rehabilitated.
- **Unknown:** Not enough data exists to respond.

Lifecycle Planning and Forecasting

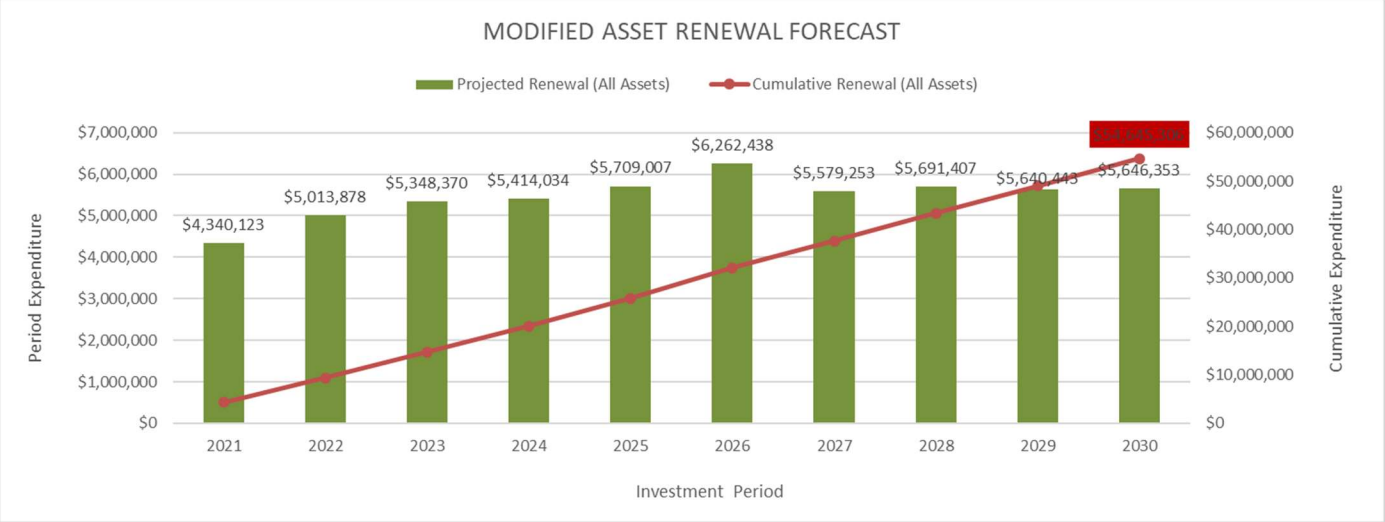
Without investment, condition is projected to deteriorate based on estimated lives set by the City's water experts.



A funded renewal program would allow the City to mitigate risks and prevent costs associated with deteriorating asset condition.

Financial Requirements

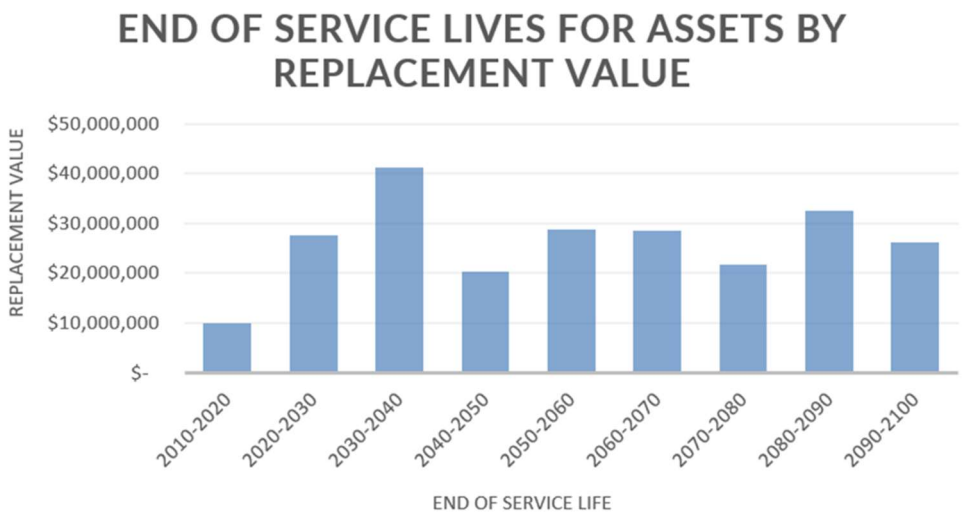
The Modified Asset Renewal Forecast shows the projected renewal investment in order to maintain asset condition.



A longer-term view of end-of-life timing for water assets shows the projected renewal by asset replacement value over a 100-year period.

The projection indicates a ramping up in required renewal work up to 2040, with a more normalized pattern at just under $30M.

Renewal spend will typically be driven by the replacement of mains reaching end-of-life and potentially related development services project, as well as coordination with other City departments' lifecycle needs.



This will result in a suggested capital renewal budget to an average of $5.5 million per year based on end-of-life replacement. This represents an increase from an average budget of $3.9M and average spend of $2.9M from 2010 to 2019.

Data Reliability

RELIABILITY			▼		
RANGE	UNKNOWN	VERY UNCERTAIN	UNCERTAIN	RELIABLE	HIGH RELIABILITY

Overall, data reliability is assessed as uncertain, based on key metrics such as age, estimated lives and current replacement value, as well as the recent introduction of work management and the expected integration with financial systems. The City would benefit from a strengthening of its data capture, collection and analysis. It is expected that the City will work to improve aspects of its data on an iterative basis through the improvement planning process.

Risks and Uncertainties

The City faces several uncertainties that may impact effective delivery of the Water AMP's forecasted approach. Notable risks include:

- Providing adequate funding for increased capital investment;
- Providing adequate resourcing for increased capital investment; and
- Improving timing and coordination of capital projects.

This AMP's analysis used information from a Risk Model developed in 2007 to assist in the prioritizing of projects for the recommended 10-year capital program (Section B.6, Appendix B). An updated Risk Model is proposed for development in 2021.

Implementation

The Water AMP must be underpinned with effective governance over the implementation of the AMP's approach. Implementation will be monitored through the City's existing Asset Management Steering Committee and Asset Management Team. Responsibility for implementation lays with the Engineering team and the Water AMP Working Group.

Improvement Plan

This AMP, in its first iteration, has revealed several gaps and opportunities for improvement. Recommendations for improvements in business process, data and information, technology, governance, and people and capacity are identified based on the process of building this initial Water AMP.

Improvement actions include the following:

- Implement process changes/enhancements to support tracking of LoS KPIs;
- Identify asset criticality and overall risk exposure through comprehensive risk review and risk model;
- Enable lifecycle costing through reconciliation of financial and work order data (integration opportunity between JDE and CityWorks);

- Review inspection and condition assessment programs for water assets to enable opportunistic data collection (incorporate into regular O&M work); and
- Implement asset data improvements (including data structure, completeness, validation and capture requirements) to ensure accuracy and completeness of asset register.

Implementation of these improvement items are critical to generating better information and hence better decisions when managing water infrastructure assets.

ACKNOWLEDGEMENTS

The Water Asset Management Plan (AMP) was prepared through the insights of the Water AMP Working Group. The Water AMP Working Group included the following members.

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LIST OF ACRONYMS AND ABBREVIATIONS

This list contains frequent acronyms and abbreviations used in the Water Asset Management Plan, as described in the City's Strategic Asset Management Plan (SAMP).

Term	Description
AM	Asset Management
AMBC	Asset Management BC
AMO	Asset Management Objectives
AMS	Asset Management System
AMP	Asset Management Plan
CAPEX	Capital Expenditures
CIP	Capital Investment Prioritization
CAO	Chief Administrative Officer
CIRC	Canadian Infrastructure Report Card
CLT	Corporate Leadership Team
City	City of New Westminster
CMMS	Computerized Maintenance Management System
CRV	Current Replacement Value
DSS	Decision Support System
EAM	Enterprise Asset Municipalities
FCM	Federation of Canadian Municipalities
FTE	Full time equivalent
GIS	Geographical Information System
ISO	International Standardization Organization
ICI	Industrial, Commercial, and Intuitional
KPI	Key Performance Indicator
LOS	Level of Service
LTFP	Long Term Financial Plan
MODA	Multi Objective Decision Analysis
NAMS	New Zealand Asset Management Support
NWWBI	National Water and Wastewater Benchmarking Initiative
OCP	Official Community Plan

Term	Description
O&M	Operations and Maintenance
OPEX	Operating Expenditures
PM	Project Management
R2-A2	Roles, Responsibilities, Authorities, Accountabilities
RACI	Responsible, Accountable, Consulted, Informed
SAMP	Strategic Asset Management Plan
SMT	Senior Management Team
SOP	Standard Operating Procedures
TBL	Triple Bottom Line
TCA	Tangible Capital Asset

GLOSSARY

This glossary contains definitions of terms frequently used in the Water Asset Management Plan, as defined in the City's Strategic Asset Management Plan (SAMP).

Term	Definition
Accountabilities	The obligation to be answerable for the results, which is the liability created for the use of the assigned authorities.
Asset	An item, thing or entity that has potential or actual value to the City. See also: Tangible Capital Asset.
Asset Class	A group of assets with common attributes and/or objectives, such as the water asset class.
Asset Condition	The measure of the physical state of an asset, but may also include functional and demand considerations.
Asset Intervention	All the measures, funded from either capital expenditures or operating expenditures that are used to maintain or enhance the performance of an asset.
Asset Management (AM)	The coordinated activity of the City to realize value from its assets. This includes making decisions about the stewardship of infrastructure to deliver services in a way that considers current and future needs, manages risks and opportunities, and makes the best use of resources.
Asset Risk	Risk to a specific asset or assets. This includes equipment failures, warranty failures, deferred maintenance backlogs, vandalism, injuries, inclement weather, service interruptions, etc.
AM Plan[1]	Outlines actions and resources required to provide defined levels of service; Identifies AM activities (operations, maintenance, renewals, capital works, disposals, etc.); Provides financial forecasts for elements within AM plans.
AM Policy[2]	Sets guiding principles to undertake AM in a structured and coordinated manner; integrates AM into the City's organizational operations.
AM Strategy[3]	Develops structured set of actions aimed at optimizing the infrastructure assets to deliver effective services to the City; Reviews current status, future vision, gap analysis and timeframes.
AM System (AMS)	The management system for asset management whose function is to establish the asset management policy and asset management objectives.
Business Case	The framework to develop and evaluate business cases for investment decisions.
CAPEX	Capital expenditure.

[1] City of New Westminster's Corporate Policy Document, Asset Management Policy, Version 1.
[2] City of New Westminster's Corporate Policy Document, Asset Management Policy, Version 1.
[3] City of New Westminster's Corporate Policy Document, Asset Management Policy, Version 1.

Term	Definition
Capital Assets	Include land, buildings, park improvement, and road, electrical, water, sewer and other transportation infrastructure, and vehicles and equipment. Capital assets have a useful economic life greater than one year and are used on a continuing basis.
Capital Maintenance	The capital-funded activities required to maintain the current level of service to the community and/or other stakeholders.
Climate Adaptation	Action taken to reduce the negative impacts of climate change. Eg. Build up dykes.
Climate Mitigation	Action taken to tackle the causes and minimise the possible impacts of climate change. Eg. Reduce GHG.
Consequence of Failure	A measure of the direct and indirect impacts on the City if an asset failure w ere to occur.
Critical Asset	Assets for which the financial, business, or service-level consequences of failure are sufficiently severe to justify proactive inspection and rehabilitation. Critical assets have a lower threshold for action than non-critical assets.
Enterprise Risk	Risk facing the organization from a strategic perspective, such as seismic events, pandemics, strikes, acts of war, dissatisfied stakeholders, reputational damage, etc.
Funding Gap	The difference between the current capital funding and the recommended capital funding.
Gap Analysis	"A method of assessing the gap between an organization's current AM practices and the future desirable AM practices" (IIMM, 2015). A gap analysis may also be referred to as a needs analysis or improvement planning.
Infrastructure	The system of core assets, facilities and/or equipment.
Inherent Risk	The risk that an asset or activity would pose if no controls or other mitigating factors were in place to alter, mitigate, or reduce either the likelihood or impact of the risk; that is, the gross risk or risk before controls.
Implementation[4]	Detailed day-to-day actions required to deliver the defined level of service; allocation of necessary resources; establishes measurable performance indicators.
Level of Service (LOS)	The outputs or objectives that the City intends to deliver; includes measures at the corporate, customer, and asset levels of the organization.
Objectives	A result to be achieved. Objectives can be expressed in a variety of ways and can be either strategic, tactical or operational.
OPEX	Operating expenditure.
Output	Specific, measurable events that contribute to the desired outcome of a service.
Outcome	The overall desired or actual result of a service. Service level outcomes define what the service is supposed to achieve, for example, a "reliable" service.
Performance Indicator/Measure	A qualitative or quantitative measure of a service or activity used to compare actual performance against a standard or target. Performance indicators commonly relate to statutory limits, safety, responsiveness, cost, comfort, asset performance, reliability, efficiency, environmental protection and customer satisfaction.

[4] City of New Westminster's Corporate Policy Document, Asset Management Policy, Version 1.

Term	Definition
Practices	The actual application, execution or use of the processes and procedures. It includes improvisational behaviours to address changing circumstances.
Probability of Failure	The likelihood or chance that an event will occur within a specified time frame.
Procedure	The sequence of steps taken to implement and achieve an activity within a process.
Process	The structured transformation of inputs into outputs. Processes typically operate across many functions and may cross department lines. A complex process may contain many procedures.
Remaining Life	The period from the current point in time to the time that an asset requires renewal.
Replacement Backlog	The estimated current replacement cost of assets that are still in-service but have exceeded their estimated useful lives.
Replacement Cost (Replacement Value)	The estimated cost to replace a capital asset with a similar asset based on studies, appraisals, industry standards and actual experience. Future estimated replacement costs are current replacement costs inflated by an appropriate factor.
Residual Risk	The risk that remains after controls are taken into account; that is, the net risk or risk after controls.
Responsibilities	The obligations or expectations to perform certain specific activities or duties according to a particular role.
Risk	The effect of uncertainty on objectives. An event that impacts the achievement of objectives and deals with the uncertainty. It is measured in terms of consequence and likelihood.
Risk Cost	The assessed annual cost or benefit relating to the consequence of an event. Risk cost equals the costs relating to the event multiplied by the probability of the event occurring.
Risk Management	The application of a formal process to the range of possible values relating to key factors associated with a risk to determine the resultant ranges of outcomes and their probability of occurrence.
Roles	The position(s) occupied (“the part played”) by certain internal stakeholders (and external stakeholders).
Senior Management	The group of people at the City who direct and control the organization at the highest level. Senior management has the power to delegate authority and provide resources within the organization.
Stakeholders	A person, group, or organization that can affect, be affected buy, or perceive themselves to be affected by a decision or activity.
Tangible Capital Asset (TCA)	The physical assets addressed by the City’s policy; including infrastructure and land.
Triple Bottom Line (TBL)	An expansion on the traditional view of an organization’s financial bottom line by also measuring the organization’s commitment to social and environmental factors.
Useful Life	The estimate of the number of years over which a capital asset is expected to be used.
Value Chain	A set of activities that an organization carries out to create value for its customers.

1 INTRODUCTION

The City of New Westminster (the "City") has developed this Water Asset Management Plan (Water AMP) to serve as a guiding document that will support the ongoing management and long-term stewardship of the City's water assets.

The Water AMP includes information on the following:

- Profile of the existing water assets;
- Desired levels of service and current performance of the City's water services;
- Anticipated growth and change required to meet future water service needs;
- Activities required for new, operations, maintenance, renewal and disposal of assets required to deliver water services today and into the future; and
- Investment required to fund the AMP for at minimum a ten-year planning window.

1.1 Background

Asset Management is identified in the Corporate Strategic Plan[5] as a priority for the City. The City is committed to "implementing a systematic asset management methodology to apply appropriate AM best practices across the organization.[6]"

The City completed its Asset Management Strategy in 2019 (EDMS # 1357644), which outlines its asset management objectives and improvement roadmap. It also provides an overview of the asset management system and its key documents, including an outline to guide asset management planning for each service area.

The City has identified the priority for greater clarity about its water system investment needs. A master plan has been developed in 2015 to assess growth and capacity needs into the future, the recommendations from which are incorporated into this report.

Prior asset management work has been conducted specifically for the City's water services, including development of initial decision-making criteria to guide selection of candidates for renewal and a review of the operations and maintenance activities and costing. The City's Water and Sewers team has recently implemented the Cityworks CMMS system, in the first of multiple phases of implementation. This AMP incorporates data from this recent work.

[5] 2019-2022 Corporate Strategic Plan: https://www.newwestcity.ca/database/files/library/Strategic_Plan.pdf
[6] Note from the Corporate Asset Management Policy, Version 1, 2017:
https://www.newwestcity.ca/database/files/library/Corporate_Asset_Management_Strategy.pdf

1.2 Purpose

The purpose of this AMP is to address key questions that will assist the City in the responsible stewardship of the assets in the water service, as well as the long-term sustainability of the water services. The questions addressed by this AMP are identified in Table 1-1.

Table 1-1
Questions Addressed by the AMP

Questions	Measures, Metrics & KPIs	Section of the AMP
1. What do we own?	Inventory and hierarchy	State of Infrastructure
2. What are our assets worth?	Valuation	State of Infrastructure
3. How long will our assets last?	Asset Service Life	State of Infrastructure
4. Which assets are beyond their theoretical service life and need to be inspected for condition?	Infrastructure Renewal Deficit (backlog)	State of Infrastructure Financial Strategies
5. What is the relative importance of our assets?	Criticality assessment completed in 2007 (used as input to AMP model)	Risks & Uncertainties
6. When do the assets need to be replaced?	Remaining Life	Lifecycle Management Strategies
7. How much will it cost to replace the assets?	Replacement Value	Financial Strategies
8. How much money will we need?	Capital load; Reinvestment Rate	Financial Strategies
9. What assets do we fix first?	Ranked Projects	Lifecycle Management Strategies
10. How much money will we have?		Financial Strategies
11. What are the next steps on our journey?	Recommendations	Implementation & Continuous Improvement

1.3 Scope

The Water AMP includes the following water assets:

- Linear water infrastructure including water mains and laterals; and
- Vertical and point assets such as PRV stations, valves, and zone and residential and ICI (2” and less) meters.

Other water assets that are the responsibility of Metro Vancouver are not included, which include water treatment plants, large diameter supply mains, reservoirs and pump stations. Like the Transportation AMP developed prior, natural assets are not currently included within the scope of this AMP.

This AMP will inform, at minimum, a ten-year planning horizon.

Assets were assigned a criticality based on the 2007 Urban Systems Risk Assessment Report (EDMS #1648308). Criticality values were used to prioritize projects for the Financial Model.

1.3.1 Water Emergency Equipment

This section will be added in future AMP revisions.

1.3.2 Climate Change and Resiliency

The impacts of climate change and the resiliency of the water assets were reviewed during the development of this AMP. Potable water is purchased from Metro Vancouver and distributed by the City of New Westminster. The source of the water is controlled by Metro Vancouver and is therefore out of the scope of this AMP.

At this time, there are no known climate adaptation actions required for the water distribution system. The City is in the planning process of a Water Conservation program to support climate change mitigation initiatives. Further details of this program will be included in the next revision of the Water AMP.

1.4 Stakeholders

The development and execution of this AMP relies on the collaborative effort of multiple City departments and the perspective of many external stakeholders.

Tables 1-2 and 1-3 identify the internal and external stakeholders and their interest. The stakeholder identification was conducted through a workshop with the Water AMP Working Group.

Table 1-2
Internal Stakeholders and Interests

Stakeholders	Interest
AMP Working Group	This group is comprised of members from the following departments: Infrastructure Planning, Operations, IT, Finance and Design & Construction. This Group is tasked with developing a cohesive AMP that aligns with the City's objectives.
Asset Management Steering Committee	This group provides direction to the City's overall asset management program and will serve as a key audience of the AMP.
City Council and Executive Team	These groups act as stewards for all City assets and approve the AM policy, establish levels of service delivery, and monitor progress and outcomes.
Engineering Department	This group provides water services, and maintains, inspects and operates the assets.
Roads and Sewers Renewal and Upgrade Project Managers	Roads and sewer renewal and upgrade projects (both capital and through developments) present opportunities for coordination of an integrated works program.
Development Services (Planning Department)	This group provides information on the OCP, Water Utility Master Plan and provides information such as growth and demand.
Finance & IT Departments (including Procurement)	This group provides financial and spatial data, and develops/supports financial and data management strategies related to the water assets, water rates setting and price stabilization reserve policies. Procurement services develop and execute policies and strategies to retain external services.
Parks & Recreation Department and other Civic Services	This group operates recreational and cultural programs and provides facilities that serve a wide range of public uses, using the water service provided.
Fire & Rescue Services	This group relies on adequate fire flow and system pressure to provide responsive, adequate and safe fire services.

Table 1-3
External Stakeholders and Interests

Stakeholders	Interest
• Water Services Customers: • Residents • Industrial • Commercial • Institutional (including Royal Columbian Hospital, schools, etc.)	These rate-paying end users rely on the water assets for their basic daily functions.
Metro Vancouver	Metro Vancouver provides the upstream water supply and distribution. This AMP must consider the objectives of Metro Vancouver and the regional water goals.
Neighbouring Municipalities	This group may influence local decision-making and may depend on water assets to supply their systems.
Third Party Utilities	This group may present opportunity for coordination.
Developers	This group creates demand which contributes to upgrades or new water assets.
Provincial and Federal Government – e.g. Ministry of Environment, Department of Fisheries and Oceans	These groups enact and enforce legislation and regulations to be followed.
Environmental Regulators	These groups may provide oversight of construction activities.
Fraser Health Authority	This group provides guidance on water quality requirements that must be followed.

1.5 Alignment with Corporate Direction and Documents

The Water AMP was prepared in alignment with existing corporate documents which provide guidance for the City as well as the relevant provincial legislation related to water services. Table 1-4 describes how this AMP supports and relates to the City's corporate objectives.

General City objectives, mandate and requirements are contained within the Community Charter, the Local Government Act, and various federal and provincial legislation. The SAMP identifies several additional objectives that have and will be considered in the development and execution of this AMP.

Table 1-4
Water AMP Alignment with City's Corporate Objectives

Corporate Objectives	AMP Section Reference	Alignment Description
Provincial and Federal Legislation	Levels of Service	Levels of service standards include the reporting and other requirements needed to adhere to provincial legislation for water distribution, including the following: • Drinking Water Protection Act & Regulation (Provincial) • Water Quality Monitoring and Reporting Plan (Metro Vancouver, Fraser Health) • Guidelines for Canadian Drinking Water Quality (Health Canada)
City's Asset Management Strategy[7] (SAMP)	Entire document structure	The Water AMP follows the guidance of the City's Asset Management Strategy, developed in 2019. The Strategy is commonly referenced as a "Strategic Asset Management Plan", abbreviated as "SAMP". The SAMP provides guidance on the following: 1. Specifics on how City objectives are translated into Asset Management Objectives; 2. Description on how they achieve the Asset Management Objectives (Roadmap); and 3. Information on AMP development standards to maintain consistency among City departments.
Corporate Asset Management Policy[8]	Entire document structure	This document sets principles for implementing consistent processes, approaches for asset management throughout the City.

[7] Asset Management Strategy, 2019
[8] Corporate Asset Management Policy, Version 1. Refer to Appendix A for the Policy.

Corporate Objectives	AMP Section Reference	Alignment Description
Various Related Bylaws	Levels of Service	Water Shortage Response Bylaw No. 6948, 2004[9]: Provides guidance to customers on water restrictions in certain times of the year. Waterworks Regulation Bylaw No. 7631, 2013[10]: Provides guidance on the water service to the public, owner and consumer including application for water service connections, water meter requirements, rates, fees and charges, etc. 2020 Water Rates[11] provide rates for various consumers. Engineering Fees and Rates Bylaw 7553, 2013[12] describes the fees and rates for services including water service.
2041 Official Community Plan[13] Last updated June 2020	Levels of Service Asset Lifecycle Strategies	The Official Community Plan defines future population numbers to the year 2041.. The projected population numbers are used to calculate Water demands. It outlines key priorities to include: safety, adequate infrastructure to sustain effectiveness through growth, and supply conservation goals such as reduction of consumption and rainwater reuse.
2019-2022 Council Strategic Plan[14]	All	The Plan identifies a priority in implementing a "systematic asset management methodology to apply appropriate AM best practices across the organization". This document reflects the continued direction of the City to continue advancing asset management efforts for all City services.
Envision 2032 New Westminster's Sustainability Framework[15]	Levels of Service	The Envision Framework provides guiding principles and a detailed plan for sustainability initiatives moving forward. This Water AMP builds on that to identify Water-specific sustainability requirements.
Water Conservation Initiatives	Levels of Service Asset Lifecycle Strategies	Future Plans may outline specific requirements for water conservation considered in development of the AMP.

[9] The Water Shortage Response Bylaw No. 6948, 2004 can be found here: https://www.newwestcity.ca/database/files/library/6948_Water_Shortage.pdf
[10] The Water Regulation Bylaw No. 763, 2013 can be found here: https://www.newwestcity.ca/database/files/library/7631_Waterworks.pdf
[11] The Water Rates can be found here: https://www.newwestcity.ca/city_hall/finance-taxes-and-budgets/taxes-and-utilities/sb_expander_articles/1271.php
[12] The Engineering Fes and Rates Bylaw 7553, 2013 can be found here: https://www.newwestcity.ca/database/files/library/7553_Engineering_User_Fees_and_Rates(1).pdf
[13] The 2041 OCP can be found here: https://www.newwestcity.ca/ocp. PDF Page 146 describes Utilities and Services Infrastructure.
[14] The City's 2019-2022 Strategic Plan and Goals: https://www.newwestcity.ca/city_hall/mayor_and_council/strategic-plan
[15] Envision 2032: https://www.newwestcity.ca/database/files/library/Envision_2032_Sustainability_Framework_FINAL_web(1).pdf

Corporate Objectives	AMP Section Reference	Alignment Description
Environmental Strategy & Action Plan[16]	Levels of Service Asset Lifecycle Strategies	This is the City's environmental master plan which identifies the corporate water goals. Goal #9 of the plan is to "Maximize the conservation and protection of drinking water", which is directly related to the water assets.
Metro Vancouver's Drinking Water Management Plan (DWMP)[17]	Levels of Service Demand Management	This document provides direction and priority for the City's water system. The plan identifies these three goals: 1. Provide clean, safe drinking water. 2. Ensure the sustainable use of water resources. 3. Ensure the efficient supply of water.
Climate Emergency Goals[18]	Asset Lifecycle Strategies	City Council has set out to achieve greenhouse gas reduction targets set out by the Intergovernmental Panel on Climate Change. A 2020 Climate Action Budgeting Framework has been adopted as well as steps to achieve this goal which include prioritizing climate emergency actions in work plans and embedding carbon pricing into decision-making. The Goals also include zero-emission heating and hot water systems and investment in a smart electrical grid. These goals should be considered in evaluating operational activities into the future.
Capital 5- and 10- Year Planning	Asset Lifecycle Strategies	Strategies for use of capital will inform Asset Lifecycle Strategies. Future capital plans will be developed based on guidance from the Water AMP.
Maintenance Plans	Asset Lifecycle Strategies	A maintenance plan for Water assets, including a resourcing review, was conducted in 2017. This will inform assumptions for resource requirements of operations and maintenance activities.
National Water & Wastewater Benchmarking Initiative (NWWBI) – Water Distribution	Levels of Service	A Nation wide initiative to collect, report, and compare level of service data from public organizations providing similar service. Refer to their website for further details (https://nationalbenchmarking.com/). LOS and KPI developed for this AMP were aligned with KPIs required for the NWWBI (Water Distribution).
Drinking Water Emergency Plan	Risk (Future AMP)	The Drinking Water Emergency Plan is currently underdevelopment.

1.6 Methodology

Methodology for development of the Water AMP involves the following steps:

- Direction-setting and definition of levels of service;

[16] Environmental Strategy & Action Plan: https://www.newwestcity.ca/database/files/library/ESAPweb.pdf
[17] Metro Vancouver's Drinking Water Management Plan is detailed here: http://www.metrovancouver.org/services/water/about/plans/Pages/default.aspx
[18] Climate Emergency Goals https://www.newwestcity.ca/environment/climate-emergency

- Current and projected state of assets analysis;
- Forecasting of capital investment needs and projection of operational implications;
- Definition of 10-Year, prioritized project list;
- Identification of financial needs, funding sources, and the funding gaps; and
- Defining improvement initiatives to be carried out following development of the AMP.

Specific methodology for these aspects is defined in subsequent chapters of this plan. Supporting methodology underlying the analysis is outlined in the State of Infrastructure Section.

1.7 Plan Inputs and Data Reliability

Table 1-5 identifies the Data Reliability Grades on a 5-point scale as recommended in the SAMP. This provides definition of the reliability levels of each data source.

Table 1-5
Data Reliability Scale

Grade	Reliability	Description	Accuracy
1	High Reliability	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 accurate +/- 2%.
2	Reliable	Data based on sound records, procedures, investigations and analysis, documented properly but has minor shortcomings, for example some of the data is old, some documentation is missing and/or reliance is placed on unconfirmed reports or some extrapolation.	Dataset is complete and estimated to be accurate +/- 10%.
3	Uncertain	Data based on sound records, procedures, investigation and analysis which is incomplete or unsupported, or extrapolated from a limited sample for which grade 1 or 2 data are available.	Dataset is substantially complete but up to 50% is extrapolated data and accuracy estimated at +/- 25%.
4	Very Uncertain	Data is based on unconfirmed verbal reports and/or cursory inspections and analysis.	Dataset may not be fully complete and most data is estimated or extrapolated. Accuracy +/- 40%.
5	Unknown	None or very little data held.	

Each data source and related section of the Water AMP contains a data confidence scale which is identified in Figure 1-1.

RELIABILITY			▼		
RANGE	5: UNKNOWN	4: VERY UNCERTAIN	3: UNCERTAIN	2: RELIABLE	1: HIGH RELIABILITY

Figure 1-1
Data Reliability Scale

It is expected that with each iteration of the AMP, the data confidence will improve due to development and implementation of the initiatives listed in the Water AMP Improvement Plan.

1.8 Plan Inputs and Data Reliability

The information collected and used in analysis in the Water AMP is based on information available at the time of preparation which includes data that was collected from the following sources.

Table 1-6
Data Source Inventory and Confidence

Data Source	Confidence Grading	AMP Section Reference	Comments
2041 Official Community Plan (OCP)	1	Levels of Service	Goal #12.1: Plan, construct and operate City services in a manner that best serves the community while protecting public health and the environment.
Envision 2032	1	Levels of Service	6 goals relevant to water assets included.
Environmental Strategy and Action Plan	1	Levels of Service	Goal #9: Maximize the conservation and protection of drinking water.
Strategic Asset Management Plan (SAMP)	1	Entire Document	The SAMP guided the development of the Water AMP including items such as growth statistics, objectives, risk framework, decision-making approach, stakeholder engagement, etc.
Maintenance Management System Pilot, 2017	1	Levels of Service Asset Lifecycle Strategies	Defines service goals and specific maintenance activities.
National Water and Waste Water Benchmarking Initiative (NWWBI) Program	1	Levels of Service	NWWBI Key Performance Indicators (KPIs) used to identify Technical Levels of Service (TLOS).
2015 Utility Master Plan	2	Levels of Service	Identify trends in demand conditions of existing and future water system, as well as growth projects

Data Source	Confidence Grading	AMP Section Reference	Comments
Point Asset GIS Data	3	State of Infrastructure	Inputs into the investment models
Linear Asset GIS Data	2	State of Infrastructure	Inputs into the investment models
Break History GIS Data	3	State of Infrastructure	Acts as one proxy for condition ratings in mains
Cityworks Water Main Break History	2	Asset Lifecycle Strategies	Identifies water main breaks for the model. This is a limited sample size.
Spend by Work Order Type/Number (JD Edwards)	3	Financial Outlook	Identifies spend each year by GL codes and work order types as defined in JD Edwards. Used to identify patterns in operational spend. Due to recent changes in coding, much of the spend is allocated to overhead.
Urban Systems Criticality Data (2007)	2	Risk & Uncertainties	Provides criticality for water mains
GAME Inspections	1	Risk & Uncertainties	Informs future inspection procedures

The SAMP identifies one key constraint impacting asset data quality and reliability: that the City's asset data sits within the City's Geographic Information System (GIS) which may not have the desired accuracy due to data entry lag. This results from a delay in as-builts being entered into the GIS inventory, resulting in some of the data not being current.

2 STATE OF INFRASTRUCTURE

2.1 Data Sources

The inventory used in this AMP is collected from GIS records. Asset values were determined using the asset inventory and asset replacement values provided by Infrastructure Planning, as summarized in Appendix B.

Tangible Capital Asset records were not used in the State of Infrastructure Analysis, but as a reference point for the asset inventory.

The asset inventory considers assets installed from the beginning of 1930 to the end of the 2019 calendar year.

Water network assets are separated into two primary categories: linear assets and point assets. Linear assets are comprised of mains and lateral assets (otherwise called services or service connections). Point assets are comprised of fountains, hydrants, meters, PRV structures, sampling stations, and valves. Data quality varies significantly by asset type.

2.2 Asset Hierarchy

The draft asset hierarchy used for AMP analysis is shown in Figure 2-1 below. A revised hierarchy for future iterations of the AMP is located in Appendix C.

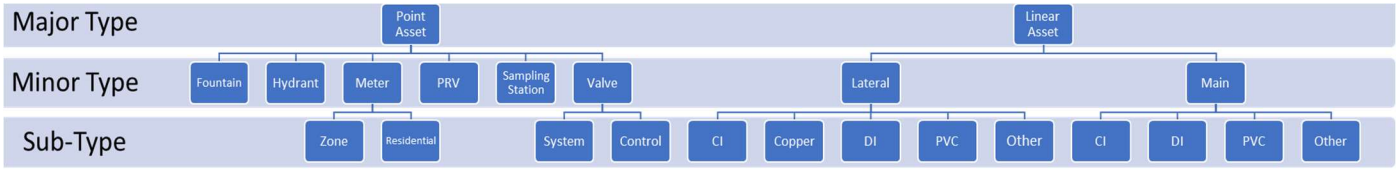


Figure 2-1
Asset Hierarchy

The complete asset inventory contains 11,654 non-abandoned asset records, of which 11,654 are linear assets, and 5,317 are point assets. Figure 2-1 illustrates the asset inventory as arranged in the City's asset hierarchy.

Of note, AMP analysis for PRVs was completed only based on valves and not other components as defined in the revised asset hierarchy. Additionally, AMP analysis for metres was based on available information which provided differentiation between Zone and Residential metres.

2.3 Asset Valuation

Asset values were determined using the asset inventory and asset replacement values provided by Infrastructure Planning. Replacement values, detailed in Appendix B, were based on tendered Watermain replacement projects between 2017 and 2019 in New Westminster, and calibrated with the 2020 Watermain Replacement tender. The replacement values were then compared against values from neighbouring municipalities. Replacement values were supplied by the Infrastructure Planning for water mains, hydrants, valves, services and meters. No updated unit replacement values were provided for PRVs, sampling stations, and fountains as those are considered asset specific. These unit costs are used to provide a high-level strategic estimate of the replacement values for the assets in the portfolio.

C:\Users\gsulem\AppData\Roaming\OpenText\DM\Temp\CNW_DOCS-#1806554-v1-ENG_2020_-_AM_-_AMP_-_Water_-_Report_-_Final.docx

The total replacement value of the portfolio is $317 million. Linear assets make up the vast majority of the asset portfolio at $290 million, in comparison to point assets at $27 million. Figure 2-2 illustrates the value of the asset portfolio.

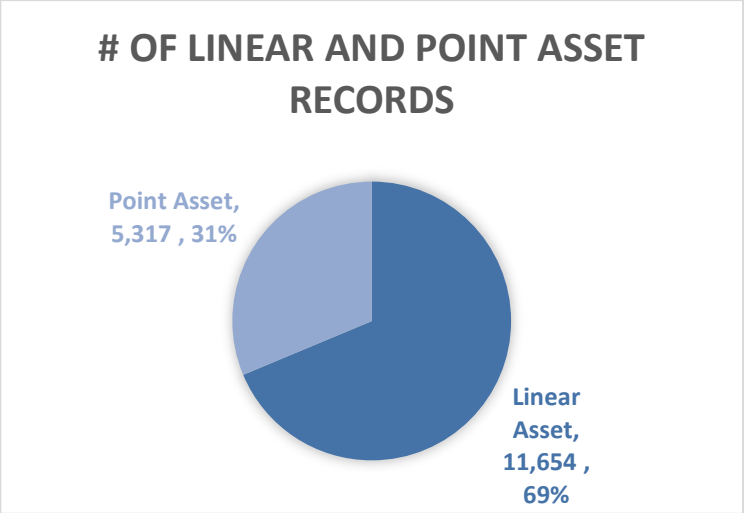


Figure 2-2
Number of Linear and Point Asset Records

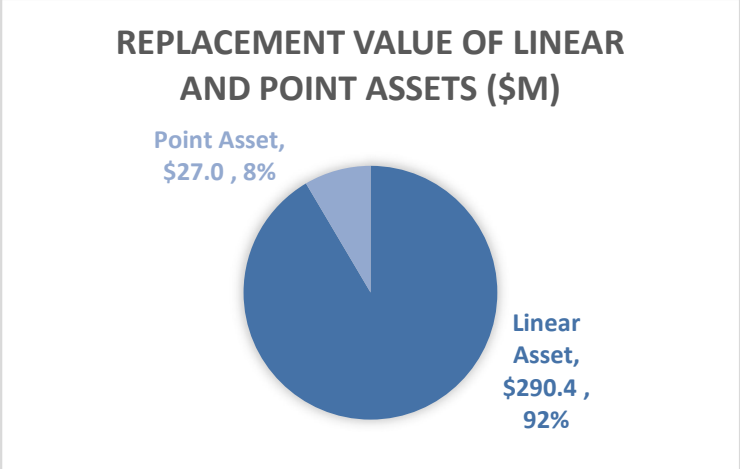


Figure 2-3
Replacement Value of Linear and Point Assets ($M)

Due to mains and laterals being broken down into short segments of varying lengths in the GIS records, it is more useful to analyze linear assets by replacement value instead of a count of GIS entries. Going forward, analysis of linear assets will consider replacement values instead of total asset counts unless noted otherwise.

RELIABILITY			▼		
RANGE	5: UNKNOWN	4: VERY UNCERTAIN	3: UNCERTAIN	2: RELIABLE	1: HIGH RELIABILITY

Figure 2-4
Asset Valuation Confidence Scale

Data reliability has been assessed as "uncertain" for unit costs.

2.3.1 Valuation Assumptions

Asset valuation is derived based on the unit rates defined in **Appendix B.**

2.4 Linear Asset Breakdown

The linear asset inventory contains 11,654 asset records, of which 3,007 are mains, and 8,647 are lateral assets. As discussed above in Section 2.3, the count of linear assets can be misleading due to differing lengths and diameters of the mains and laterals in the inventory. By replacement value, $236 million of the portfolio is made up of mains, and $55 million is made up of laterals. By length, there are 206 km of mains and 72 km of laterals. Figures 2-5 and 2-6 compare the replacement values to the length of mains and lateral assets.

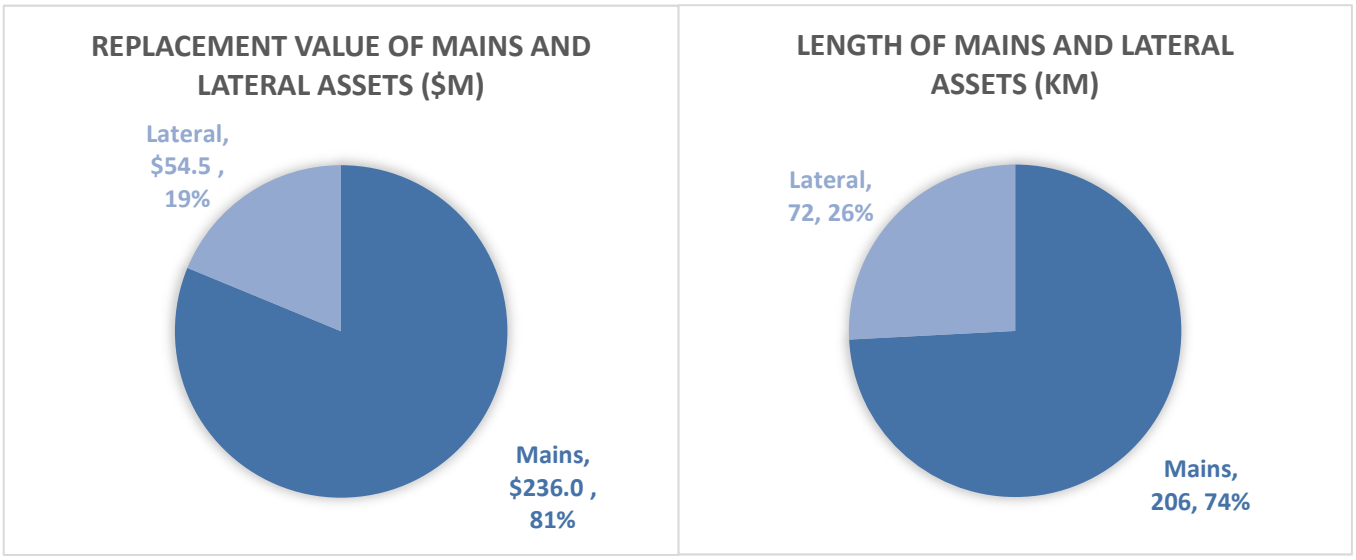


Figure 2-5 Replacement Value of Mains and Lateral Assets ($M)
Figure 2-6 Length of Mains and Lateral Assets (km)

Asset data is more complete for mains than for lateral assets. At first glance, main data seems to have more "unknowns" for the different asset characteristics, but there is reason to be cautious about the quality of lateral asset data. It is likely that a significant number of lateral asset characteristics have been inferred or entered incorrectly. This will be discussed in more detail in Section 2.4.1.



Figure 2-7
Main Data Confidence Scale

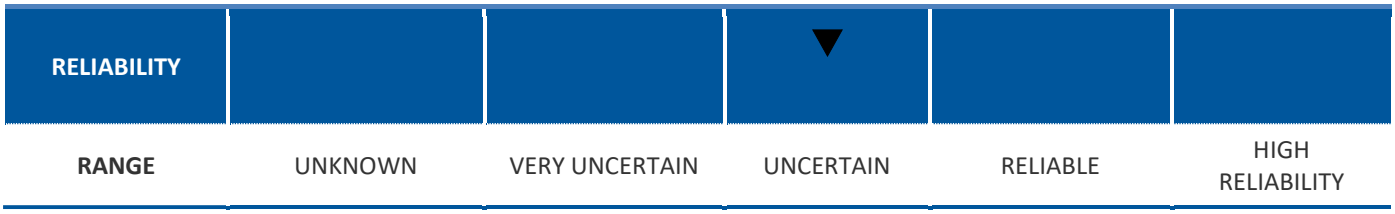


Figure 2-8
Lateral Asset Data Confidence Scale

The earliest recorded installation dates for mains and lateral assets are 1930. The average age of mains in the inventory is 44 years. Main ages are relatively evenly distributed. The average age of lateral assets, including estimated ages, is 41 years. Lateral assets have a younger average age than mains at 28 years. The majority of recorded lateral assets were installed between 10-30 years ago.

Ensuring that installation dates for main and lateral assets continue to be recorded accurately is important for strategic planning going forward. Figure 2-10 illustrates the distribution of mains and laterals by installation dates.

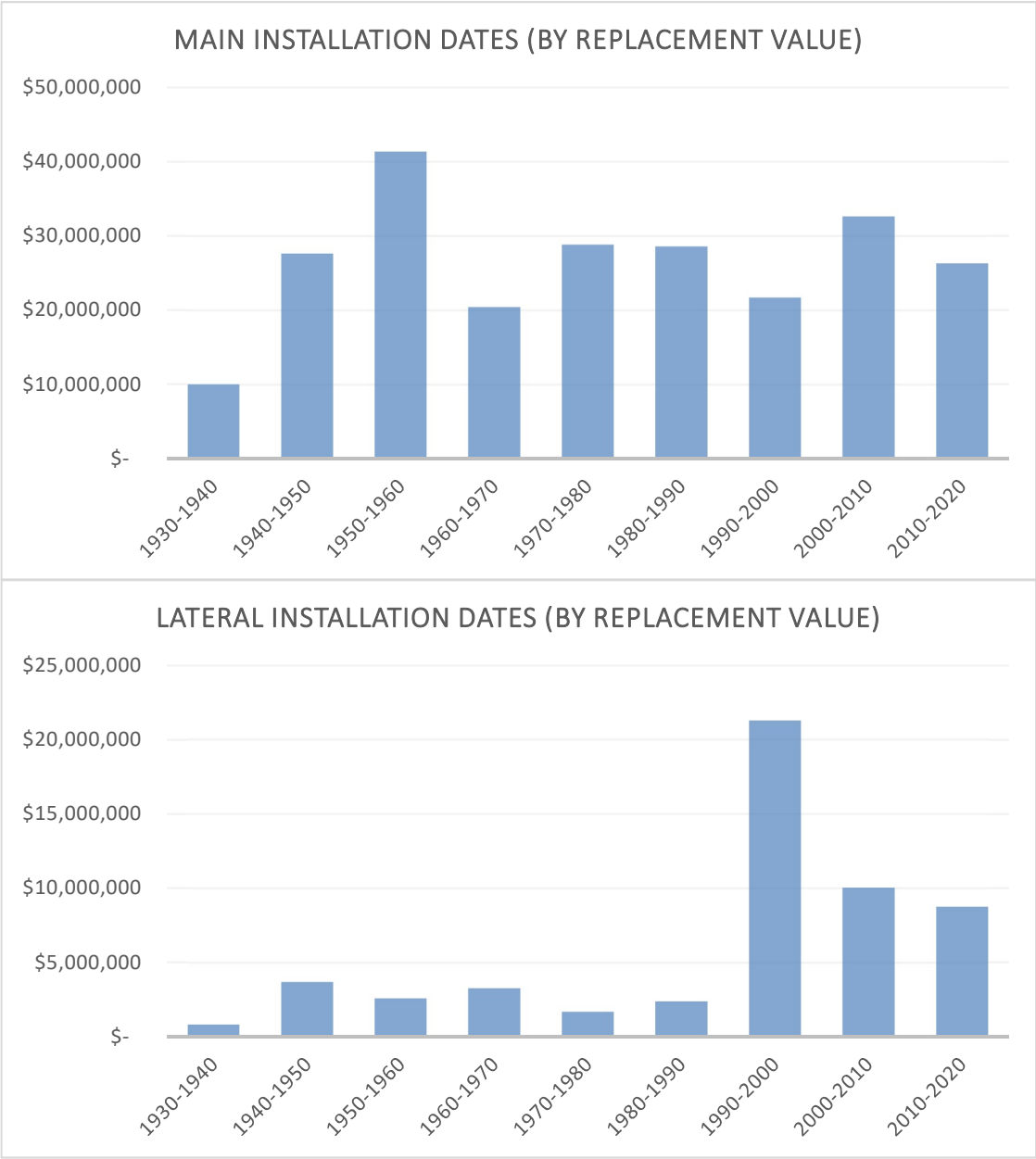


Figure 2-9
Main and Lateral Installation Dates by Replacement Value

Given the expected lifespan of mains of different material types is approximately 80 years, the 10-year period between 2030-2040 is expected to see a larger than average demand for replacement corresponding with the increase in main installations between 1950-1960.

Material data is better documented for mains than lateral assets. By length, the majority of mains are made of known materials. A larger proportion of lateral assets are made of unknown materials.

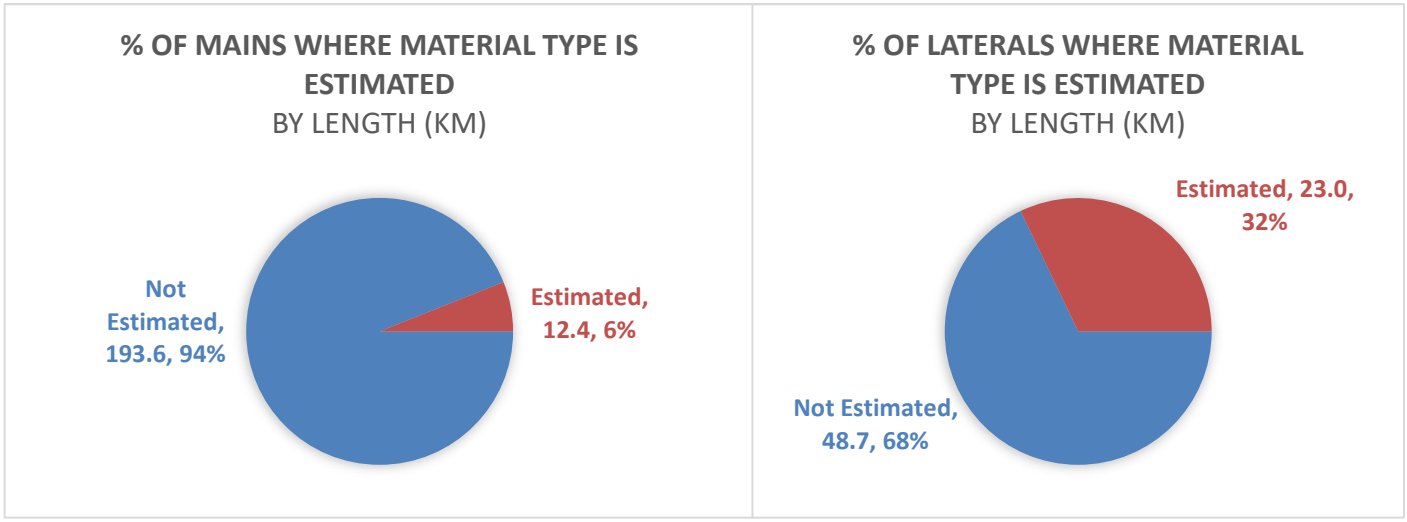


Figure 2-10
% of Mains and Laterals where Material Type is Estimated by Length (km)

Main materials are split relatively evenly between ductile iron (DI) and cast iron (CI), with a small proportion of mains being PVC[19]. Most lateral assets are copper, with a small number of large lateral assets being DI or CI. Note that all laterals that received an automatically assigned installation date of January 1, 2000 (further discussed in section 2.4.1) were also assigned copper as the material type. It is likely that some of these laterals are not actually copper. See Appendix B for a discussion on how main materials were estimated.

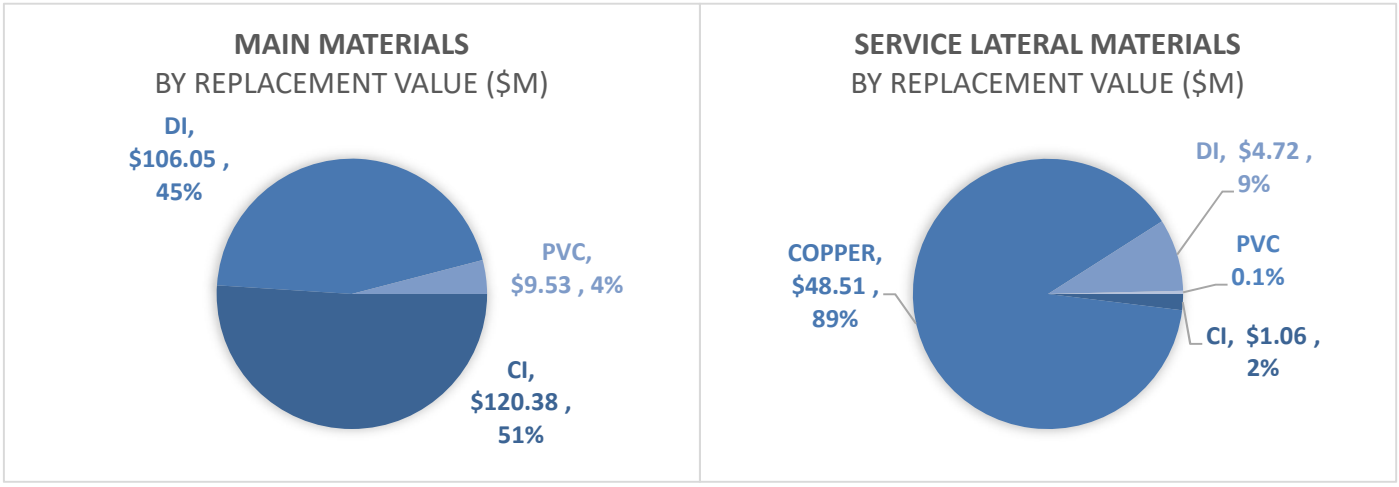


Figure 2-11
Main and Lateral Materials by Replacement Value ($M)

[19] The exact number of PVC mains in the City is uncertain. PVC is not a preferred material, and staff suggest this may be a data entry error.

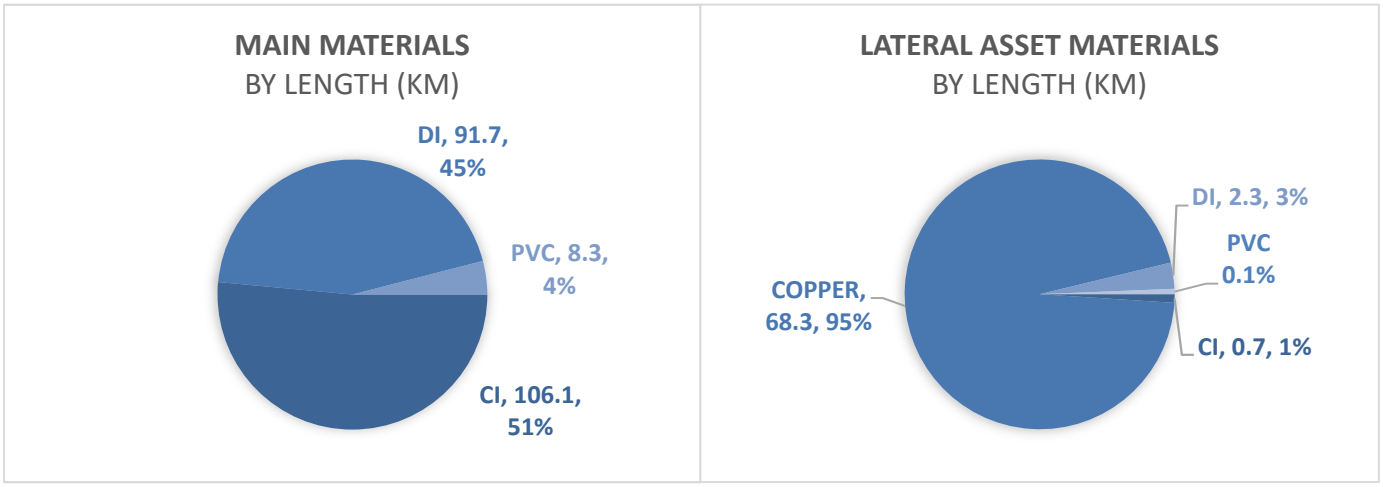


Figure 2-12
Main and Lateral Materials by Length (km)

Diameters are better known for mains than for lateral assets. See **Appendix B** for a discussion on estimation of main and lateral diameters for strategic planning purposes.

The majority of mains are 150mm in diameter (59% of all mains), and the vast majority of laterals are 19mm in diameter (89% of all laterals).

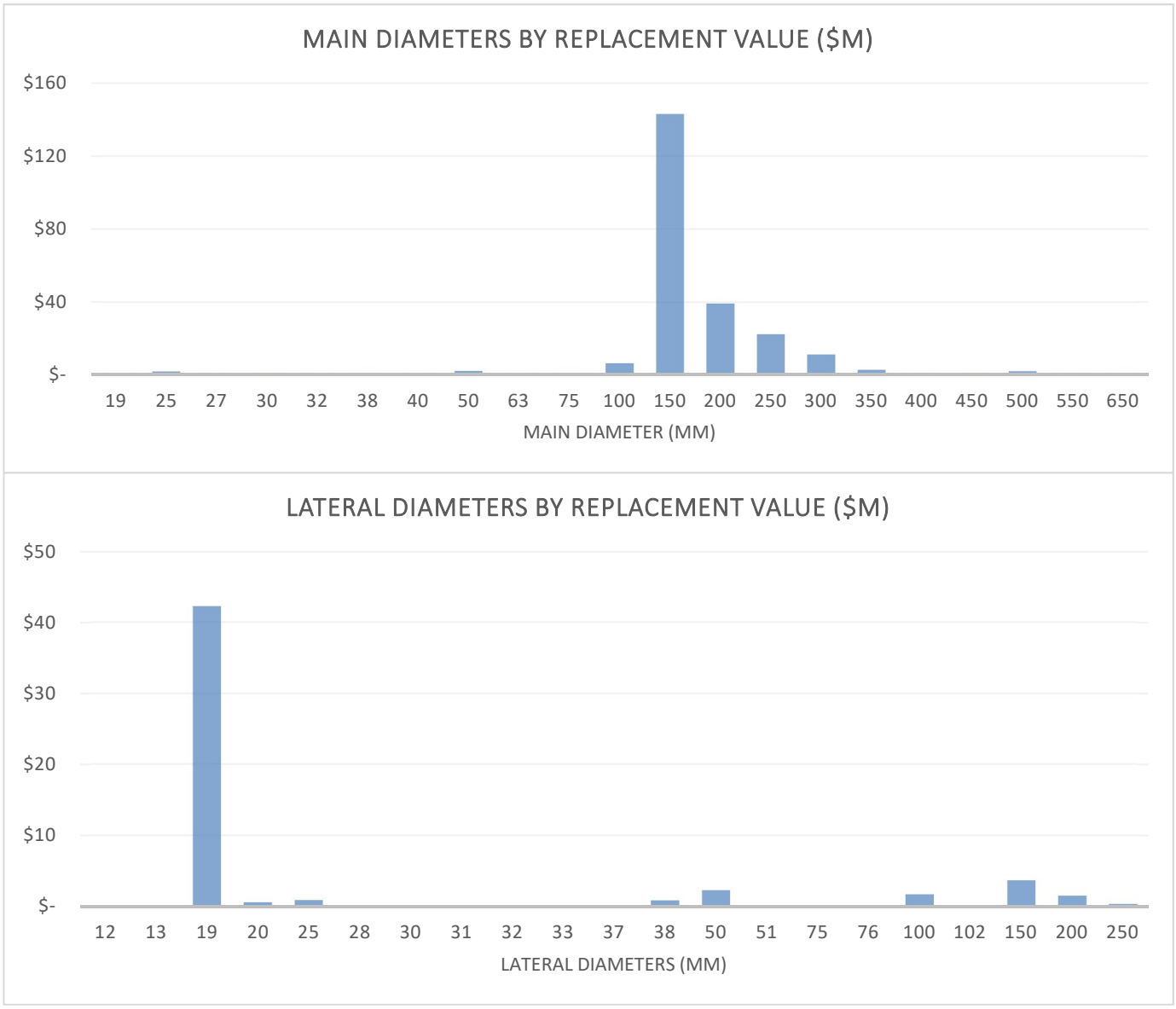


Figure 2-13
Main and Lateral Diameters by Replacement Value

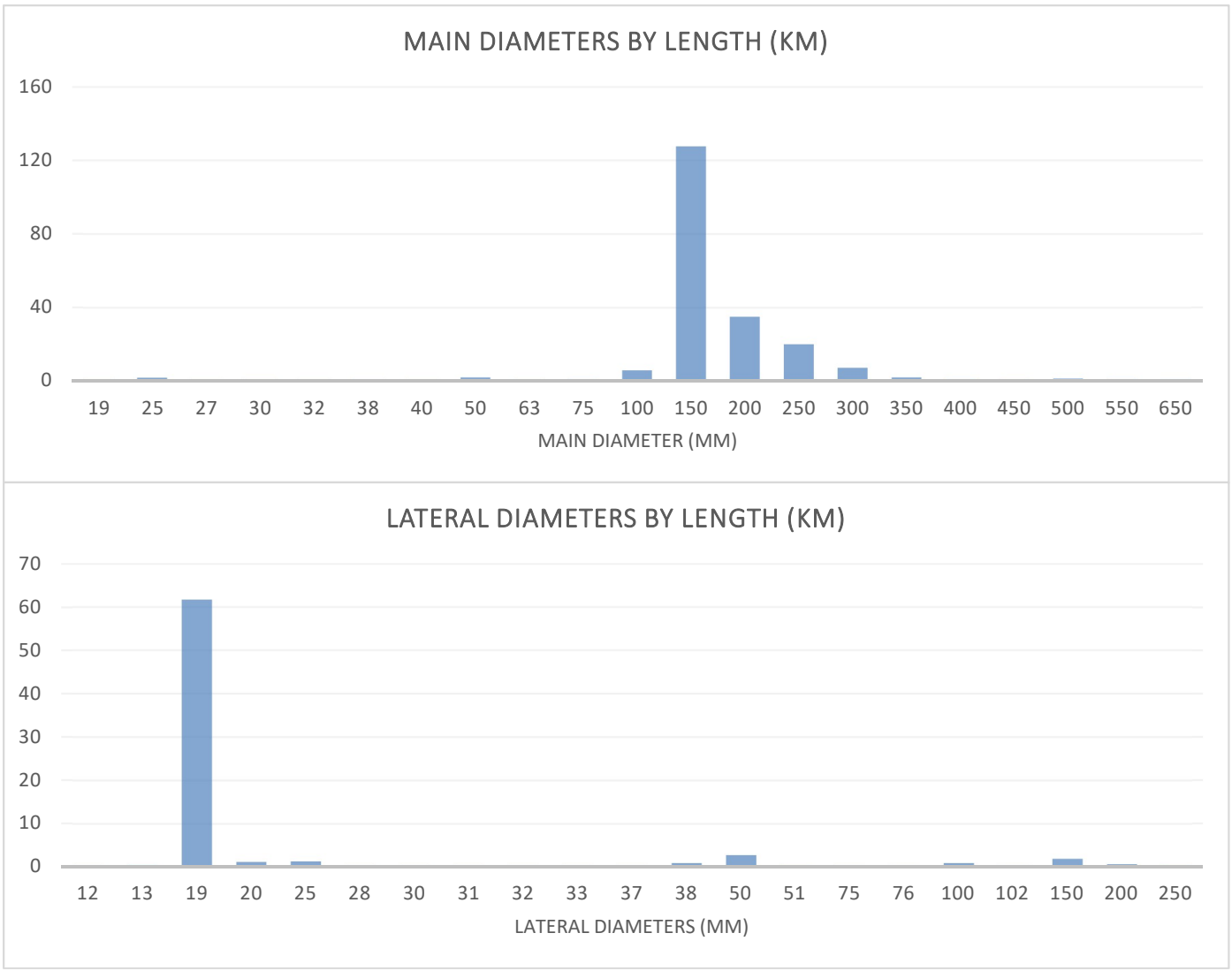


Figure 2-14
Main and Lateral Diameters by Replacement Value and Length

2.4.1 Lateral - Estimated Date of Install

Linear asset installation dates are well known. Main installation dates are better known than lateral asset installation dates. 3,234 lateral asset records in the system had install dates of January 1, 2000. This date was automatically given to the assets by the system if no installation date was provided. Each of these lateral assets were also listed as copper, with most having an unknown diameter. For lateral assets with installation dates of January 1, 2000, on recommendation by Infrastructure Planning a comprehensive prioritized schema was used to estimate installation dates depending on available information, including building permit information, water main installation year, and age of building. See **Appendix B** for more discussion on the methodology used to assign estimated install dates to assets.

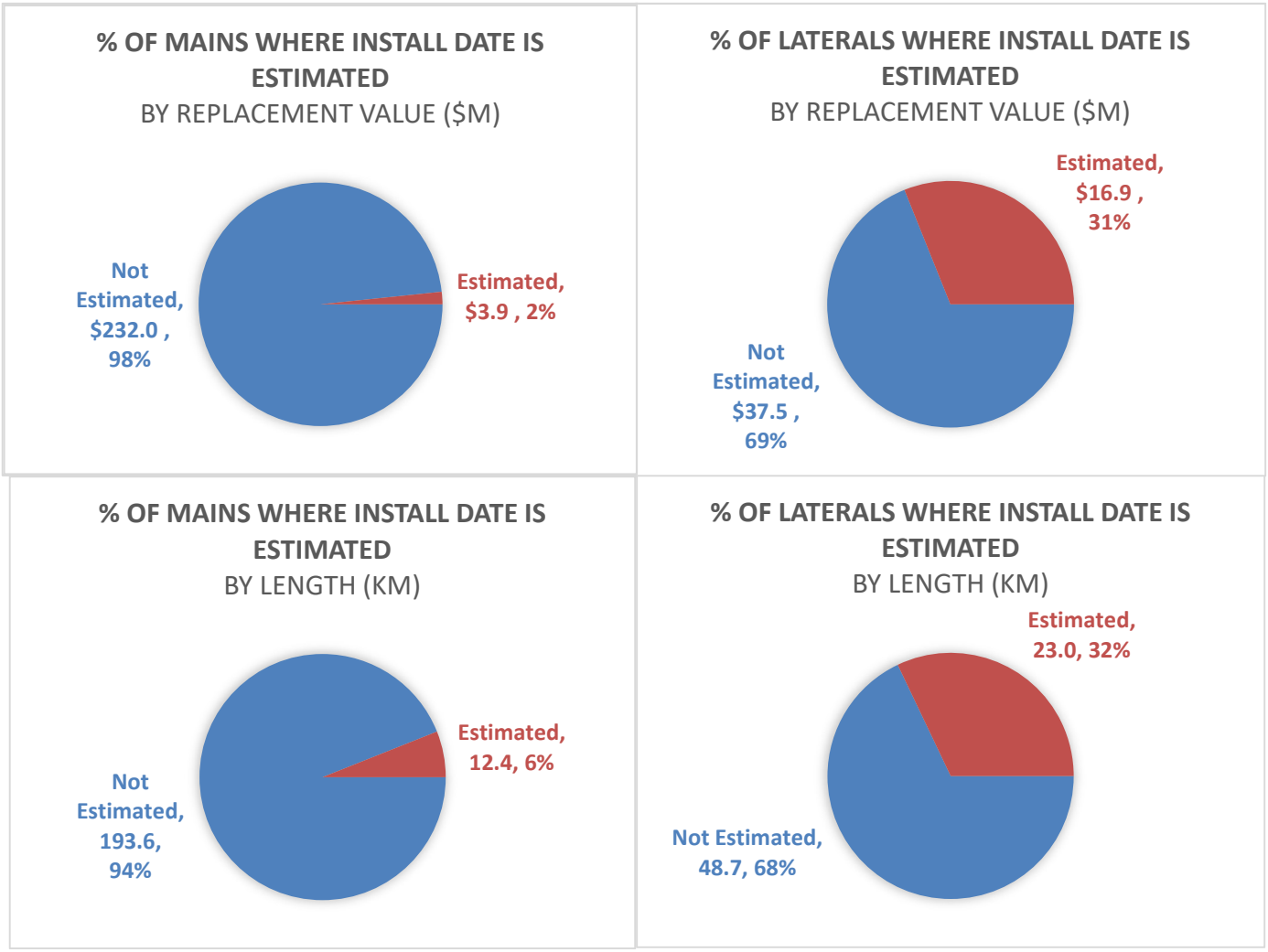


Figure 2-15
% of Mains and Laterals Where Install Date is Estimated

2.5 Point Asset Breakdown

The point asset inventory consists of 5,317 assets of different classes including: system valves, fountains, hydrants, PRV stations, sampling stations, zone meters, and both residential and institutional, commercial, and industrial (ICI) water meters 2" and less in diameter[20]. Service connections are not included in the inventory. System valves, residential and ICI water meters, and hydrants make up the majority of point assets.

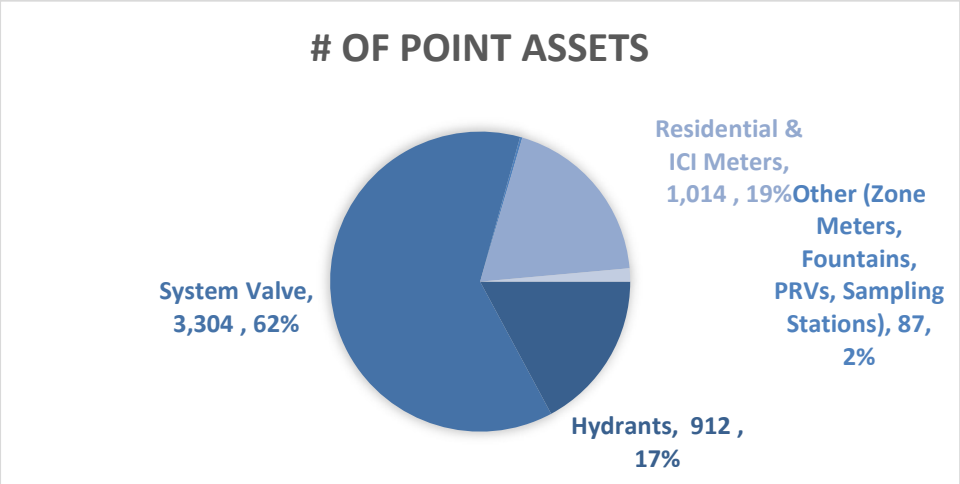


Figure 2-16
# of Point Assets by Type

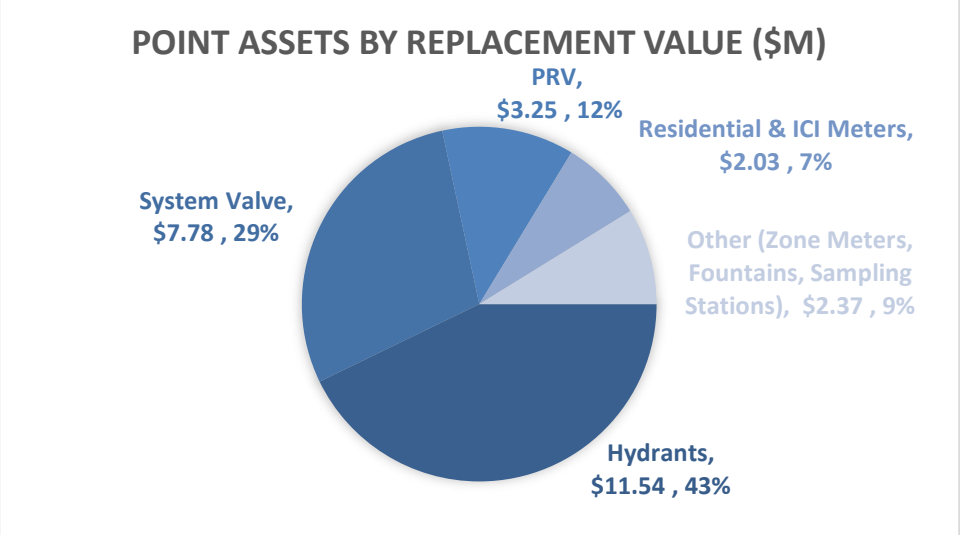


Figure 2-17
Point Assets by Replacement Value

[20] All meters larger than 2" are privately owned and excluded from this report. The GIS data did not differentiate ICI meters from residential or zone meters, and ICI meters are not considered a separate category in this version of the AMP. These may be differentiated in future iterations of the AMP if the source data is clarified.

Data on point asset characteristics is not comprehensive or complete, and as a whole, point asset data is less well known than linear assets. For each point asset class, the majority of installation dates are unknown. Asset characteristics, like the type of fountain or the diameters of valves are not recorded for the majority of entries.

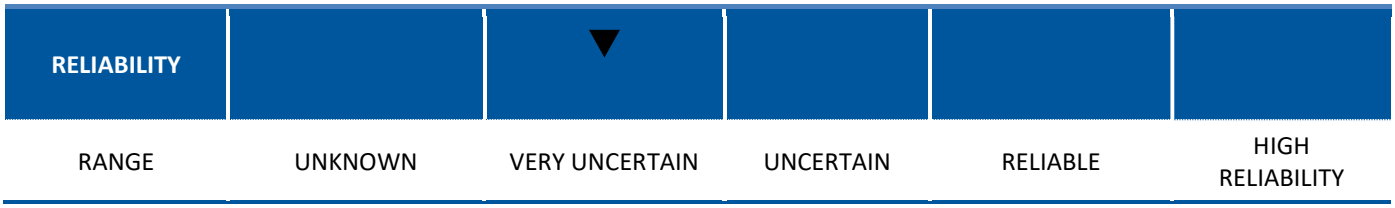


Figure 2-18
Point Asset Data Confidence Scale

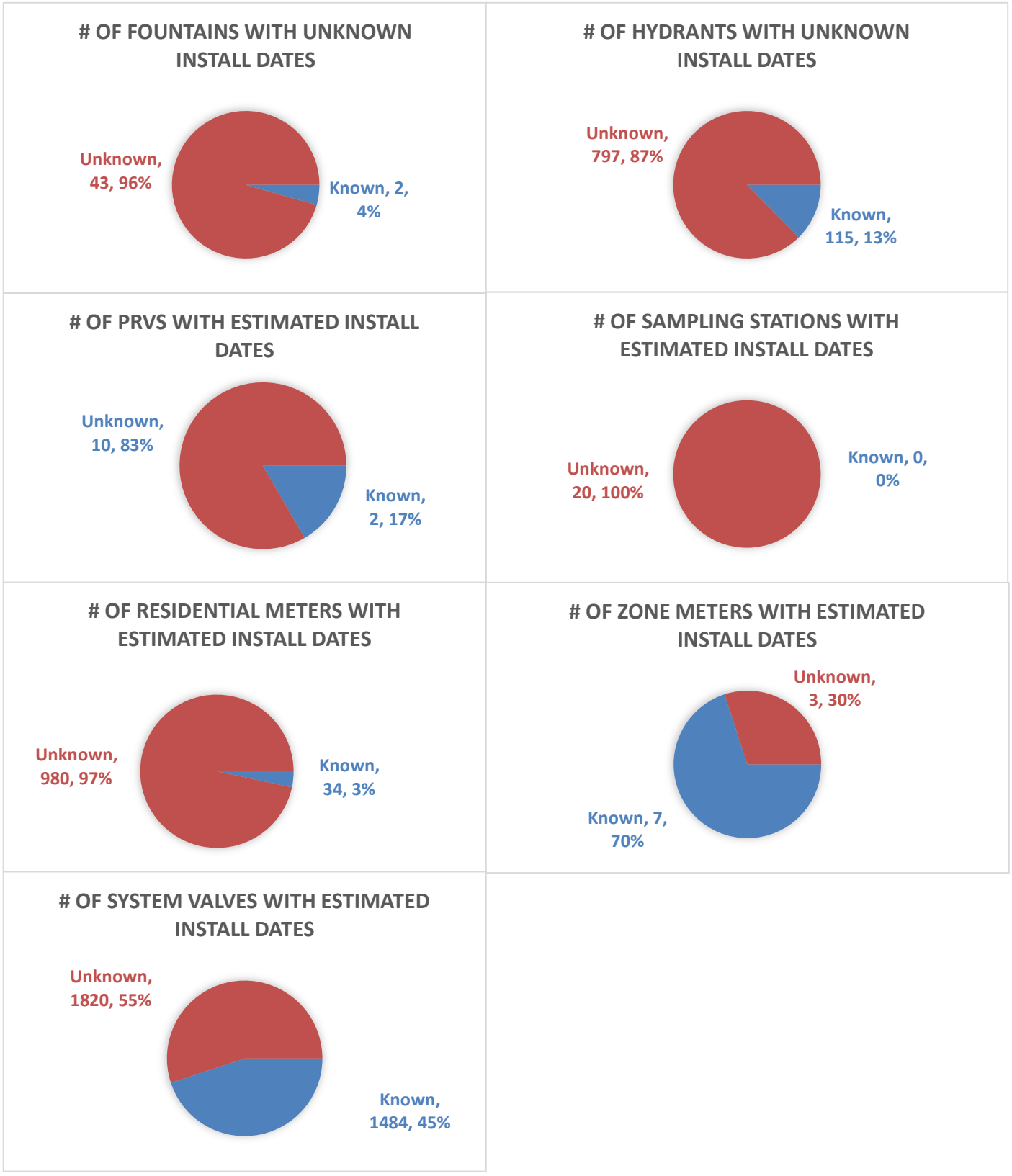


Figure 2-19
# of Point Assets with Estimated Install Dates (by Sub-Type)

As the majority of install dates for each asset class are unknown, it is not possible to create informative asset age profiles for point assets.

A limitation of the point asset GIS data is that it is not grouped by facility or associated mains. This makes it difficult to determine easily which linear assets and point assets belong to the same facility or main for the purposes of planning replacements. A preliminary effort was made to group assets by the "Location" tag in GIS records, but there is potential for significant improvement in this regard. A review of important point assets would make it possible to create better risk profiles, as well as make it easier to plan maintenance and replacements on a facility-by-facility basis.

2.6 Asset Condition and Data Gaps

The condition profile of the Water assets is based on the age of the infrastructure and estimated lives. For mains, the age-based condition was modified with available main break data. A snapshot of the condition is below. Detailed methodology is provided in Section 4 Asset Lifecycle Strategies.

A snapshot of the estimated asset condition profile (as at 2020) for all assets and specifically for mains is provided in the following figures. Replacement of mains tends to drive replacement of all associated assets, and as such that condition profile should give an indication of replacement priorities.

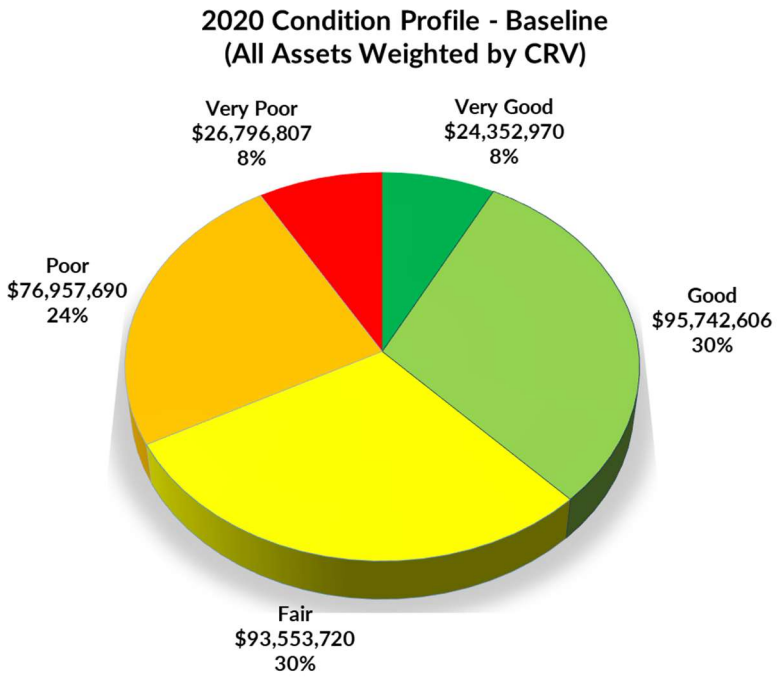


Figure 2-20
2020 Estimated Condition Profile for all Assets

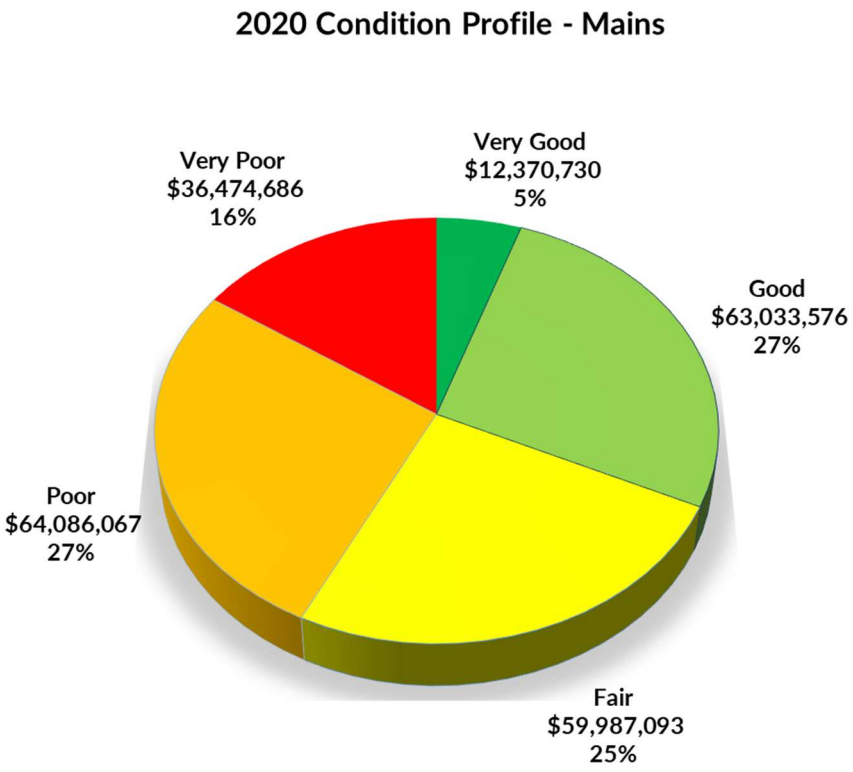
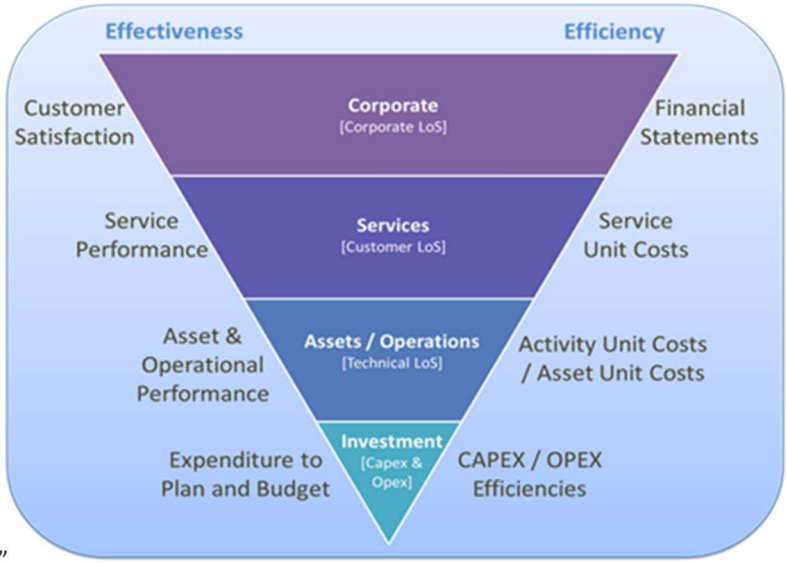


Figure 2-21
2020 Estimated Condition Profile for Mains

3 LEVELS OF SERVICE



Delivering water services is part of the City's core mandate. Understanding the Levels of Service (LOS) that the City provides its customers and stakeholders will allow the City to better deliver on the expectations of those parties. It frames service delivery around the customer rather than the organization. It enables the City, once available data is in place, to analyze and strike a balance been levels of service and the cost to deliver them.

One of the City's Asset Management Policy Principles (April 2019) states that "we shall clearly define and measure our Levels of Service for delivering on customer and stakeholder requirements."

The LOS indicators for the Water AMP were determined though answering questions aligned to a service-based decision-making approach as described in the SAMP. They were defined by answering the following types of questions:

1. Who is the customer?
2. What services are being provided to them?
3. What can be measured to understand the customer experience?
4. What activities will support the customer experience?
5. What operational/technical performance measures contribute to the customer experience?

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The LOS approach for the Water AMP follows the process identified in the SAMP. Table 3-1 summaries the SAMP's LOS Process.

Table 3-1
LOS Process

Steps	Tasks	Details
1	Identify universal customer values	The LOS measures are arranged in the following categories: availability, cost-effectiveness, reliability, responsiveness, safety, suitability, and sustainability.
2	Establish business objectives	Business objectives are defined for each customer.
3	Develop CLOS measures	Develop Customer Levels of Service (CLOS) measures that are aligned to the universal customer values as identified in the SAMP.
4	Develop TLOS measures	Develop Technical Levels of Service (TLOS) measures that align with CLOS and are arranged in the following categories: operations, maintenance, renewals and upgrades.
5	Monitor performance – collect data	Once measures are defined, then data can be collected to provide a performance baseline.
6	Set targets	Set performance targets and develop strategies to gradually improve toward set targets.
7	Benchmark results	Compare the City's performance scores against other similar organizations within different regions.
8	Publishing of performance results and consulting with customers	Communicating on targets and affordability of strategies should be done as soon as there is confidence in the numbers.

3.1 Levels of Service Framework

The typical focus for municipalities is on maintaining assets without necessarily having a complete understanding of whether those assets support the corporate, customer and technical LOS requirements. Establishing LOS for the Water AMP enables the City to measure and improve its service performance.

The LOS developed in the Water AMP connects and creates a line of sight between the City's objectives, the customer expectations and the daily operational activities that support the water assets. Understanding the LOS of the water assets will better inform decision making, management practices as well as the financial expenditures required to manage the assets.

Figure 3.1 graphically identifies the different LOS by category.

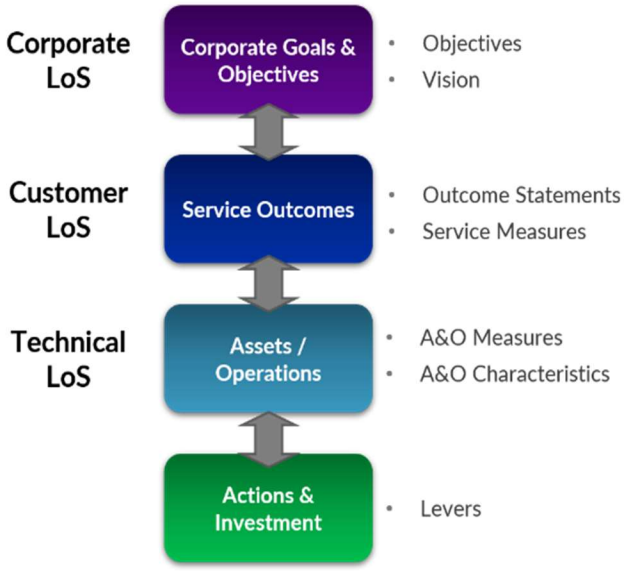


Figure 3-1 Levels of Service Framework

3.1.1 Alignment with the City's Organizational Objectives

The LOS indicators were reviewed to determine if they support the City's vision, corporate goals, objectives and expectations of customers and stakeholders. Table 1-4 lists corporate documentation that provides guidance in the development of the Water

AMP. The City's organizational objectives translated into asset management objectives were identified in the SAMP. This section further elaborates on the alignment of the City's objectives with the development of the water asset management objectives.

3.1.1.1 Regulatory Requirements

The City of New Westminster must provide safe drinking water as regulated by the Province's Drinking Water Act. The Drinking Water Protection Act sets out criteria for drinking water operators to ensure provision of safe drinking water. Under the Drinking Water Protection Act New Westminster is required to obtain a permit from Fraser Health to operate a water distribution system and produce an annual report summarizing the water quality.

3.1.1.2 The City's Vision

The delivery of quality water services directly supports the City's Vision for a "healthy, inclusive and thriving community" as set out in the City's Official Community Plan (OCP).

New Westminster is a healthy, inclusive and thriving community where people feel connected with each other. This sustainable city showcases a spectacular natural environment, public spaces and unique neighbourhoods that are well-integrated and accessible. Superior urban design integrates its distinctive character, heritage assets and cultural identity. Growth and development provide a variety of services and employment opportunities that contribute to a high quality of life for all

3.1.1.3 The City's Community Goals

The City's Official Community Plan (OCP) identifies 12 goals to achieve the City's vision. Goal 12 relates to the City's utilities and service infrastructure, outlining reliable and innovative servicing.

12 UTILITIES AND SERVICE INFRASTRUCTURE

New Westminster has reliable and innovative servicing that efficiently and effectively meets the needs of the community and reduces impacts on the environment.

Goal 12: New Westminster has reliable and innovative servicing that efficiently and effectively meets the needs of the community and reduces impacts on the environment.

Policy 12.1: Plan, construct and operate City services in a manner that best serves the community while protecting public health and the environment.

Policy 12.2: Integrate stormwater management into the planning and design of buildings, infrastructure and open spaces.

Policy 12.3: Decrease the amount of waste generated and divert the maximum amount of material possible from the waste stream.

Policy 12.4 Provide the infrastructure that enables a digital economy.

This Plan...acknowledges the importance of utilities in supporting the health and well-being of the community and the natural environment. It also demonstrates the City's commitment to developing and implementing strategies to prepare for the effects of climate change.

This Plan also aligns with the Regional Liquid Waste Management Plan's directions towards managing stormwater by recognizing the targets established by New Westminster's Citywide Integrated Stormwater Management Plan, adopted in 2017. The Development Permit Areas included in this Plan make specific reference to the Integrated Stormwater Management Plan, which includes a Best Management Toolkit, since new development in will play a critical role in achieving the City's stormwater management targets.

Within the OCP, Policy 12.1 can be tied directly to the water utility, identifying the intent to "Plan, construct and operate City services in a manner that best serves the community while protecting public health and the environment."

3.1.1.4 The City's Sustainability Charter



The City developed ten (10) guiding principles within the City's Sustainability Framework, "Envision 2032" to help the City evaluate future decisions and initiatives with a lens on social, economic and environmental perspectives. The Envision 2032 framework is shown in Figure 3.2 which identifies the environmental and economic factors and further expands on social factors to include: Arts and Culture as well as Community, Liveability and Social Equality.

The Envision 2032 Guiding Sustainability Principles that were identified as being relevant to the water assets are included below:

- "Apply long-term thinking to all decision making;
- Minimize our ecological footprint, which is the total impact of our production and consumption activities on the earth, whether this takes place within or outside of the City;
- Support people with the resources they need to live more sustainable lifestyles and foster active participation in achieving the community's future vision together;
- Engage and enable community partners, including organizations, business, institutions and other levels of government, to work towards a common, sustainable future;
- Strive towards continuous measurable improvement in meeting sustainable objectives; and
- Institutionalize accountability and transparency in governance practices."

3.1.1.5 The City's Environmental Strategy & Action Plan

To support the environmental sphere of Envision 2032, the City developed the Environmental Strategy and Action Plan to guide the City's environmental protection and preservation. It was designed to provide current and future strategies for the City to achieve their path toward making "New Westminster one of the most sustainable urban cities in British Columbia", as described in the Plan.



The Water, Waste & Materials section of the plan identifies **Goal #9** to **"Maximize the conservation and protection of drinking water"** which is directly related to the water assets. This goal was designed to support the aim "to minimize our impact on the earth's natural resources and work towards a net-zero society."

Goal #9 identifies five (5) strategies and seven (7) actions. The 5 strategies are listed following with inclusion of the specific references to how these strategies relate to the water assets:

- Strategy 9.1 Improve residential water efficiency – measure water consumption on a sample group of single family homes via the use of water meters to better understand water us by this sector.

- Strategy 9.2 Reduce water use in City facilities and parks – conduct phased audits of its civic facilities and irrigated properties to identify system losses and opportunities for water use improvements; reduce water consumption for water main flushing.
- Strategy 9.3 Improve on-site water reuse in new multi-family or ICI developments – no direct correlation to water assets currently.
- Strategy 9.4 Improve landscaping and irrigation water efficiency – no direct correlation to water assets currently.
- Strategy 9.5 Improve water efficiency in business – no direct correlation to water assets currently.

The actions relevant to the strategies above are listed as follows:

- 9.1a. Implement measures outlined in the 2017 Assessment of Water Conservation Measures Council Report.
- 9.1b. Explore the use of water monitoring, pricing and enforcement.
- 9.2a. Conduct irrigation audit to identify measures to reduce water consumption and leakage.
- 9.2b. Conduct audits of City facilities and other operations to identify and implement water conservation measures.

3.1.2 Stakeholder Analysis

The stakeholder groups and their requirements are identified in Section 1.4. The stakeholders align with those identified in the SAMP and were further refined in the LOS Workshop held with the Working Group. The SAMP identifies that "a Stakeholder is any person or organization who can affect or be affected by a decision or activity carried out by the City." The internal and external stakeholders identified in Section 1.4 either affect or are affected by the water assets.

The SAMP describes that stakeholder analysis is the process of understanding the needs, requirements and expectations relative to each of the stakeholders' requirements.
Figure 3.3 identifies the levels of stakeholder engagement and the corresponding communication goals as shown in Table 32 of the SAMP.

Table 32 – Levels of Stakeholder Engagement

Level of Engagement	City Goal	City Promise	Level of Effort
Inform	To obtain balanced and objective information in a timely manner	"We will keep you informed"	Low
Consult	To obtain feedback on analysis, issues, alternatives and decisions	"We will listen to and acknowledge your concerns"	Low
Involve	To work with public to make sure that concerns and aspirations are considered and understood	"We will work with you to ensure your concerns and aspirations are directly reflected in the decisions we make"	Med
Collaborate	To partner with the public in each aspect of decision making	"We will look to you for advice and innovation and incorporate this in decisions as much as possible"	High
Empower	To place the final decision making in the hands of the public	"We will implement what you decide"	High

Figure 3-2
Levels of Stakeholder Engagement (from SAMP)

Stakeholder groups should be eventually "involved" in validating the levels of service defined within this AMP.

3.1.3 Identified Level of Service

The following service outcomes have been defined for this AMP:



These outcomes were defined by the Working Group through a comprehensive facilitated customer values exercise and mapped to existing objectives and performance frameworks.

Customer Values were defined by the Water AMP Working Group as part of the development of the Water AMP. The values align with the universal customer values identified in the SAMP Service Goals for the water assets were identified in the development of the Maintenance Management System Pilot for the Water Pilot in 2017. These Service Goals were further defined through the development of the Water AMP. The Service Goals and related customer values are included in Table 3-2.

Table 3-2
Service Goals, Customer Values, and Outcome Statement

Service Goals	Defined Water Service Customer Values	SAMP-Defined Customer Values	Customer Outcome Statement
Provide Reliable Service and Infrastructure	Reliability	Reliability	Water service is reliable and meets the current and future needs.
Meet Service Requirements with Economic Efficiency	Affordability & Long-Term Sustainability		Drinking water supply is cost-effective.
Provide a Safe and Productive Workplace	Safety Productivity	Safety	Water services are provided using safe work practice.
Have Satisfied and Informed Customers	Responsiveness, Customer Service & Reputation	Quality Accessibility	Provide exemplary customer service.

Service Goals	Defined Water Service Customer Values	SAMP-Defined Customer Values	Customer Outcome Statement
	Aesthetics		The water quality appears safe for consumption.
Protect Public Health and Safety	Regulatory Compliance Water Quality Fire Fighting Capacity	Quality Safety	Meet legislative water quality standards and have the ability to provide required fire fighting capacity. Customers are satisfied with the quality.

3.1.4 Investment Drivers and Levers

There are a number of internal and external key drivers that could impact the City's water service delivery. These drivers and TLOS impacts are identified below in Table 3-3.

Table 3-3
Drivers and Impacted TLOS

Drivers	Description	LOS Impacted
Climate Change	Can potentially impact on demand; summers will tend to be drier resulting in higher demand and less reservoir levels.	System flow and pressure
Legislative Changes	Legislation evolves which can impact water quality requirements, worker training and certification. The City will need to monitor and evaluate the impacts of the changing legislation as they are enacted. This involves federal, provincial, and regional legislation.	To be defined as legislative changes evolve
Growth	Although the City's OCP identifies the grown areas for redevelopment within the City, effective prediction of the growth rate and timeline within a service area is challenging. The growth rates and timelines are driven by market demand. Scheduled capital projects may need to be advanced to align with development projects.	System flow and pressure On-time delivery of projects and maintenance
Aging Infrastructure	The City's aging infrastructure has inherent risk as service levels may decline due to failure.	Systems Disruption / Interruption Breaks Leakages Emergency Repairs
Staff Retirement	Certified skilled labour is aging out of the workforce. In addition to the qualifications, tactic knowledge is also leaving with the retiring workforce. Both of these losses could create inefficiencies, additional investment in training and temporary gaps in available certified operators.	On-time delivery of projects and maintenance Available Resources
Social Equity	Access to clean, safe, drinking & fire fighting water for everyone in our community. Affordable housing is an ever growing concern in the City and a strategic priority. This priority may drive growth in neighbourhoods that support social housing, and require delivery of water upgrades and renewal to support growth and consistent delivery of water LOS.	On-time delivery of projects and maintenance System flow and pressure
Global Pandemic	During the COVID-19 global pandemic, the delivery of services had to be adjusted to protect the health and safety of the City workforce and public. The change in work processes have had impacts to the efficiency of delivery of the projects and could have impacts on available resources if staff got sick.	On-time delivery of projects and maintenance Available Resources

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3.2 LOS Measurement

3.2.1 Performance Measures for the LoS Framework

This section identifies the Customer Levels of Service (CLOS) and Technical Levels of Service (TLOS). TLOS measures which are based on the asset and operational measures required for the assets to support the CLOS. The TLOS originated from the Key Performance Indicators (KPIs) that the City identified through the National Water and Waste Water Benchmarking Initiative (NWWBI) program. The City's SAMP identified a number of examples of LOS Measures in the Water Asset Class.

3.2.2 Performance Legend

The following legend in Table 3-6 identifies the meaning behind LOS performance trend indicators.

Table 3-4
LOS Performance Trend Indicators

Symbol	Trend	Description
↗	Positive Upward Trend	Improvement in LOS is anticipated over the AMP's planning horizon, likely to result in a positive outcome for the City.
↘	Positive Downward Trend	
↗	Negative Upward Trend	Decline in LOS is anticipated over the AMP's planning horizon, likely to result in a negative outcome for the City.
↘	Negative Downward Trend	
↔	Consistent/Stable Trend (Positive)	LOS is trending consistently at the target level, and no changes are anticipated over the AMP's planning horizon.
↔	Consistent/Stable Trend (Negative)	LOS is trending consistently at an unacceptable level, and no changes are anticipated over the AMP's planning horizon.

3.2.3 Performance Metrics Dashboard (Framework Only – Data to be collected)

Table 3-5
Service Performance Metrics Dashboard

Service Outcome	Measure	Type	Supporting Asset	Metric	Target	Current	Trend
Reliability	Water Consumption	Technical	System	Average Residential Daily Consumption (L/Cap/day)			
	Unplanned Service Disruption / Outage (Average)	Customer	System	Total customer days without service/ total # of service connections (unplanned outages)			
	Planned Service Disruption	Customer	System	Total customer days without service/ total # of service connections (planned outages)			
	Systems Disruption / Interruption	Technical	System	Number of unplanned system interruptions/ 100 km length			
	Breaks	Technical	Mains	# of main breaks/100 km of length			
	Leakage	Technical	System	% water leakage total system			
	Leakage	Technical	System	% of inoperable or leaking valves			
	Leakage	Technical	System	% of valves cycled			
	Emergency Repairs: System	Technical	System Components	# of emergency repairs & replacements / 100 km of length (linear) or #			
	On-time delivery of projects and maintenance	Technical	System	% of projects and work orders delivered on time			
	Emergency Repairs: Service Connections	Technical	Service Connections	# of emergency service connection repairs & replacements / # of service connections			
	Metering Resources	Technical	Meters	# of in-house metering field FTEs/1000 meters			

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Service Outcome	Measure	Type	Supporting Asset	Metric	Target	Current	Trend
	All Resources	Technical	Linear	Total # of FTEs/100 km length (including metering, other operations)			
	O&M Resources	Technical	System	# of O&M FTEs/100 km length			
	Unplanned Maintenance	Technical	System	Total corrective maintenance hours/total maintenance hours			
	Systems Disruption / Interruption	Technical	System	Number of unplanned system interruptions/ 100 km length			
Affordability & Long-Term Sustainability	Water Rates	Customer	System	Water Rates			
	Unit Revenues Unit Costs	Customer	System	$/m^3 of water consumed by: System Type of Service			
	Aligned with Sustainability Targets	Customer	System	# of areas in the City where investment/timing is not aligning with sustainability planning			
	Reinvestment Rate	Customer	System	Capital and operating dollars invested back into infrastructure			
	Reserve Adequacy	Customer	System	Capital renewal reserves as a percentage of current replacement value			
	Aligned with Growth Plan	Customer	System	# of areas in the City where investment/timing is not aligning with planned and/or anticipated growth			
	Costs	Technical	System	Capital and Operating Costs '000/km length			

Service Outcome	Measure	Type	Supporting Asset	Metric	Target	Current	Trend
	O&M Costs: Linear	Technical	System	O&M Costs '000/km length for Pipes			
	O&M Costs: Metering/Hydrants	Technical	System	O&M Costs '000/# for Metering & Hydrants			
Public Health & Safety	Overall Water Safety	Customer	System	Performance in Annual Water Quality Report; Infractions as % of Total			
	Time-Loss Injuries	Customer	System	# of Time-Loss Injuries or # of Hours Lost due to Injuries	0	XX (Annual?)	
	Hydrant Outage	Customer	System	% of hydrants out of service			
	Sufficient Fire Flows	Customer	System	Residual pressure during max day or fireflow			
	Main Cleaning	Technical	Mains	% of Cumulative Main Length Cleaned			
	Hydrant Inspection	Technical	Hydrants	% of hydrants inspected & winterized			
	Hydrant Function	Technical	Hydrants	% of inoperable or leaking hydrants			
Regulatory Compliance	Water Quality Incidents / Rate	Customer	System	# of reported water quality incidents; per total customers			
	Other Key Regulatory Requirements	Customer	System	# of obligations met			

Service Outcome	Measure	Type	Supporting Asset	Metric	Target	Current	Trend
Aesthetics & Water Quality	Customer Complaints (Smell / Taste / Hardness / Color)	Customer	System	# of reported aesthetics complaints; per 1000 people			
	Customer Surveys (do not currently measure)	*Customer*	*System*	*Level of satisfaction (dependent on survey structure and availability)*			
	Customer Complaints	Customer	System	# of reported quality complaints; per 1000 people Track pressure complaints specifically			
	Boil Water Notices	Customer	System	# of boiled water notices			
	NWWBI Metrics (Various)	Technical	System	Detailed metrics include: • Turbidity • Total coli • Fecal coli • E. coli • THMs • Bromodichloromethane	See annual Water Quality Report	See annual Water Quality Report	
	Source Water Quality (MV Connection)	Technical	Water Quality Test Results	Source Water Quality (MV Connection)			
Responsiveness, Service & Reputation	Timely Connection	Customer		Average lead time to schedule service installs / water meters			
	Incident Response	Customer		Length of time to respond to incident			
Productivity, Efficiency & Employee Safety	Available Hours	Customer		Total Available O&M Hours/Total Paid O&M Hours			
	Overtime Hours	Customer		Total Overtime O&M Hours/Total Paid O&M Hours			

Service Outcome	Measure	Type	Supporting Asset	Metric	Target	Current	Trend
Environment	Water Conservation		System	Average Residential Daily Consumption (L/Cap/day)			

3.2.4 LOS Monitoring and Reporting

The LOS defined above have been identified by the Water AMP working group as the most relevant and meaningful measures by which to understand, monitor and manage the state of the water service. The majority of the KPIs above also align with NWWBI.

These KPIs will be measured on at least an annual basis to monitor trends in service and understand how successful implementation of the AMP is. Performance against these measures will be reported to the Manager, Infrastructure Planning, the City's Asset Management Steering Committee, the City's senior management and Council.

3.3 Demand Analysis

The goals of demand analysis within the Water AMP are listed as follows:

- Understand the trends of water use;
- Determine potential changes in the demand projections.

Future revision of the risk model should incorporate the future demands of the system.

3.3.1 Growth Projections

The City's SAMP identifies key growth statistics as reported from the OCP which are identified in Table 3-9.

Table 3-6
City Growth Statistics

	2016 (Actual)	2041 (Projected)	Percent Increase
Population	70,996	103,871	46%
Total housing units	32,705	48,088	47%
Total jobs	n/a	46,030	

The 2015 Utility Water Master Plan was also reviewed to identify projected trends in the demand condition of the existing and future system, and to identify planned projects meant to address growth and demand changes.

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The Plan identifies the future demand projections based on population growth with the assumption that there will be no change to the residential water consumption which is 235 L/cap/day for attached and detached single family and 224 L/cap/day for apartment multi-family dwellings, and a consistent demand of 90 L/cap/day was used for the industrial, commercial and institutional growth. The Plan identifies that there will be a 40% increase in total water consumption by 2041.

Figure 3-3 identifies the City's population compared to historical water consumption, as taken from the 2015 Utility Water Master Plan. This data suggests an overall decline in daily (per person) water consumption. Documenting and reviewing the average residential water consumption rate KPI will confirm this trend.

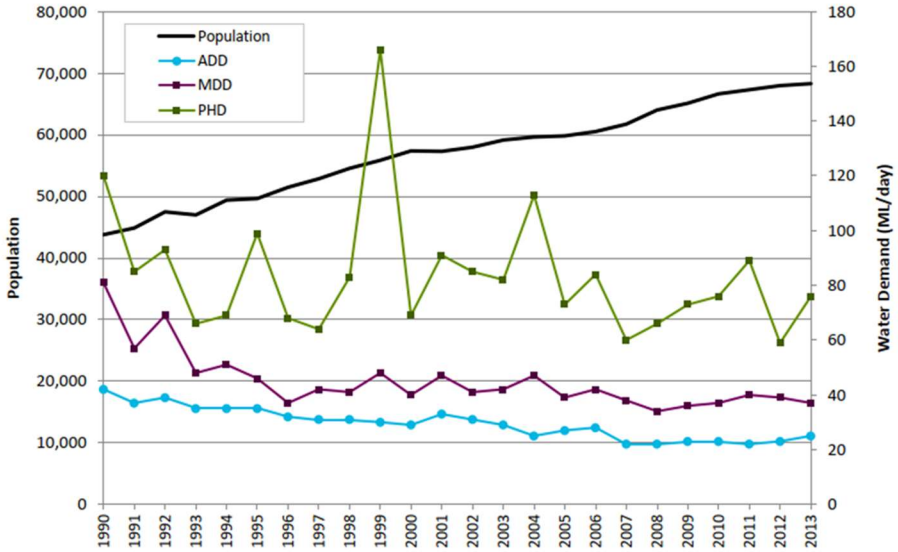


Figure 5-1: City of New Westminster Population vs. Water Consumption

Figure 3-3
City of New Westminster Population vs. Water Consumption, 2015 Utility Water Master Plan

3.3.2 Demand Measures

Demand measures relevant to the water assets include the following as listed in Table 3-10. These should be tracked and considered in future planning for the Water service.

Table 3-7
Demand Measures by Water Asset

Asset Categories	Demand Measures
Water System	• Ability to meet required fire flow • Ability to meet peak hour demand
Pressure Reducing Valve Stations (PRVs)	• Ability to meet adequate pressure
Water Meters	• Ability to accurately measure the total water consumed by the City. • Ability to accurately measure water consumption by customer type. • Ability to accurately measure water loss.

3.3.1 Demand Trends

Anticipated trends in demand include the following as listed in Table 3-11. These are likely to impact expectations for and actual delivery on LOS into the future.

Table 3-8
Anticipated Trends in Demand

Trend	Implications for Service Demand	Mitigation
Continued development and densification	Continued development and densification of housing will result in increased demand for capacity within the current water system, both for overall water service and for safety requirements such as increased fire flows.	This will necessitate more than ever the effective integrated planning of growth and capacity-related projects, as well as projects with other departments. Projects from the Utility Water Master Plan have been integrated into the ten-year capital plan. Additionally, a metering program is being implemented opportunistically with development, allowing for monitoring of water consumption, with the intention of conserving water.
Increasing regulatory pressure on water quality and environmental practices	While the City is not directly responsible for source water quality, it has some influence on quality as well as environmental outcomes. As the regulatory environment becomes more stringent in these areas, the City will need to respond appropriately.	Regulatory requirements are being measured and future requirements being anticipated. The City participates in industry and regulatory stakeholder engagement wherever possible.
Increasing requirements and costs from Metro Vancouver operations	The strategic and tactical plans of Metro Vancouver, in terms of capacity/demand, system functionality and condition, water quality, and other key aspects of water delivery, will have a direct impact on requirements for the City. In addition, Metro Vancouver operational practices will directly influence source water coming into the City system.	Depending on the specific impacts, the City may require additional interventions both in terms of operational and capital activities (e.g. additional flushing to address water quality and/or aesthetics concerns). The City may also need to consider additional costs that are driven as a result of system interplay with the broader Metro Vancouver water distribution system.

3.3.2 Meeting the Demands of Growth

The prioritized project list for the ten-year timeframe of the AMP, as defined in Appendix C defines both capital upgrade and renewal requirements. Capital upgrades are itemized based on recommendations from the Water Master Plan.

4 ASSET LIFECYCLE STRATEGIES

The following section outlines strategies and approaches for various aspects of the water infrastructure asset cycle.

4.1 Asset Renewal Forecast

4.1.1 Asset Renewal Methodology

The following methodology outlines how renewal projections were determined for the next ten years. Key renewal assumptions and projections are identified through this section and in Appendix B.

4.1.1.1 Estimated Asset Condition

There is no existing asset condition rating data to draw from for any of the asset classes. While there were main inspections done as a trial by GAME, these inspections apply to very few mains and did not assign a standardized condition rating to the mains inspected. Without assessed condition data to draw from, proxies for asset condition were used. Condition ratings were assigned to assets based on age and modified by number of main breaks for mains. The condition rating methodology is discussed in Appendix B.

A snapshot of the estimated asset condition profile for 2020 weighted by current replacement value (CRV) is provided:

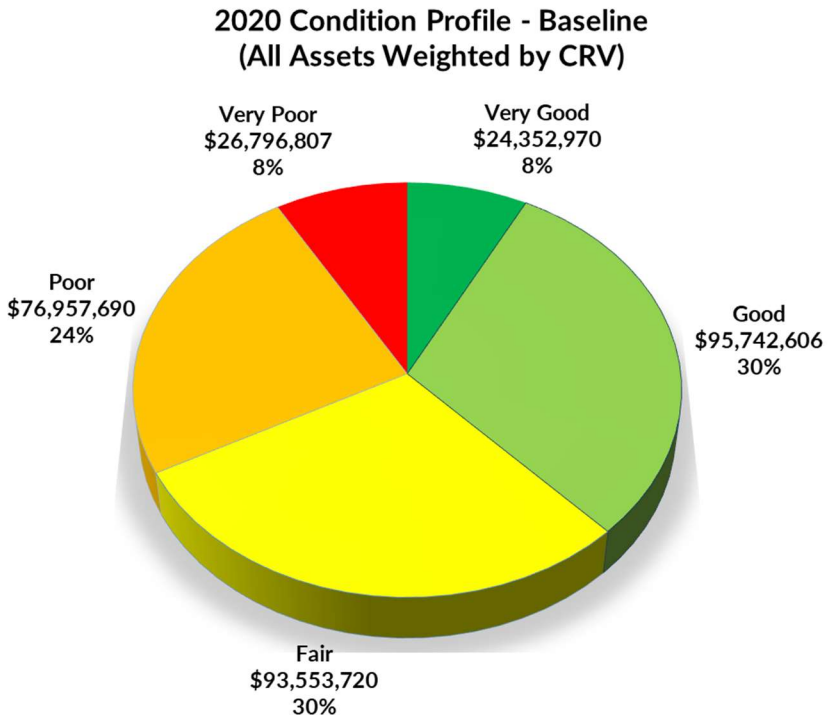


Figure 4-1
2020 Condition Profile

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The majority of assets are in “Good” or “Fair” condition. It is likely that asset condition throughout the portfolio is better than what is portrayed in this snapshot. Assets with unknown installation dates have received a condition rating of “poor” absent any information to the contrary. Given that a significant number of assets have unknown installation dates, this likely overweighs the “Poor” condition category.

4.1.1.2 Linear Asset Failure Curves

190 main breaks were recorded between 1980 and 2015. Main break data is of variable quality. After accounting for main breaks which do not have break dates, do not have installation dates for the main, and removing duplicates and errors, the number of breaks that could be used to construct empirical failure curves drops to 73. The majority of main breaks recorded are for cast iron mains, with ductile iron making up a small portion of the recorded breaks.

Due to the small sample size for ductile iron mains, empirical failure curves can not be created. Theoretical failure curves were created for each material type, drawing on input from the City’s main break data, theoretical models for mains failures, data from other cities, as well as SME input. It should be noted that theoretical failure curves may not adequately capture regional differences in expected main and lateral lives within New Westminster. Local soil conditions or groundwater levels could affect the rate at which assets deteriorate.

An example of a typical failure curve for a main with an 80-year expected service life is shown in Figure 4-2. Failure curves for each of the asset classes used in this AMP can be found in Analysis Workbook 2.

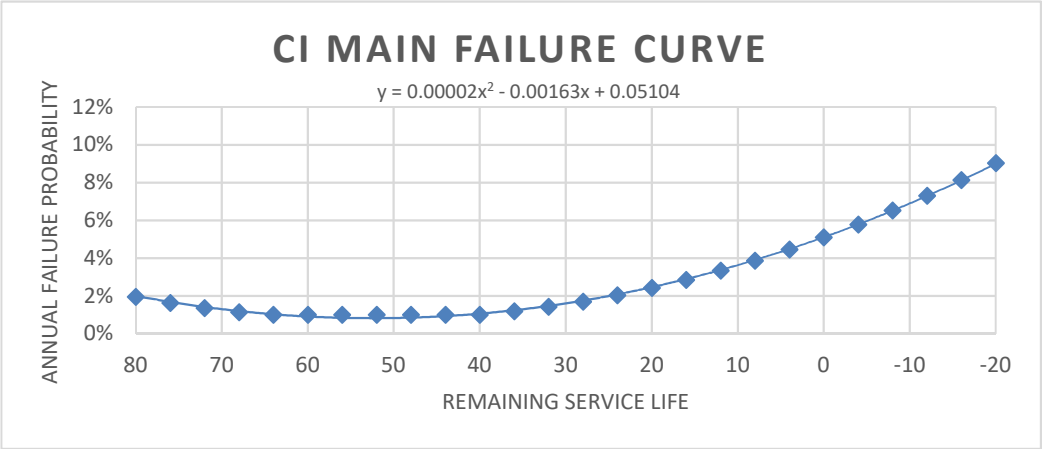


Figure 4-2
Example Failure Curve for Main with 80-Year Service Life

The empirical data for the City does not line up directly with the theoretical failure curves. This is largely because there is limited empirical data, particularly for older mains. This has the effect of underrepresenting failures for older mains. Ensuring that main breaks are captured and recorded accurately, particularly that failure dates and installation dates for the main are both recorded, would help increase the accuracy of these empirical failure curves, and improve the accuracy of theoretical curves.

It should be noted that many main breaks have incomplete descriptions. This makes it difficult to determine whether the main was repaired or completely replaced. More detailed descriptions of the breaks and the actions taken to fix them can help when determining timelines for replacements as well as inform their impact on condition ratings.

Lack of data for assets installed before 1930 makes it difficult to determine how many assets are nearing the end of their useful line in the next 10 years. This is particularly relevant for cast iron mains with expected service lives of 100 years.

4.1.1.3 Point Asset Failure Curves

Theoretical failure curves were constructed for point assets as well. These failure curves were likewise created from theoretical failure models for similar assets, data from other cities, and SME input.

An example of a typical failure curve for a hydrant with a 100-year expected service life is shown in Figure 4-3.

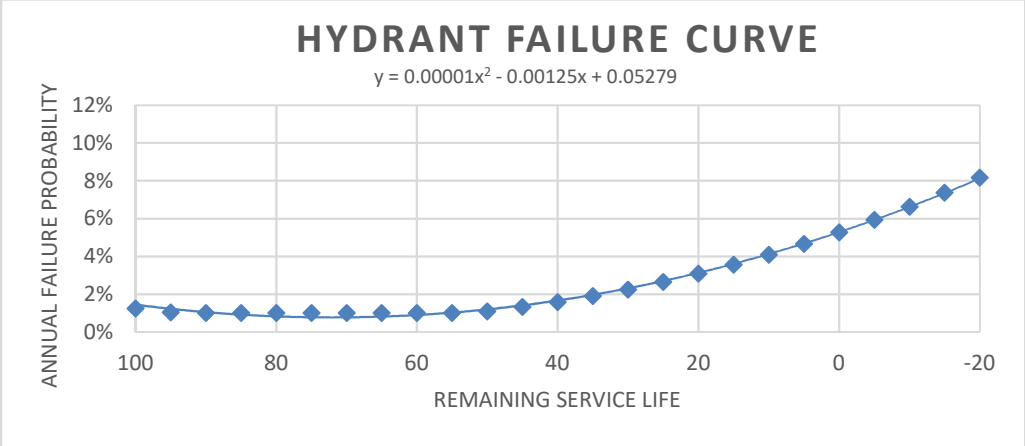


Figure 4-3
Example Failure Curve for Hydrant with 100-Year Service Life

4.1.2 Asset Renewal Forecast

There are $54.6 million in assets reaching the end of their service lives within the next 10 years. The spike in 2021 represents assets already past their service lives ("deferred renewal").

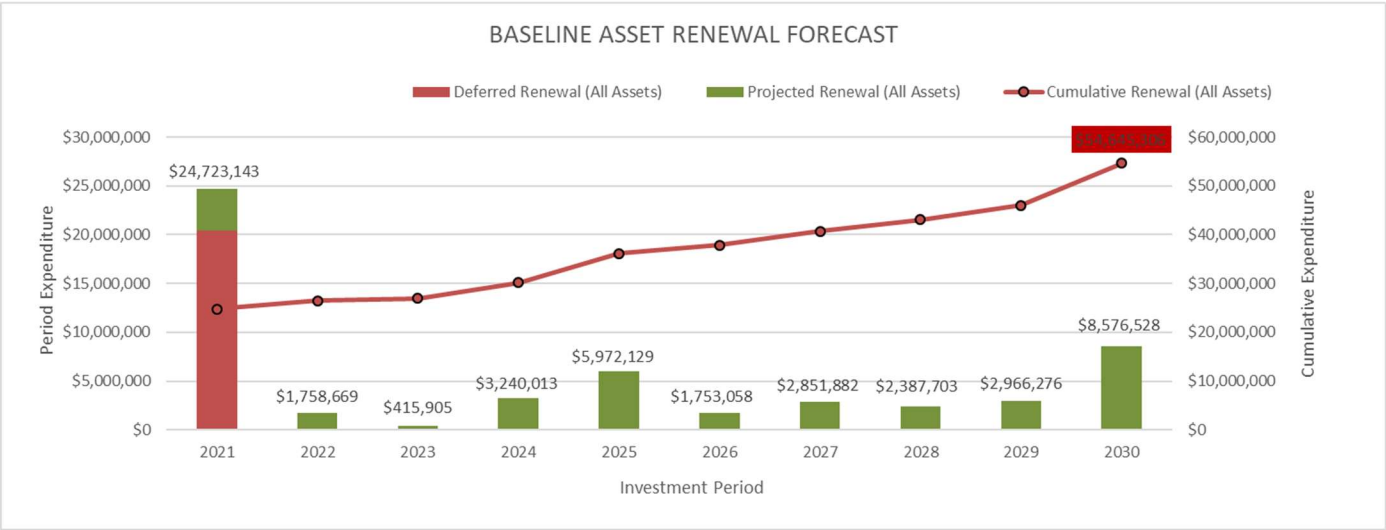


Figure 4-4
Baseline 10-Year Renewal Forecast

Accounting for 2021's budget being already in place at $4,275,800, levelling the renewal forecast over the 10-year period leads to a profile that averages out to nearly $5.5 million per year. Due to bundling of aligned projects, the anticipated potential spend could be up to $4.3 million in 2021.

Refer to appendix D for a list of all business units and programs included in the 2021 CAPITAL Budget. Of note, the following programs are captured within the $4,275,800 amount:

- Water Trench Restoration;
- Water New Hydrants (includes replacement); and
- Watermain Replacement.

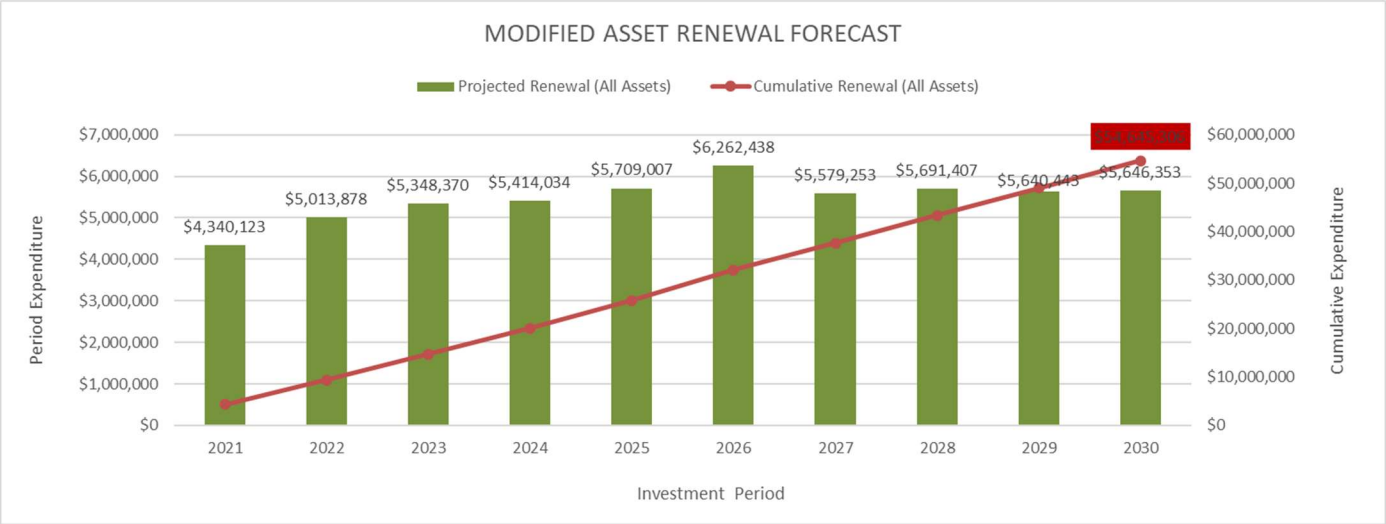


Figure 4-5
Modified 10-Year Renewal Forecast

This represents assets reaching the end of their service lives and requiring renewal by 2030. Reflected in this forecast is $3.4 million in assets reaching the end of their service lives by 2030, already listed for upgrades in the Utilities Master Plan.

A further $5.2 million in assets in the Utilities Master Plan are growth-driven projects not bundled with renewal needs and their value is not reflected in the renewal program in Figure 4-5. When undertaking upgrade projects identified in the Master Plan, some efficiencies may be found through combining renewal and upgrade projects.

Table 4-1
Capital Upgrade Projects Included in Renewal Forecast

Capital Projects included within 10-year Renewal Program 2021 to 2030		
Priority	**Length**	**CRV**
High	1,164	$1,104,868
Med	1,100	$577,743
Low	1,866	$1,601,165
Total	**4,130**	**$3,283,776**

As the system continues to age, the average condition of assets in the system will continue to deteriorate if assets are not renewed. If assets are not renewed, the average condition score of assets in the system will deteriorate from 3 to approximately 3.5 by 2030 and continue deteriorating to past 4 by 2050. If assets are renewed by the end of their service lives, the average condition will improve slightly and then remain between 2.5-3.

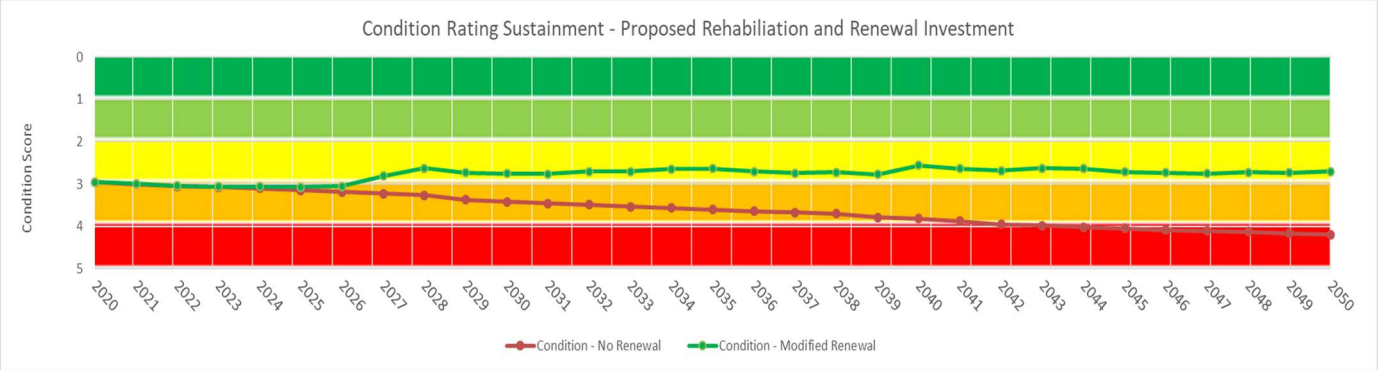


Figure 4-6
Average Condition Scores of Assets With and Without Renewal Over Time

The period of 2031-2040 is the period in which the largest number of assets reach the end of their service lives. In contrast, a smaller number of assets will reach the end of their service lives in 2041-2050.

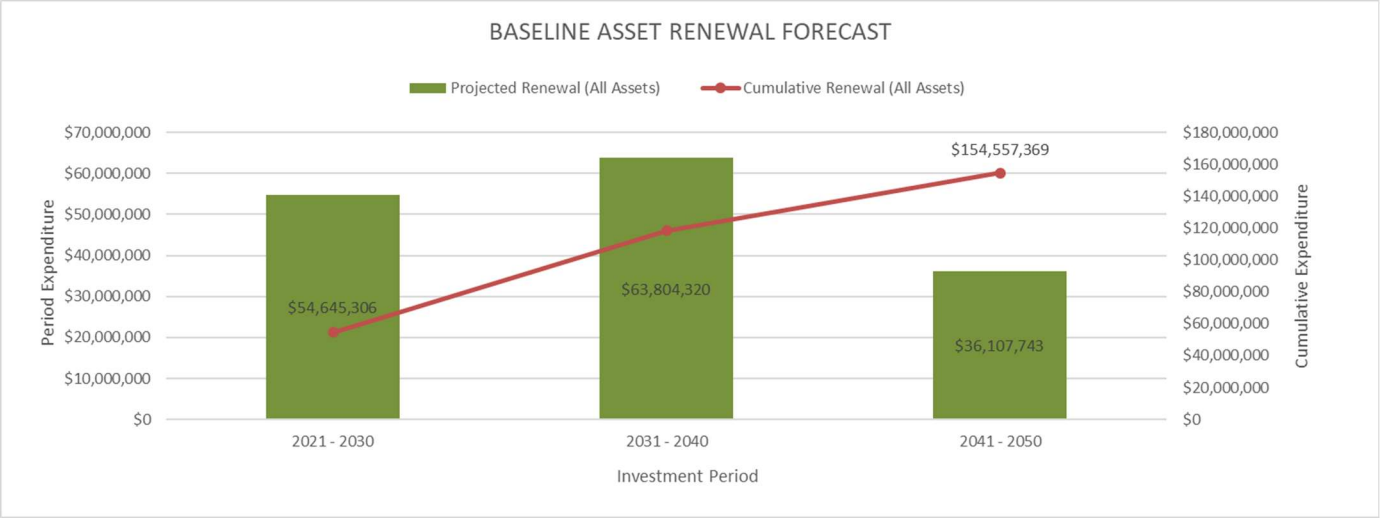


Figure 4-7
Renewal Forecast 2020-2050

This trend is in line with the share of mains reaching the end of their service lives. As mains make up the bulk of the replacement value of the asset portfolio, 2030-2040 will be the period of greatest replacement spending within this century.

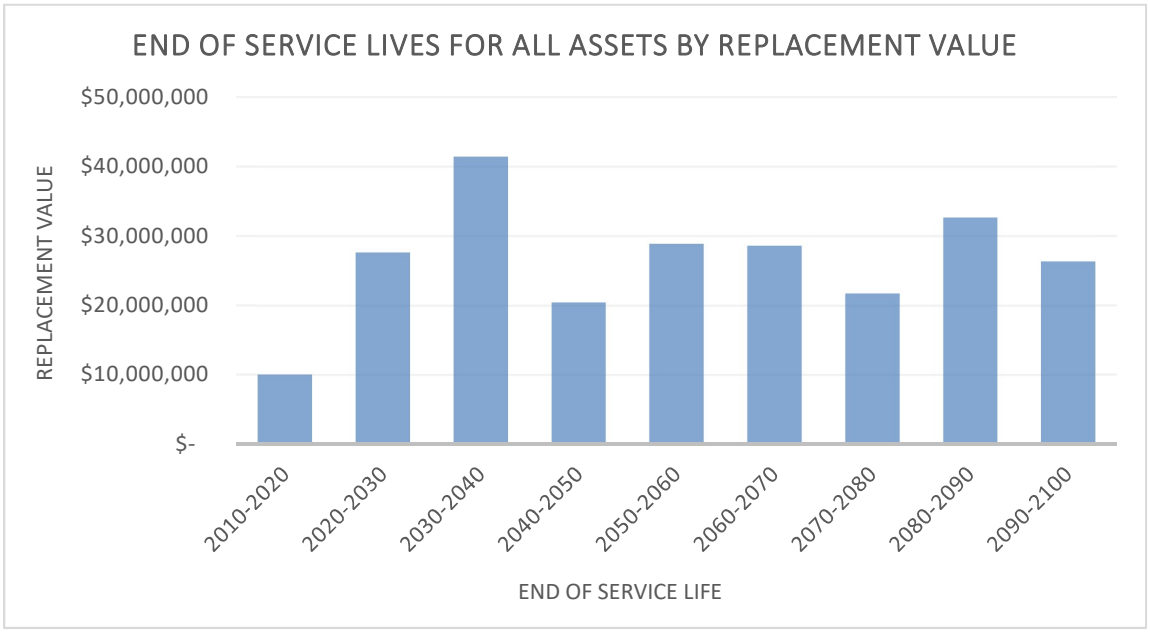


Figure 4-8
End of Service Lives for All Assets

4.1.3 10-Year Prioritized Project List

In addition to completion of this AMP, the team developed a 10-year capital project list that incorporates identified renewal requirements and identified projects from the Water Master Plan. Development of the of the ranked project list included identification of projects, bundling of aligned projects, and consolidation of the proposed work in a ranked list.

This work will drive capital planning for Water moving forward. Details on the approach for this list are included in Section B.6 of Appendix B. The prioritized 10-year project list was provided in a separate set of files, including an Excel-based list of proposed bundled projects and a set of GIS files that document the proposed projects spatially.

4.2 Demand Management

Based on the projections identified in Section 3.3 Demand Analysis, the need to meet future demand was translated into a set of capital projects for upgrades and upsizing. This is pulled directly from projects identified in the Water Master Plan.

4.3 Asset Operations and Maintenance

A maintenance review conducted in 2017 outlined a set of key maintenance and operational activities that are regularly undertaken, published as the draft report for the Maintenance Management System Water System Pilot. This review resulted in an estimation of required FTEs for the previous and upcoming years of the review, which should be continuously validated and assessed on an annual basis. This document is saved internally as EDMS #1157958 and EDMS #1293228. This document is attached separately as Appendix F.

Maintenance efforts were analyzed based on the following categories of asset classes and functions:

- Mains;
- Valves;
- Hydrants;
- Service Connections;
- Meters;
- PRVs;
- Customer Service;
- Capital Works;
- Development;
- Third Party; and
- Overhead Hours

This work was an hours-based analysis based on available work management data. In the future, this could be analyzed iteratively based on documented work and hours in the Cityworks system through documentation of Equipment, Labours, and Materials (ELM).

Analysis of historical spend on operations and maintenance activities is provided in **Section 6: Financial Strategies**. Because this information was generated through the core financial system JD Edwards, the categorization is not exactly equivalent. However, the financial data has been segmented into similar categories.

4.4 Non-Asset Solutions

The following non-asset solutions should be highlighted for consideration during future iterations of the AMP:

- Continuous review of emerging climate change and asset resiliency practise and strategies by the industry;
- Non-asset strategies: policy, advocacy and education programs to promote appropriate water usage/demand strategies and appropriate use of and expectations for water assets;
- Considerations for Water Supply requirements and/or Metro Vancouver considerations; and
- Update of the Risk Model for the water system.

5 RISK & UNCERTAINTIES

Understanding the risk and uncertainties that infrastructure assets may experience throughout their lifecycle is essential to successfully managing assets. This section lays out risk theory that should be used as a guideline for a revised risk model for the water assets, as well as the identification and evaluation of enterprise-level risks.

5.1 Introduction to Risk Management

The level of risk is identified through defining the likelihood and consequence of an impact from a potential uncertainty. In very broad terms risk can be simplified as:

Risk = Likelihood x Consequence

Asset risk is derived from understanding **remaining life** and **asset criticality** and should be the primary decision-making criteria for determining asset interventions.

The **remaining life** of existing assets may be used as an indicator of **likelihood** of asset failure which can be based on asset age or condition. The older an asset, the more likely it is to stop working or fail to provide acceptable service.

Asset criticality is an indicator of the importance of an asset in relation to the level of service objectives. The **criticality** of the asset can be used as an indicator of **consequence**. A more critical asset is one which is more important and if it were to fail, it would significantly impact service to the community.

This section follows the six-step risk management process as outlined in the SAMP:

1. Risk Context
2. Risk Identification
3. Risk Analysis
4. Risk Evaluation
5. Risk Treatment & Control
6. Risk Monitoring & Review

5.2 Risk Context

Understanding the risk landscape in context of what the City is trying to achieve is the first component to realizing an effective risk management methodology. Figure 5-1 shows Change Model #4 from the SAMP, which describes the City's existing Risk Context. The SAMP resulted in development of a preliminary risk framework for the City, which was to be pilot tested in accordance with the Figure below.

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Case Study	Change Model	Description
The "Problem"	Current State	• Individual departments do not currently document asset specific risks • Asset risks are addressed intuitively/subjectively by each department • There is no formal risk treatment plan • Residual risk has not been quantified
The "Solution"	Transition State	• Pilot testing of the risk framework within one of the service areas
	Future State	• A fully developed and operationalized risk framework consistent across service areas that is used to make risk-based decisions • Criticality scores are assigned to all assets and consistently recorded in GIS
The "Outcome"	Benefits	• To mitigate risk • To improve operational efficiencies • To treat/control and monitor risk

Figure 5-1
Change Model for the City's Existing Risk Framework

This change model will be used to drive improvement actions in Section 7. At the time of writing of this AMP, the risk framework had not yet been pilot tested within one of the City's service areas. This AMP provides an initial opportunity to test and adjust the framework.

As described in the SAMP, Risks may be categorized into the following two types of risk:

1) **Asset Risk** which includes items such as equipment failures, warranty failures, deferred maintenance backlogs, vandalism, injuries, inclement weather, service interruptions, etc.
2) **Enterprise Risk** which includes items such as seismic events, pandemics, strikes, acts of war, dissatisfied stakeholders, reputational damage, etc.

5.3 Risk Identification

The Water AMP Working Group may wish to host an annual "Risk Review" to capture risks into the Risk Register and jointly discuss the implications and likelihood of risks in context of the City. Risks should be assessed every 5-years to identify changes in risk.

Table 5-1 and Table 5-2 provide preliminary lists of sample Asset Risks and Enterprise Risks.

5.3.1 Asset Risk in Current Iteration of the AMP

Evaluation of risk specific to individual assets was provided in the lifecycle analysis (see Appendix B) as much as is possible with existing data. The lifecycle analysis identifies specific risks related to the following water assets:

- Linear water infrastructure including water mains and laterals; and
- Point assets such as PRV stations, valves, hydrants, and zone and residential and ICI meters.

As identified above, the City plans to revise its Water Asset Risk Model in alignment with the SAMP Risk Framework.

Examples of asset risks and related risk events to be considered in a future risk exercise are provided in Table 5-1.

Table 5-1
Preliminary Asset Risks

Asset Class	ID	Type of Risk Events	Cause (due to…)
Water	WA.1	Water supply loss.	Equipment failure or water main break.
	WA.2	Poor water quality.	Turbid water from main replacement. Deficient chlorine residual from defective monitoring equipment. Contamination due to tampering and system failure.
	WA.3	Equipment failure.	Inadequate preventative maintenance.
	WA.4	Service interruption.	Unplanned maintenance work (emergency repairs).
	WA.5	Major failure such as a main break.	Age and condition of infrastructure.

5.3.2 Enterprise Risks

The Enterprise Risks are related to the water system overall. These risks were generated through a risk identification exercise and validated by the Water AMP Working Group. Through identification of these risks, improvement plan options were developed, which are identified in Section 5.5 Risk Treatment & Control and Section 7 Implementation & Continuous Improvement. These mitigation options need to be considered in future business and strategic planning exercises.

Table 5-2
Preliminary Enterprise Risks

Service	ID	Type of Risk Events	Cause (due to…)
Water	WE.1	Do not achieve water conservation targets.	Inability to implement water conservation initiatives such as the residential metering program due to limited resources.
Water	WE.2	Unexpected increase in operating costs.	Increase in MV charges and market inflation. Note this expense is currently ¾ of City's annual utility expenditure.
Water	WE.3	Increase to capital expenditure.	Regulatory Changes for soil remediation. E.g. req. main replacement due to soil contamination from chlorine.

Service	ID	Type of Risk Events	Cause (due to…)
			Market conditions.
Water	WE.4	Inadequately trained staff lead to inefficiencies and accelerated asset failures.	Staff require EOCP Operator Training Certificate Upgrading.
Water	WE.5	Inaccurate replacement costs.	Increase in construction costs have made it difficult to estimate replacement costs. Lack of construction pricing data.
Water	WE.6	Major failure such as a main break.	Due to seismic activity. Due to third party accidental hits.
Water	WE.7	Inadequate data management practice.	Inadequate data and knowledge management practices in terms of data capture, storage, maintenance and retirement in CityWorks, GIS or the Financial system, e.g. inaccurate asset cost data when using historical asset costs compared to recent cost data. e.g. outdated GIS due to time lapse between completed constructed work and updating the GIS dataset. In many cases, attribute data is missing, which has potential to lead to inaccurate analysis on future needs.

5.4 Risk Analysis

Risk analysis requires consideration of the causes of risk: likelihood of occurrence and consequence of occurrence. The consideration of existing controls will also support the determination of likelihood. Determining the level of risk will enable the City to develop treatment and control to mitigate those risks.

5.4.1 Risk Equation

The risk equation can vary based on the degree of sophistication applied to the City's assets. The SAMP recommends that the risk equation will be kept to a "Level 2 complexity" which sums up the value of the consequences, as follows:

Risk = Likelihood x Σ Consequences

Due to lack of available consequence data across all consequence categories, a "Level 1" complexity was employed, as follows:

Risk = Likelihood x Highest Consequence

Because the available data with respect to consequence is largely focused on financials, summing the value of consequences was not a useful exercise for this iteration of the Water AMP. In order to move to a "Level 2" complexity, a risk study would need to be conducted in order to assign consequence across all categories.

5.4.2 Determining Likelihood

The potential likelihood of an impact is traditionally determined by a frequency-based determination, i.e. "how likely will the asset be affected?" The frequency of occurrence is graded on a scale of 1 to 5 as defined in Table 5-3, as guided by the SAMP. The Likelihood Scale identifies how likely an event is expected to occur.

Table 5-3
Likelihood Scale

Likelihood		Score	Description
Almost Certain	≥90%	5	Very high probability that risk will occur in the next 36 months
Likely	≥70% to <90%	4	High probability that risk will occur in the next 36 months
Possible	≥25% to <70%	3	Moderate probability that risk will occur in the next 36 months
Unlikely	>1% to <25%	2	Low probability that risk will occur in the next 36 months
Rare	≤1%	1	Very low probability that risk will occur in the next 36 months

5.4.3 Determining Consequence

Consequences or impacts of risks can be determined also on a 1 to 5 scale as defined in Table 5-4. Assets with a significant consequence in the event of failure are considered critical assets.

The City has identified six (6)[21] types of consequences:

1. Financial
2. Health & Safety
3. Availability/Reliability
4. Legislation
5. Environment
6. Corporate Image

These consequence categories are pulled directly from the City's SAMP, except for "Corporate Image" which the City has added as a result of Working Group discussions during AMP development.

[21] Items 1-5 reflect the SAMP and Item 6 incorporates "Corporate Image", as identified in the Asset Management Program Phase III Summary conducted by Urban Systems in 2007.

Table 5-4
Consequence/Impact Matrix

Consequence Categories	1 Insignificant	2 Minor	3 Moderate	4 Severe	5 Catastrophic
Financial	Damages, losses (including 3rd party) or fines less than $10,000	Damages, losses (including 3rd party) or fines $10k to $100k	Damages, losses (including 3rd party) or fines $100k to $500k	Damages, losses (including 3rd party) or fines $500k to $1M	Damages, losses (including 3rd party) or fines greater than $1M
Health & Safety	No impact to health and safety	Minor injury or illness without lost time	Illness/injury resulting in lost time	Illness/injury resulting in permanent or long-term disability	Illness/injury resulting in fatality
Availability/ Reliability	Small number of customers experiencing disruption/impact (less than 100 people or up to 2 hours)	Localized service disruption/ impact (100 to 500 people or up to 1 day)	Significant localized disruption/impact (500 to 1,000 people or up to 1 week)	Major service disruption/impact (1,000 to 5,000 people or up to 2 weeks)	Organizational wide service disruption/impact (greater than 10,000 people or loss of services for longer than 2 weeks)
Legislation	No expected violations of regulations, Acts or bylaws	Potential verbal or written warnings/notices	Compliance orders or notice of violations	Potential for charges to individuals or the Corporation	Numerous charges to individuals or the Corporation or labelling as a repeat offender
Environment	Very negligible impact or can be restored within 1 week	Material damage/ improvements of local importance. Minor, short term (within 1 month) very isolated damage/ improvements to the environment	Significant short term (up to 2 months) local damage/ improvements to the environment	Significant long term (up to 1 year) widespread damage/improvements to the environment. Some Provincial importance.	Major long term (greater than 1 year) or permanent widespread damage/improvements to the environment. Federal importance.
Corporate Image	Event only of interest to individual. Nil effect or community concern	Minor community interest. Local media report	Public community discussion. Broad adverse media coverage	Loss of confidence in Council. National publicity. Public agitation for action.	Public investigation. International coverage. Management changes demanded

5.4.4 Criticality

Urban Systems conducted a study with the City's Water team in 2007 to assign criticality values to watermains. Urban Systems used a methodology which incorporated Financial, Loss of Service, Safety & Health, Environmental, and Corporate Image considerations to assign mains a criticality rating of "Low", "Medium", and "High". For mains that were built before the Urban Systems study, criticality is captured directly. For new mains which replaced mains in the Urban Systems study, the criticality of the nearest main is used and criticality is flagged as an estimate.

A small number of mains were new developments, primarily mains in two neighborhoods: the eastern end of Queensborough and a new development south of Glenbrook Ravine Park. These are residential areas, and the mains surrounding them are flagged as being "Medium" criticality. Mains in these neighborhoods are assigned a "Medium" criticality score and are flagged as an estimate.

The ranked 10-year prioritized project list used the 2007 Water Risk Model (Appendix G) as secondary criteria for ranking projects.

5.4.5 Risk Matrix

The level of risk is determined through plotting the Likelihood against the Impact/Consequence. The level of risk determines the risk tolerance strategy. Figure 5-2 as copied from the SAMP identifies the Risk Exposure Matrix.

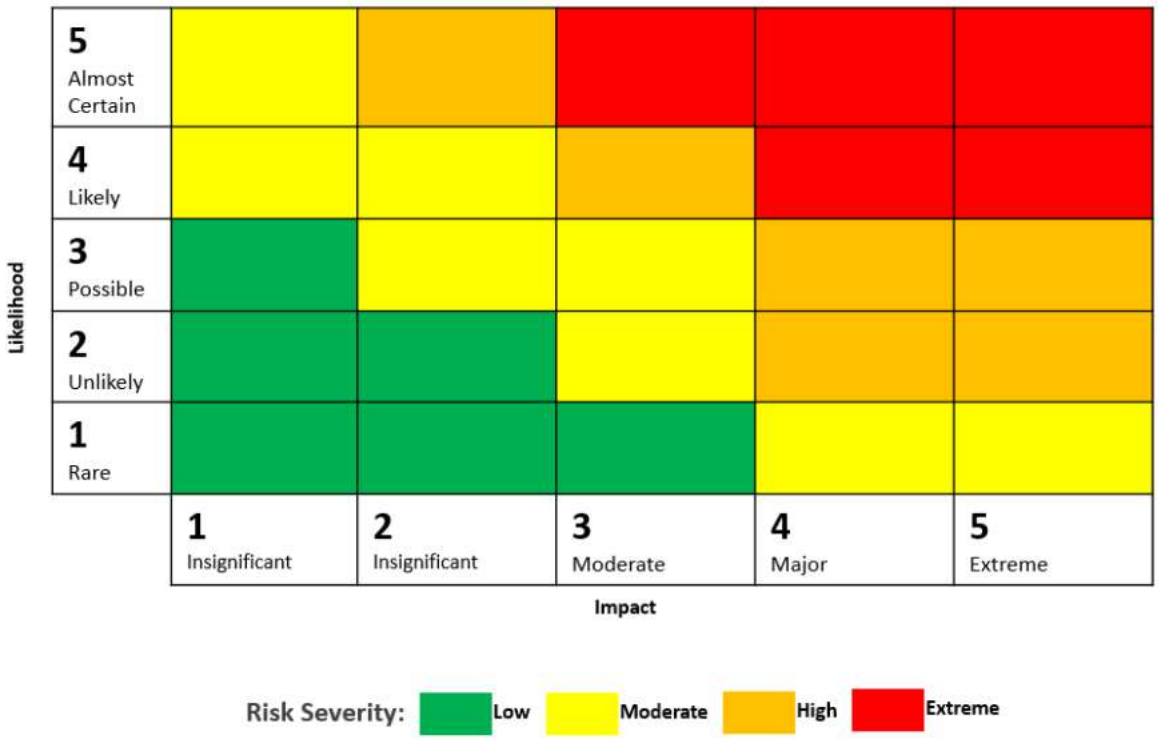


Figure 5-2
Risk Exposure Matrix.

The level of tolerance to a risk helps in the development of the risk management response measures and the balancing of the risks to the asset against the risks to the service. Table 5-5 identifies the tolerability of the risk scale.

Table 5-5
Risk Tolerance Zones

Level of Tolerance	Description
Extreme Risk	The risk is intolerable and must be reduced. The potential for failure must be addressed as a high priority.
Major/High Risk	The risk is manageable, but consequences are experienced upon failure. Monitoring and maintenance actions are required.
Moderate	The risk can be tolerated if it is as low as reasonably practicable. If a cost-effective action can be identified to reduce the risk, then it should be implemented.
Low	The risk is acceptable provided there are replacements and contingencies in place to ensure smooth operations. Run to fail strategies may be provided for non-critical assets.

5.5 Risk Evaluation

Risk evaluation is the review of the identified risk tolerances as presented in the previous section. Actions to manage risks should consider the overall management of the services, not just the minimisation of risk to an asset. If possible, proposed actions should align with other initiatives to:

- Reduce capital investment costs;
- Reduce operating and maintenance costs;
- Reduce business risk exposure;
- Increase effective asset life/value; and
- Sustain or enhance level of service.

The risk information in the Risk Register can be used to prioritize investment needs within the Water Asset Class. High risk assets with very low or negative remaining life should be prioritized for asset replacement. This iteration of the Water AMP will only identify mitigation or treatment actions related to Enterprise Risks. Interventions are provided in the Lifecycle Model for Asset Risk, based on available information.

5.5.1 Risk Snapshot - 2020

Making use of the City's likelihood, consequences, and risk matrices, the vast majority of assets in 2020 fall between low risk and moderate risk.

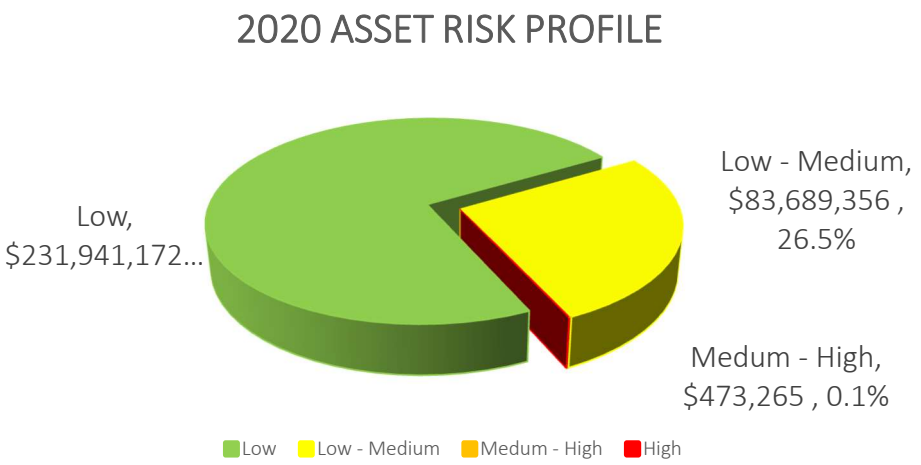


Figure 5-3
2020 Asset Risk Profile

This is largely a result of the definition of likelihood (Table 5-3) and consequences matrices (Table 5-4). Given that the vast majority of assets in the inventory have values below $500,000, consequences of failure rarely exceed a consequence rating of "3". Likewise, given that the majority of assets with the exception of residential water meters have long expected service lives, the 36-month risk of failure for any given asset is nearly always less than 25%, even at the end of service life. As a result, the likelihood ratings rarely exceed "2".

While using these matrices allows for comparisons between assets in other departments, for decision-making purposes it is more useful to examine the relative position of assets with each other in the Risk Register rather than relying on their absolute risk scores.

5.5.2 Risk Evaluation

Risk evaluation is the review of the identified risk tolerances as presented in the previous section. Actions to manage risks should consider the overall management of the services, not just the minimisation of risk to an asset. If possible, proposed actions should align with other initiatives to:

- Reduce capital investment costs;
- Reduce operating and maintenance costs;
- Reduce business risk exposure;
- Increase effective asset life/value; and
- Sustain or enhance level of service.

5.6 Risk Treatment and Control

Risk Management should be explored further during the development of an updated risk model. The general steps to assess risk are:

- Identify risks to be treated and map defined treatments against them, including elimination of cause, reducing likelihood or consequence by managing risk drivers, sharing, transferring, insuring, outsourcing, etc.
- Identify risk controls to be put in place on an ongoing basis.
- Discuss business continuity / recovery procedures and any gaps / improvements.
- The consideration of risk treatment options will depend on the root cause of the risk. Risk treatment options will include the elimination of the causes of risk, reducing the likelihood or consequences of risk, sharing or transferring the risk to other parties through outsourcing or insuring against the risk or simply accepting the risk.
- The nature of the risk together with an understanding of likelihood and probability will help determine the appropriate strategy to apply to modify the risks. Examples are listed as follows:

High Consequence but Very Low Likelihood Risks – These are typically disaster scenarios, such as earthquake, wildfire in populated areas, outbreak of illness, or loss of water supply. For these risks, contingency plans or emergency plans should be established that will reduce the consequences of the risk.

High Consequence and High Likelihood Risks – These are the highest category of risk and should be eliminated or reduced to a tolerable level. These risks will often require capital interventions, such as upgrading of a water treatment plant, fencing, fire breaks/fire smarting activities, or upgrading of infrastructure.

Low Consequences but High Likelihood Risks – These are often about working practices and may require changes to working processes and procedures including potentially outsourcing work to a third party who is better able to manage the risk.

Low Consequence and Low Likelihood Risks – These risks may be recognized and accepted with no further action other than monitoring the risk through regular review.

The success in implementing the strategies developed will be dependant on the City's capacity to be resilient. Table 5-6 identifies generic risk treatment options, as presented in the SAMP. Also identified in this table are each of the seven (7) Enterprise Risks that might be mitigated through the identified options.

Table 5-6
Preliminary Risk Reduction/Treatment Options

	Risk Reduction/Treatment Options	Reduce Likelihood	Reduce Consequence
1	Asset renewal	●	
2	Asset rehabilitation	●	
3	New redundant asset		●
4	Enact Policy	●	
5	Develop Standard Operating Procedures (SOPs)	●	●
6	Rigorous maintenance program	●	
7	Enhanced monitoring regime	●	
8	Contingency planning	●	●
9	Staff training	●	●
10	Signage	●	
11	Critical spares inventory		●

Corresponding Risk Treatment Options were developed for the Enterprise Risks, validated by the Water AMP Working Group. Table 5-7 identifies specific treatment options for each Enterprise Risk.

Table 5-7
Enterprise Risk Treatment Options

Asset Class	ID	Type of Risk Events	Risk Treatment
Water	WE.1	Do not achieve water conservation targets.	Propose and implement water conservation initiatives, such as individual water meters to monitor water usage.
Water	WE.2	Unexpected increase in operating costs.	Negotiate fixed long-term fees and adjust water rates to accommodate increase, when possible. Communication with Metro Vancouver regarding proposed rate increases. Propose gradual rate increase as early as possible.
Water	WE.3	Increase to capital expenditure.	Prepare financial plan for future water main replacements based on recent main replacement costs that includes materials and labour.
Water	WE.4	Inadequately trained staff lead to inefficiencies and accelerated asset failures.	Plan funding required for training on an on-going basis.

Asset Class	ID	Type of Risk Events	Risk Treatment
Water	WE.5	Inaccurate replacement costs.	Maintain a summary of recent constructed works to better estimate future replacement costs. Obtain more data from other municipalities.
Water	WE.6	Major failure such as a main break.	Consider adding redundancy into the system.
Water	WE.7	Inadequate data management practice.	Set up business process whereby new or changed assets are updated in each of the related information systems within a specified timeframe.

5.7 Risk Monitoring and Review

Monitoring and reviewing risk levels, emerging risks and risk trends is important to manage uncertainty in the delivery of water services. In addition, actions and controls to address risks should be monitored and reviewed for effectiveness. The review process will also require consideration of lessons learned when risks materialize.

The Water AMP Working Group may wish to host an annual "Risk Review" to capture risks into the Risk Register and jointly discuss the implications and likelihood of risks in context of the City. Risks should be assessed every 5-years to identify changes in risk.

In addition to identifying the risks, the use of a Risk Register identifies the implications of likelihood of risk. It provides actions and indicators to drive and monitor progress. The following items are included in the Risk Register:

- **Inherent Risk:** The likelihood and impact of the risk *without* controls in place.
- **Current Risk:** The likelihood and impact of the risk *with* controls in place.
- **Mitigating Controls:** Identify controls currently in place to mitigate the risk. These controls should be working practices or procedures, checks, alarms, or alternative arrangements.
- **Action Plan:** Determine what can be done to further mitigate the risk.
- **Monitoring:** Identify if and how the risk needs to be monitored and identify if it needs to be reported.
- **Status of the Action:** Identify if the controls are proposed or in progress.

5.8 Risk Applied within the Renewal Forecast

The renewal forecast incorporated risk methodology in the following manner:

- Consequence of failure: Primarily based on financial consequence of replacing end-of-life assets; and
- Probability of failure: Defined through theoretical failure curves alongside a limited set of watermain break data.

The ranked 10-year prioritized project list used the 2007 Water Risk Model (Appendix G) as secondary criteria for ranking projects.

6 FINANCIAL STRATEGIES

6.1 Financial Policies and Rules

The setting of the annual budget, 5-year rates, and funding forecast are guided by the following financial sustainability principles:

- **Sustainable:** Maintain assets in a state of good repair through reasonable tax/rate hikes without disruptions to services; living within our means;
- **Adaptable:** The ability to change debt levels or leverage reserves; ability to ramp up or down on spending;
- **Stable:** Predictability of the City's sustainable revenue sources, and less reliance on external funding and third-party funding; and
- **Accountable:** Fiscally prudent and responsible; the ability to ensure that the City's financial decisions are in the best interest of all.

Long-term financial planning, 5 Year Financial Plan Bylaw and annual budgeting for the operating and capital budgets processes:

- 30 Year Vision: guided by the City of New Westminster OCP, AMP and strategic choices about investments, a high-level financial model is created which sets the minimum/maximum levels for reserve and policy
- 5 Year Financial Plan Bylaw: from the 30 Year Vision forecast short-term priorities for projects/program spending; forecast rates and other funding sources; create a detailed financial model
- 1 Year Budget (Operating and Capital): starting with the 5 Year Financial Plan, identify the projects with detailed information on the outcomes, estimated spends, delivery strategy and net operating budget enhancements – seek council approval for the projects and associated rate/funding strategy.

The City of New Westminster community plan and the asset management plan, along with the water purchase costs (Metro Vancouver levy) and consumption estimates, any inflationary pressures/efficiency gains from market pricing and/or internal labour costs, provide city finance staff with the critical information to create the water rate outlook and define the minimum requirements for a water infrastructure/price stabilization reserve that is sustainable for the longer-term.

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6.2 Historical Analysis – Capital Expenditure

6.2.1 Historical Capital Spend (CAPEX)

The following chart demonstrates the actual capital yearly spend for renewal and upgrade projects.

Please note that values shown in Figure 6-1 include DCC projects which are partially funded through the DCC program. The implementation of DCC projects are dependent on the development.

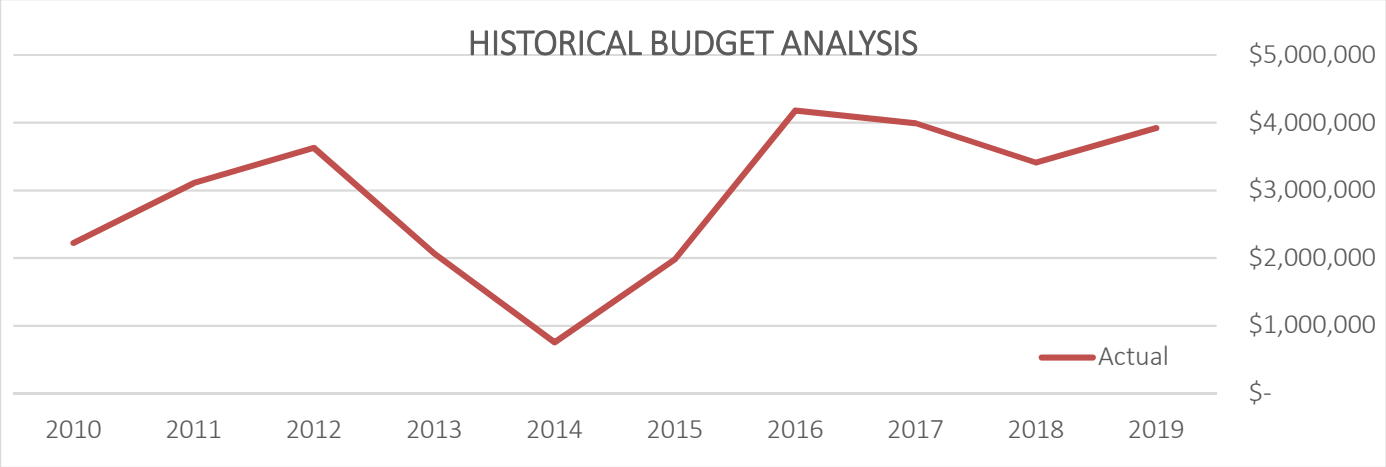


Figure 6-1
Historical Capital Budget Analysis

6.2.2 Historical Funding Sources

As demonstrated by the following chart, the use of funding sources varies on an annual basis.

The use of Development Cost Charges (DCCs) is for strictly growth-driven expenses and is used only in years in which development-related water system upgrades are completed (last used in 2010). The City also makes use of third-party contributions. The primary funding source annually is the Water Reserve, which is funded by water user fees and water fund operating surplus.

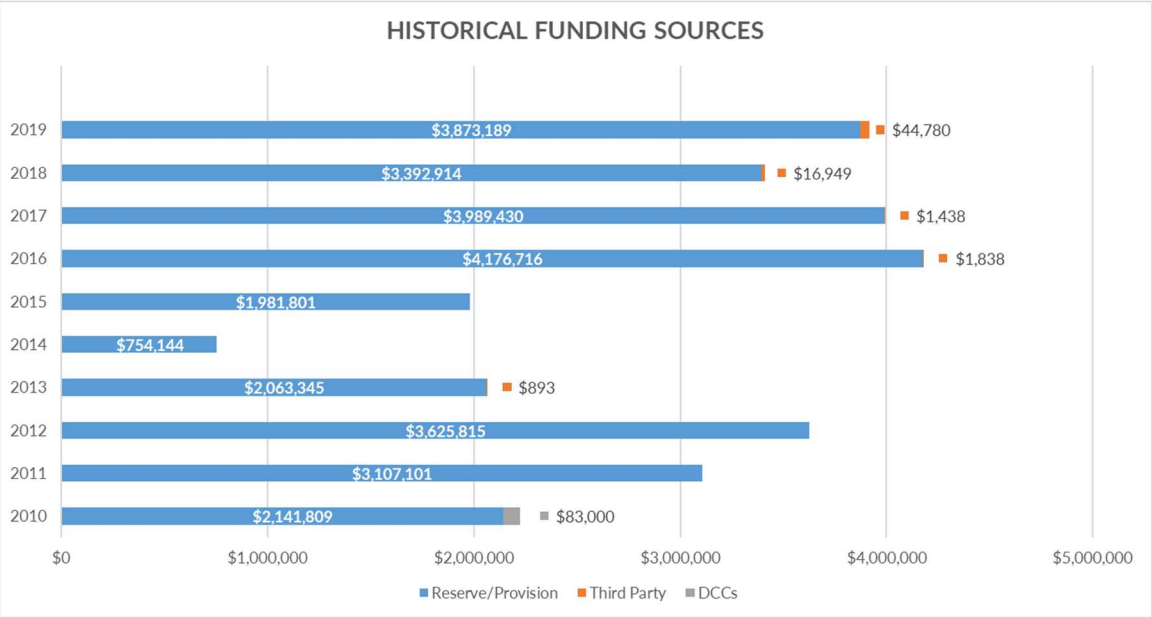


Figure 6-2
Historical Funding Sources

6.2.3 Reserve Funding

The city currently holds the following reserves specific to supporting the water utility:

- Provision for Future Expenditure, Water:
  - Capital infrastructure life cycle planning of existing assets (some growth included – planning for future);
  - Water rate stabilization against fluctuations in annual spending and Metro Vancouver levy; and
  - 5 – 10% capital asset replacement value.
- Equipment Replacement, Water:
  - Vehicle and IT equipment life cycle planning of existing assets; and
  - Maintain funds to support replacement of water vehicles and IT equipment; end of useful life (build in 5% inflation at time of replacement).
- Development Cost Charges, Water:
  - Growth – new water infrastructure as a result of major development; and
  - Developer specific projects and developer funded (funds collected at permit stage for future works).

The reserves support the key strategic objectives and align with the financial sustainability principles in the following ways:

- Address the growing need to renew the City's critical infrastructure and amenities and maintain them in a state of good repair;
- Optimize the City's network of infrastructure and amenities to support economic development and growth; and
- Advance Council and community priorities in a sustainable and resilient manner.

Key questions will need to be considered, including:

- Current water rates, projected future water rates, and potential limitations on the extent and speed of rate increases;
- Alternative funding source availability; and
- Overall City reserve and financial policies, including risk appetite for water-related financial risk and risk to service delivery.

6.3 Historical Analysis – Operational Expenditure

The following chart presents a summary of the financial requirements needed to maintain the water system. Analysis within the figure below is limited to Standing Work Orders which are typically used and repeated annually. Overhead has been purposely removed from the analysis because the structure to charge Fleet vehicles were changed in 2013 and would the summary. Note that the Water Operations team completes more tasks than what is presented below, such as service connections for developers.

Prior to future iterations of the AMP, there is an opportunity to better categorize items in JDE, following an agreed asset hierarchy, to better present all the activities of Water Operations. Summary of the breakdown of the activities included in each category is provided in Appendix E.

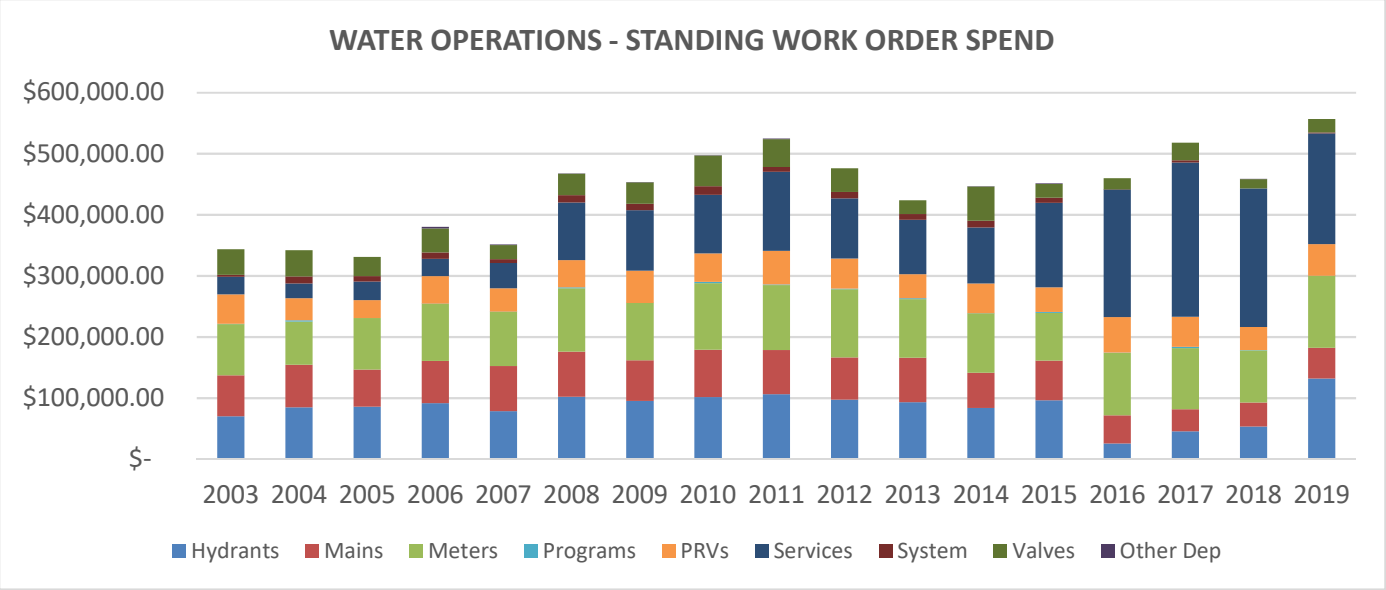


Figure 6-3
Summary of Standing Work Orders for Water Operations

6.4 Metro Vancouver Water Fees

The following charts presents a summary of the City's cost to purchase water from Metro Vancouver. This value is not included in the Operational Expenditure summary (previous section). Metro Vancouver has two rates: peak and non-peak. Peak period is applicable between June and September. Non-Peak Period is January to May, and October to December.

Historical Rates shown in the chart below were obtained from the meeting minutes from Regular Board Meeting Minutes of GVWD Board of Directors. Yearly City costs were obtained from Financial Records (account 9400.6810).

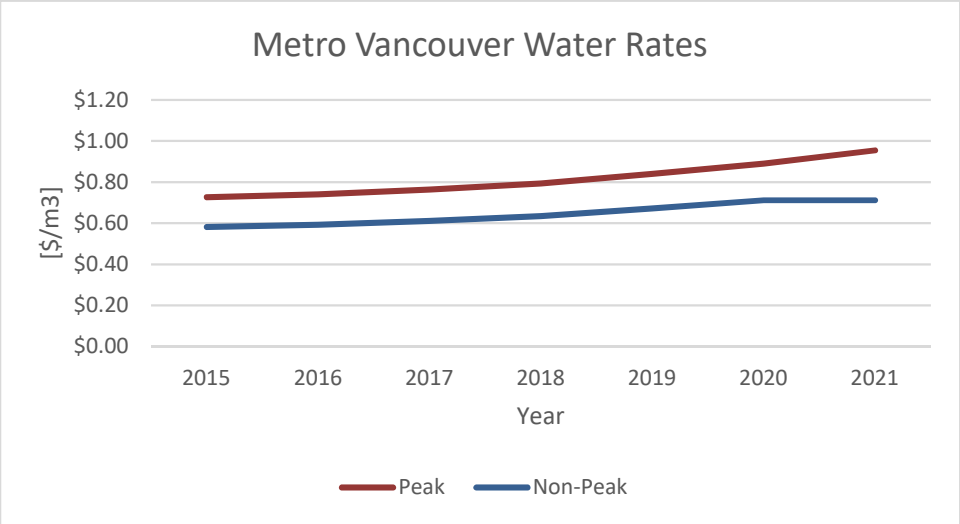


Figure 6-4
Historical Metro Vancouver Water Rates

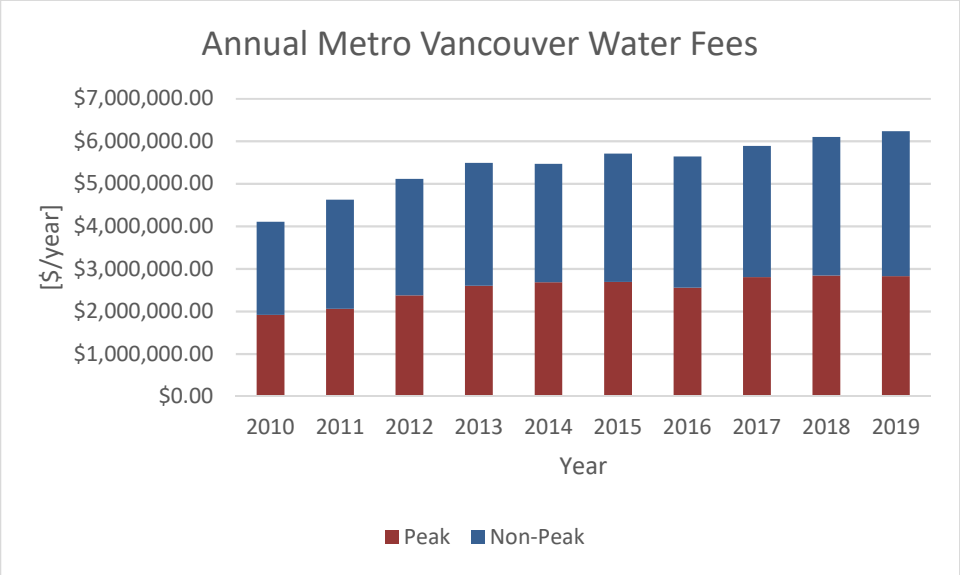


Figure 6-5
Historical Cost of Purchasing Water

6.5 Current Funding Deficit

Based on the renewal projections provided in Section 4.1.2 Asset Renewal Forecast, the current levels of capital funding are insufficient to meet required renewal investment. Funding this AMP will require a ramping up of current investment to approximately $5.5M annually.

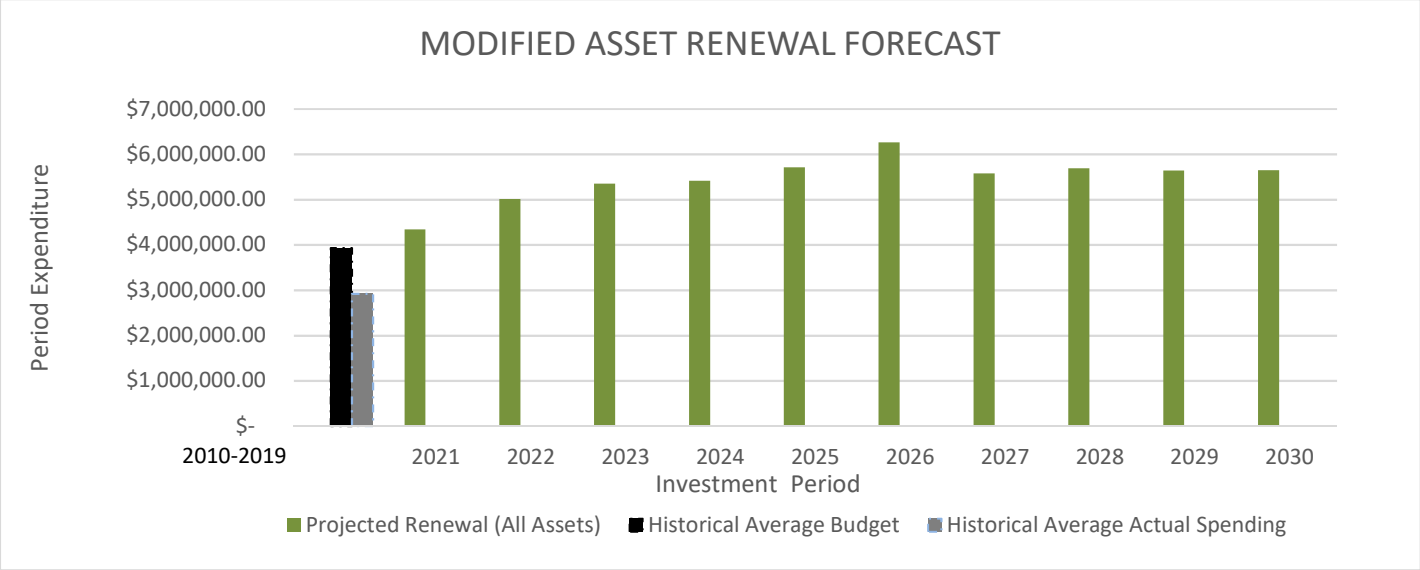


Figure 6-6
Renewal Requirements Compared to Historical Investment

This represents an increase from an average budget of $3.9M and average spend of $2.9M from 2010 to 2019.

7 IMPLEMENTATION & CONTINUOUS IMPROVEMENT

The City is committed to continually improving the way assets are managed and how services are delivered. This Water AMP will require continual improvement of the water asset management practices employed as part of the City's asset management journey. To achieve continuous improvement, suggested monitoring controls and governance are included in this section.

7.1 Governance Model

Supporting the continuous improvement for the Water AMP will involve commitment from active stakeholders engaged in the advancement of asset management at the City of New Westminster. Table 7-1 identifies roles of the active stakeholders and the governance structure to support the successful implementation of the Water AMP. Key activities for implementation include:

- Continuously communicating the AMP objectives and strategies which will further advance the culture of asset management;
- Implementing the AMP recommended renewal program and investment;
- Tracking performance against LoS KPIs, including investment outcomes, to determine it outcomes are being achieved and determine where additional supports may be required;
- Implementing the Improvement Plan through multi-departmental initiatives; and
- Reviewing and updating the AMP.

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Table 7-1
Water AMP Governance Structure

Stakeholder	Role
AMP Working Group	This group is comprised of members from the following departments: Infrastructure Planning, Operations, IT, Finance and Design & Construction. This Group is tasked with developing a cohesive AMP that aligns with the City's objectives, and then implementing and monitoring the outcomes related to the AMP.
Asset Management Steering Committee	This group provides direction to the City's overall asset management program and will serve as a key audience of the AMP. This group will support implementation by monitoring implementation progress.
City Council and Executive Team	These groups act as stewards for all City assets and approve the AM policy, establish levels of service delivery, and monitor progress and outcomes.
Engineering Department	This group maintains, inspects and operates the assets. This group is fundamental in achieving service delivery and management of the water assets daily. Water asset condition, criticality, risk, decision making, performance, planning, and regulatory compliance are influenced by this department. This group also collects and maintains the asset data.
Finance & IT Departments	This group provides financial and spatial data and develops/supports financial and data management strategies related to the water assets.

7.2 Delivery Risks and Uncertainties

The City faces several uncertainties that may impact effective delivery of the Water AMP's forecasted approach. Notable risks include:

- **Providing adequate funding for increased capital investment:** Resources are scarce, and one of the goals of the AMP is to maintain affordability for water rate payers. As a result, dynamic prioritization of investment may be required through the ten-year life of this AMP.
- **Providing adequate resourcing for increased capital investment:** Both internal and external resources will need to be bolstered to provide effective system design, coordinate investment planning and construction with other teams, manage projects and contracts, and provide sufficient operations, procurement, human resources, and financial support.
- **Timing and coordination of capital projects:** Successfully delivery of the AMP will require effective integration of capital projects from across the City's service areas as each seek to deliver required investment to sustain services. This will require advance definition and scoping of projects, which will have the added benefit of being first-to-market in a high-cost construction environment.

7.3 Implementation Roadmap

The Water AMP will serve as the guiding document to effectively and efficiently manage the City's water infrastructure. It provides guidance on level of service, data collection, maintenance, operation, risk, capital and operational planning, and integrates the water assets across departments including engineering, finance and GIS. This document must be useful and relevant to each department.

Table 7-2 identifies recommended activities that support the implementation of the Water AMP. This table assigns scheduling and responsibility.

Table 7-2
Implementation Activities

Item	Frequency	Accountability for Completion
Endorsement of Water AMP by City Council. Presentation to, review by and adoption by City Council, which includes assigning support to implement the Water AMP.	3 years	City Council and Executive Team, Water AMP Working Group
Implement Water AMP Recommendations. Prioritize and plan for the implementation of the Water AMP recommendations. Assign and review roles and responsibilities, set timelines and milestones	Annual (aligned with capital and operational budget process).	Engineering
Implement Water AMP Improvement Plan. Prioritize and plan for the implementation of the Water AMP improvement activities Assign and review roles and responsibilities, set timelines and milestones	Annual (aligned with annual business planning process).	Engineering with support from a wide range of corporate stakeholders
Update Water AMP to remain current.	Every 3 years, as identified in the SAMP.	Water AMP Working Group
Coordinate, Engage, Collaborate and Communicate the Water AMP. Implement Standing Meeting Agenda: • Condition of assets; • Repairs, replacements and renewals of assets; • Risk assessment conducted and changes in risk status of assets; and • Asset management budgeting.	Monthly	Asset Owners: Infrastructure Planning Water Operations
Develop Business Cases. Develop and submit business cases for proposed asset intervention and capital projects as part of the annual budget requests to demonstrate options to address needs and the benefits to service delivery.	Annual	Engineering
Prepare Benefits Summary. Measure the success of projects based on whether CLOS and risk levels have been achieved.	Annually	Water AMP Working Group
Implement Quality Assurance Audit. Assess the level of effort of the current data collection methods and quality of information.	Annually	Engineering

Table 7-3 incorporates indicators of AMP success defined for consideration by the Water AMP Working Group and the Asset Management Steering Committee.

Table 7-3
Key Indicators of Success

Key Indicator	Detail	Recommended Frequency	Accountability for Completion
Legislative Compliance	100% compliant with legislative requirements.	Every 1 – 2 years	Infrastructure Engineer
Quality of Service	100% compliant with Level of Service targets.	Every 1 – 2 years	Water Superintendent
Capital Project Delivery	Percent of projects completed on schedule and budget.	Every 1 – 2 years	Infrastructure Engineer
Operational Performance	Percent of operational and maintenance KPIs achieved.	Every 1 – 2 years	Water Superintendent
Risk Management	Number of unplanned risk events.	Every 1 – 2 years	Infrastructure Planning Manager
Benchmarking	Quality of benchmarking to previous years' targets and current years' targets.	Every 1 – 2 years	Asset Management Engineer
Data Reliability	Quality of asset data collected including reliability, consistency across departments and accuracy. .	Every 1 – 2 years	Asset Management Engineer

The broader City asset management roadmap is outlined in the SAMP and provides guidance on corporate capability improvements in asset management. Like the Water AMP implementation activities, these asset management efforts need to be championed and communicated effectively by City Council and the Executive Team and resources must be assigned to carry out the activities.

7.4 Improvement Plan

The Water AMP will be in effect over the lifespan of the water infrastructure. This AMP, in its first iteration, has revealed a number of gaps and opportunities for improvement. Table 7-2 identifies recommendations will help the Water AMP evolve and improve its analysis through each iteration. Recommendations for improvements in business process, data and information, technology, governance, and people and capacity are identified based on the process of building this initial Water AMP.

7.4.1 Improvement Recommendations

The recommendations in Table 7-3 identify gaps/opportunities and recommendations for consideration by Water AMP stakeholders and City leadership.

Table 7-4
Water AMP Improvement Recommendations

Item	Gap/Opportunity	Recommendation
Regularly monitor and report LOS KPIs.	Understanding the performance of the water service and its assets will support long-term planning and evaluation of expenditures bases on outcomes	Implement process changes and enhancements to ensure that each KPI is measurable and effectively measured. This will include documenting service requests through Cityworks and standardizing the approach to managing and documenting work orders.
Augment available risk data to support a risk-based intervention approach (rather than primarily age-based)	Currently, there is limited understanding of asset criticality based on a 2007 study. In addition, there is limited understanding of asset risk based on the consequence- and likelihood categories and scale as defined in the SAMP.	Identify asset criticality and overall risk exposure through a comprehensive risk review for the Utility assets (opportunity to combine water and sanitary/storm sewer assets). This is typically achieved through a main-by-main analysis.
Integrate available datasets to support lifecycle costing	Work management and financial data is currently not reconcilable through the multiple systems and asset data structures used. At least half of all operational spend right now is tracked in overhead and programs, making it challenging to analyze operational spending and effectiveness.	Enable lifecycle costing through reconciliation of financial and work order data. As JD Edwards, GIS, and CityWorks are further integrated, take the opportunity to align the datasets and build a meaningful GL structure that will allow for effective costing of both operational and capital expenditure. Track work orders in CityWorks (and associated resources) to assets and move away from standing work orders.

Item	Gap/Opportunity	Recommendation
Augment available asset condition data	There is little condition data to support an evidence-based approach.	Review inspection and condition assessment programs for water assets[22]. Incorporate opportunistic data collection into regular operations and maintenance activities by providing guidance and structure to complete assessments. Ensure inspection and assessments are repeatable.
Improve asset data overall	Through the process of AMP development, several data improvement opportunities were identified. Recommendations include the following areas of practice: • Data Architecture • Data Lineage • Data Quality	Undertake asset data improvements as detailed in Section 7.4.2.
Improve accuracy of key asset attributes	Through the process of AMP development, several data improvement opportunities were identified. Key areas that would benefit from more accurate numbers include: • Current Replacement Value; • Asset identification, segmentation, and hierarchy; • Asset age/installation date; and • Collection and analysis of asset failure data through documentation of failures in work orders.	Develop a strategy to prioritize and address each field. This may include putting in place better practices for initial data capture, data quality management and review, data analysis and reporting, and ongoing maintenance and/or refresh of the data.

Implementation of these improvement items are critical to generating better information and hence better decisions when managing water infrastructure assets.

7.4.2 Data Improvement Plan

Ensuring that asset data is properly catalogued and maintained can reduce the amount of effort required to analyze that data, improve the accuracy of future forecasts, and allow for new kinds of decision-making. The recommendations in this section are

[22] Example: Hydrant inspection, PRV inspection.

primarily focused on the data used by GIS, but would apply to any dataset or tool used. There are three main areas of focus for data improvement: data architecture, data lineage, and data quality.

7.4.2.1 Data Architecture and Asset Hierarchy

It is important that there is a shared and easily understood classification for the data captured. This classification structure should start by ensuring that assets are classified in a way that aligns with the asset hierarchy used in the AMP. A diagram of the asset hierarchy or a glossary of terms can be shared with data users. Building common classifications also includes ensuring the terms used to capture different characteristics are standardized across asset classes (e.g. “Replacement Value” or “TCA Value” instead of using an open-ended descriptor like “Value”). This is especially important for improving interoperability between different tools and areas of analysis.

Ensuring that there are common structures for data between different assets, to the extent that it is reasonably possible, reduces the amount of effort required to compare and manipulate the data. Keeping data structures (column names and positions) identical between asset classes can help reduce the amount of effort required to manipulate or compare assets of different classes in a full inventory of the data. Currently, each asset class has different characteristics recorded in different orders, sometimes with different names for the same characteristic, making quick comparison between classes difficult without extensive data manipulation. A common column naming and order for all point and linear assets can be established. Some columns may not be applicable to each asset type (e.g. diameters for fountains, # of ports for hydrants), but it is easier to populate these columns with blanks or #N/As than to rearrange columns when constructing a common inventory. Having a glossary documenting the purpose of the column as well as the unit type for columns containing quantities can reduce the room for error when recording values.

When creating a common structure, unimportant, uninformative, or very infrequently used columns that are not likely to see more usage can be removed. Nearly every point asset has many unused or uninformative columns which could be stripped away or combined into a single column. Where possible, recording data that can be represented as a quantity numerically instead of as text can reduce the amount of effort required during analysis (e.g. recording “1/2 IN” valve diameters as “0.5”, or in metric as “12.7”).

Having a single unique identifier for each asset in the inventory is extremely important and will cut down on a large amount of unnecessary re-cataloguing and errors during data analysis. Currently, each asset type has its own facility ID which may be identical to a facility ID of another asset class (e.g. a main and a system valve may both have a facility ID of “103”). A single unique identifier, either numeric or numeric and text, should be assigned to each asset (e.g. “M103” for a main, “V103” for valves).

When an asset is abandoned or decommissioned, its unique identifier should not be re-used for the asset replacing it. Currently, active and abandoned assets can share identifiers, leading to unnecessary difficulties when selecting and sorting those assets. To capture which asset an abandoned asset has been replaced by or which asset has replaced an abandoned asset, a column should be created for “Preceding/Replacement Asset” with the unique identifier of that asset.

Having a common system for assigning locations to assets will also greatly cut down on effort required for future analysis. Currently, there is a column named “Location” for each asset class that is used infrequently. Mains and laterals tend to use this column more often than point assets. “Location” should be broken down into four columns:

- Building number
- Street (N-S)
- Avenue (E-W)
- Full Location including each of the above

This will allow for easier analysis by allowing the user to quickly select all assets along a given street or section of street. If the City uses a common numbering for blocks, this should be included as well.

In addition to this, non-main assets can be grouped together, potentially by the main they connect to. For example, system valves or laterals should have a column recording the unique identifier of the main they connect to. Meters should also have a column recording the lateral or main they connect with (this will likely have to be the main they connect to, as lateral and meters can not be easily grouped together with the quality of location data in the present). This grouping would drastically cut down the level of effort required to track or estimate the age of non-main assets and allow for easier grouping of assets into similar projects.

7.4.2.2 Data Lineage

Ensuring that the source of the data is clearly recorded, as well as data entry dates and potentially the name of the inputter can help record the path of data as it moves from different sources to different end uses. This can help trace errors and omissions as data is passed from source to end use. A flowchart of where data originates, how it is recorded, and where it is used can be a helpful tool for visualizing the path of data as it passes through the organization. A flowchart like this can help connect the end users of the data to the people who initially capture or record it to allow for better communication between the users and the people who best understand the extents and limitations of the data being recorded. A flowchart can also help identify if any data has been missed or exists elsewhere during the initial data-discovery phase of a project.

7.4.2.3 Data Quality

Ensuring that data quality is properly maintained reduces the uncertainty of analysis going forward and increases confidence in the results obtained. Improving data quality can include improving the completeness, consistency, timeliness, validity, and accuracy of the data recorded.

- Completeness: ensuring that data is input without gaps for an asset class. Where data is not available, being sure to record “Unknown” instead of leaving the column blank (e.g. The “City-Owned” column should be fully populated for every asset in the inventory).
- Consistency: ensuring that the characteristics captured are recorded in the same manner or that the same characteristics are not represented in different ways (e.g. having both “Ductile Iron” and “DI” tags for main material types, recording “0.5 IN” and “1/2 IN” for valve diameters).
- Timeliness: ensuring that all data is entered in the system in a timely manner, preferably as soon as the data is available. Data should also include a “Data Entry Date” (e.g. only data up to October 2019 was available in the GIS records).
- Validity: ensuring that data in the system reflects the conditions in-the-ground. Regularly ‘sanity-checking’ this data with staff knowledgeable about the assets can help identify if there are any gaps or errors in the data.
- Accuracy: ensuring that data in the system reflects an appropriate level of knowledge of the assets. This can include clearly labelling where data has been estimated, and recording how that data has been estimated (e.g. many installation dates were estimated during the creation of this AMP. The GIS data has been updated to reflect the estimated installation dates and a new column clearly flags whether the installation date is an estimate or not for every asset. The methodology for how these dates were estimated was recorded for future reference in Appendix B in this document)

7.5 Decision-Making Processes and Tools

7.5.1 Decision Making Criteria

To make optimized asset renewal decisions, key decision-making criteria need to be identified and understood by staff tasked with making the decision, with the customer level of service (CLOS) and technical level of service (TLOS) in mind. Assets that are compromising the achievement of these objectives may need to be replaced or upgraded or new assets may need to be created. Older assets or assets in poor condition are more likely to fail leading to service impacts. Age and condition can be used as indicators of likelihood to support a risk evaluation. Asset criticality can be used as an indicator of consequence. More critical assets are those that, in the event of failure, may lead to a bigger impact on service levels. This approach to decision making is summarized in the following sections, and was used to develop the 10-year prioritized project list discussed throughout the AMP and Section B.6 in Appendix B.

7.5.1.1 Remaining Life

The remaining life of existing assets may be used as an indicator of likelihood of failure. Estimates of remaining life are included in the lifecycle analysis. Assets with a very low or negative remaining life may need to be replaced. Where condition information is available, the condition assessment should be used to indicate remaining life. Where there is no condition information, the age and life expectancy (measured in years) of the asset can be used to evaluate remaining life. This age-based approach needs an understanding of the asset creation date.

The condition of an asset is typically measured on a defined scale, i.e. 1 (excellent) to 5 (almost certain, poor). Condition ratings can trigger, or be a factor in triggering, treatment solutions. There are two (2) primary methods available to determine remaining life which are both relevant in developing an asset renewal strategy:

1) Age-based approach to calculate deprecation.
2) Condition assessments from suitably trained resources to determine treatment methods or replacement requirements.

Age-Based

Age-based remaining life is determined by adding the date of original installation with the assets original useful life and then simply taking the difference between this value and the current date. The formula for calculating age-based remaining life is as follows:

Remaining Life = (Date of Asset Installation + Useful Life of Asset) – Date of Asset Assessment

This method assumes an asset will deteriorate at an average rate based on industry standards. If the asset is functioning beyond its originally planned service life, the calculation will indicate a negative value or asset ‘backlog’. The backlog indicates the number of years beyond which the asset was originally planned to provide service. This backlog is important from an accounting perspective because it will indicate the asset has fully depreciated in value. The asset may still be in good condition and provide the intended services even though it has a book value of zero.

Assumptions:

- Uses estimated life expectancies for assets and assumes complete renewal at end of service life.

Condition-Based

Conditioned-based remaining life is determined by considering the condition rating, i.e. 1 (excellent) to 5 (poor), and the original useful life of an asset. The condition rating them modifies the remaining life estimate based on the assumed percentages of remaining life.

Assumptions:
This is based on identified condition and modelling of remaining life as follows:

- With full replacement at end of life; and
- With defined investment intervention, i.e. repair, rehabilitation, or renewal based on condition.

7.5.1.2 Asset Criticality

Asset criticality is an indicator of the importance of an asset in relation to the level of service objectives. An indication of asset criticality is included in the lifecycle analysis. The City should continue to review critical assets on an ongoing basis. Critical assets may require preventative maintenance to mitigate failure. In addition, emergency and contingency plans may need to be considered for critical assets. This may include the holding of critical spares or emergency plans.

7.5.1.3 Asset Risk

Asset risk is derived from understanding **remaining life** and **asset criticality** and should be the primary decision-making criteria for determining asset interventions. High risk assets with very low or negative remaining life should be prioritized for asset replacement. High risk assets with a long remaining life should be considered for upgrade or have a contingency plan established. Risk assessment is the central basis for a renewal strategy.

The GIS information provided by CNW at the time of preparing this Water AMP provided a criticality indication for much of the City. The Water Risk Model in Appendix G provides the graphical representation of the assets across the City. There were two areas of the City that did not have criticality assigned to the linear assets, likely due to the new installations of that infrastructure. It is recommended that the City conduct future criticality assessments to ensure that risk data remains current as the water network grows.

APPENDIX A - CORPORATE ASSET MANAGEMENT POLICY, V1

To be attached as a separate PDF.

APPENDIX B - AMP ASSUMPTIONS

AMP Assumptions

Key assumptions of the Water AMP analysis include:

- Asset replacement values (derived from a consultant-provided review of past Metro Vancouver tenders and moderated by the City's review of their own tenders);
- Expected service lives (based on professional judgment);
- Installation date and material type estimates for different asset classes;
- The choice of condition assessment framework (based on the Canadian Infrastructure Report Card);
- The choice of failure curves for the different assets in the AMP (based on professional judgement and informed by other projects);
- The choice of risk framework (based on the SAMP and further elaborated in the Water AMP model);
- Maintenance planning (based on previously developed maintenance plans and professional judgment).

These assumptions are outlined in the following sub-sections.

Asset Replacement Value

Asset replacement values were defined through an internal review of past Water Main Replacement tenders in the City of New Westminster. The review was then validated against neighbouring municipalities across Metro Vancouver. Average estimates were provided for all linear assets and some point assets.

Based on this data, the total water assets amount to an estimated $316 million. Comparison with two neighbouring municipalities established that this is reasonable. The cost of completing underground construction in Metro Vancouver has significantly increased since 2015, resulting in higher than usual asset replacement values.

The replacement values by unit for the different asset classes are provided in the table below. The model built to estimate these replacement values were based on the awarded tendered construction cost (ie. lowest bid), and include engineering costs (+12% of construction costs), and 25% contingency.

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Asset Class	Sub-Class	Estimated Service Life	Fixed Cost	Unit Cost	Notes
Main	Cast Iron	80		$1,120/m for diameter <300mm, $1,676/m for diameter >=300mm	Unit Cost scales with the length of the main
Main	Ductile Iron	80		$1,120/m for diameter <300mm, $1,676/m for diameter >=300mm	Unit Cost scales with the length of the main
Main	PVC	80		$1,120/m for diameter <300mm, $1,676/m for diameter >=300mm	Unit Cost scales with the length of the main
Lateral	Cast Iron	80	$2,640	$149/mm	Unit Cost scales with the diameter of lateral
Lateral	Ductile Iron	80	$2,640	$149/mm	Unit Cost scales with the diameter of lateral
Lateral	Copper	40	$2,640	$149/mm	Unit Cost scales with the diameter of lateral
Lateral	PVC	80	$2,640	$149/mm	Unit Cost scales with the diameter of lateral
Meter	Zone	15	$2,000		
Meter	Residential	15	$2,000		This is the cost for meter-readiness. Costs do not include the meter itself.
PRV		25	$50,000		These costs are placeholders. Costs vary on an asset-by-asset basis
Sampling Station		50	$50,000		These costs are placeholders. Costs vary on an asset-by-asset basis
Hydrant		100	$12,656		

Asset Class	Sub-Class	Estimated Service Life	Fixed Cost	Unit Cost	Notes
Valve	System Valve	100	$2,240 for diameters <300mm, $4,480 for diameters >=300mm		
Fountain		50	$50,000		These costs are placeholders. Costs vary on an asset-by-asset basis

B.1 Expected Service Life

Expected service life estimates were based on professional judgment and local understanding of Associated Engineering and City of New Westminster staff. Expected service lives for the different asset classes are summarized below:

Asset Group Identifier	Asset Identifier	Estimated Service Life
Main	CI	80
Main	DI	80
Main	PVC	80
Lateral	CI	80
Lateral	DI	80
Lateral	Copper	40
Lateral	PVC	80
Meter	Zone	15
Meter	Residential	15
PRV	PRV	25
Sampling Station	Sampling Station	50
Hydrant	Hydrant	100
Valve	System	100
Fountain	Fountain	50

B.2 Installation Date and Material Type Estimates

Installation dates were missing for a large amount of assets. Installation dates were estimated using different decision making criteria for the different asset classes.

Assets that received an estimated installation date were flagged as having been estimated, and assigned an override condition rating of "Poor" to reflect uncertainty about their condition.

B.2.1 Mains

The majority of mains had installation dates attributed to them. For the small number of mains without installation dates, dates were estimated by (in order):

1. Taking the installation date of the oldest main it intersects with;
2. Assigning an installation date of 2000 for any remaining mains without installation dates

Mains made of an unknown material are assumed to be cast iron and flagged as having an assumed material.

B.2.2 Laterals

A significant number of laterals did not have installation dates attributed to them. Dates were estimated by (in order):

1. Assigning years based on the BP issue date of the building they attach to;
2. Assigned the water-main installation year for laterals intersecting ductile iron mains;
3. Assigned based on the age of building in the GIS records;
4. Assigned the water-main installation year for non-ductile iron mains;
5. Assigning an installation date of 2000 for any remaining laterals without installation dates

Mains made of an unknown material are assumed to be copper and flagged as having an assume material.

B.2.3 Hydrants

A significant number of hydrants did not have installation dates attributed to them. Dates were estimated by (in order):

1. Assigned the water-main installation year for hydrants which intersect mains;
2. Assigned an installation date of 2000 for any remaining hydrant;

B.2.4 System Valves

A significant number of system valves did not have installation dates attributed to them. Dates were estimated by (in order):

1. Assigned the water-main installation year for system valves which intersect mains;
2. Assigned an installation date of 2000 for any remaining system valve;

B.2.5 Residential Meters

A significant number of residential meters did not have installation dates attributed to them. Dates were estimated by (in order):

1. Assigned based on the age of building they intersect in the GIS records;
2. Assigned the lateral installation year for laterals they intersect;
3. Assigned an installation date of 2000 for any remaining residential meter;

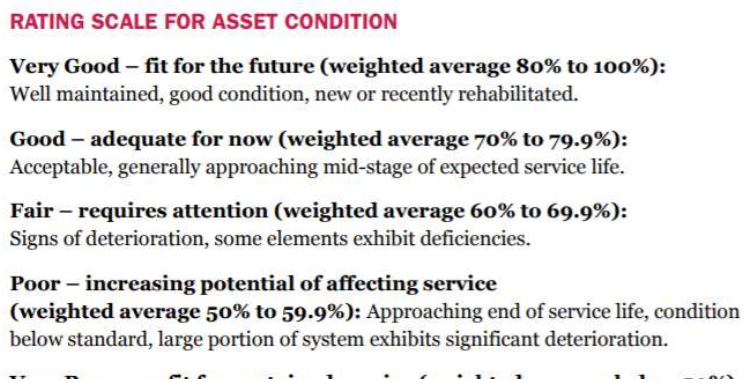
B.2.6 Other Assets

For any assets not covered by the above decision-making procedures, an installation date of 2000 was assigned to the asset.

B.3 Condition Assessment Framework

Asset condition is estimated using the five-point scale established by the Canadian Infrastructure Report Card[23], most recently published in 2020. This scale includes the following scale and definitions.

These definitions are largely qualitative and provide a high-level indication of the asset's current status. The five-point scale has been worked into the planning tool to guide decision-making.


RATING SCALE FOR ASSET CONDITION

Very Good – fit for the future (weighted average 80% to 100%): Well maintained, good condition, new or recently rehabilitated.

Good – adequate for now (weighted average 70% to 79.9%): Acceptable, generally approaching mid-stage of expected service life.

Fair – requires attention (weighted average 60% to 69.9%): Signs of deterioration, some elements exhibit deficiencies.

Poor – increasing potential of affecting service (weighted average 50% to 59.9%): Approaching end of service life, condition below standard, large portion of system exhibits significant deterioration.

Figure 7-1
Canadian Infrastructure Report Card (CIRC) Condition Scale

Age bands were used to assign condition grades to the five-point scale. The banding upper and lower values differ from the bandings in the Canadian Infrastructure Report Card to provide better resolution between assets in the middle of their service lives and end of their service lives, and to prevent older assets from being categorized as very poor when they may still have decades of remaining service life.

Table 7-5
Mapping of CIRC Condition Scale, Rating and Estimated Remaining Service Lives

Existing Condition	Condition Rating	Remaining Service Life (RSL)
Very Good	1	100% to 90%
Good	2	89% to 60%
Fair	3	59% to 30%
Poor	4	29% to 5%
Very Poor	5	< 5%

B.4 Selection of Asset Failure Curves

Failure curves were created based on data and experience from other jurisdictions and SME input that tuned the failure curve based on the failure rates that would be expected at different points in the asset's life. These points in an asset's life include the "teething" stage where manufacturer's defects or issues during construction lead to early failures, the start, middle, and end stages, and the discard stage past an asset's expected service life.

[23] The Canadian Infrastructure Report Card 2019 can be viewed here: http://canadianinfrastructure.ca/en/index.html.

A discussion was had to determine whether to create Weibull[24] failure rate curves fit from main break data provided by the City of New Westminster. There were major concerns about sample size and the quality of main break data available to estimate parameters for a Weibull curve. The main break data is incomplete, with many mains the breaks were attributed to not having installation years. This was particularly the case for main breaks that occurred farther in the past. As a result of incomplete main data for older breaks, initial investigation showed that fitting parameters to this data would lead to results that would show a much lower failure rate later in the main's life than would be expected in comparison to other jurisdictions. The following failure curves have been incorporated into the AMP analysis:

Table 7-6
Failure Curves

Asset Category	Examples	Annual Probability of Failure					Curve Shape
		Teething	Start	Middle	End	Discard	
Main/Lateral	CI Main	2%	1%	1%	5%	10%	Bathtub
Main/Lateral	DI Main	2%	1%	1%	5%	10%	Bathtub
Lateral	Copper Lateral	2%	1%	1%	5%	10%	Bathtub
Main/Lateral	PVC	2%	1%	1%	5%	10%	Bathtub
Instrumentation & Control	System Valve	1%	2%	5%	10%	30%	Fatigue
Instrumentation & Control	Meter	1%	1%	3%	10%	50%	Fatigue + Wear Out
Structures	Network Structures, Sampling Stations	1%	1%	3%	10%	10%	Fatigue + Wear Out
Structures	PRV	1%	1%	3%	10%	20%	Fatigue + Wear Out
Hydrants + Fountains	Hydrant	1%	1%	1%	5%	10%	Fatigue
Hydrants + Fountains	Fountain	1%	1%	1%	5%	10%	Fatigue

Probability of failure at key points within the curve are illustrated in Table 7-6.
The generic shape of these curves for example purposes is shown in Figure 7-2.

[24] Weibull is another type of distribution curve that can be used to model failures. It is a skewed normal distribution curve. It is the curve City of Vancouver and City of Burnaby uses. Refer to EDMS doc 1677505 for further detail.

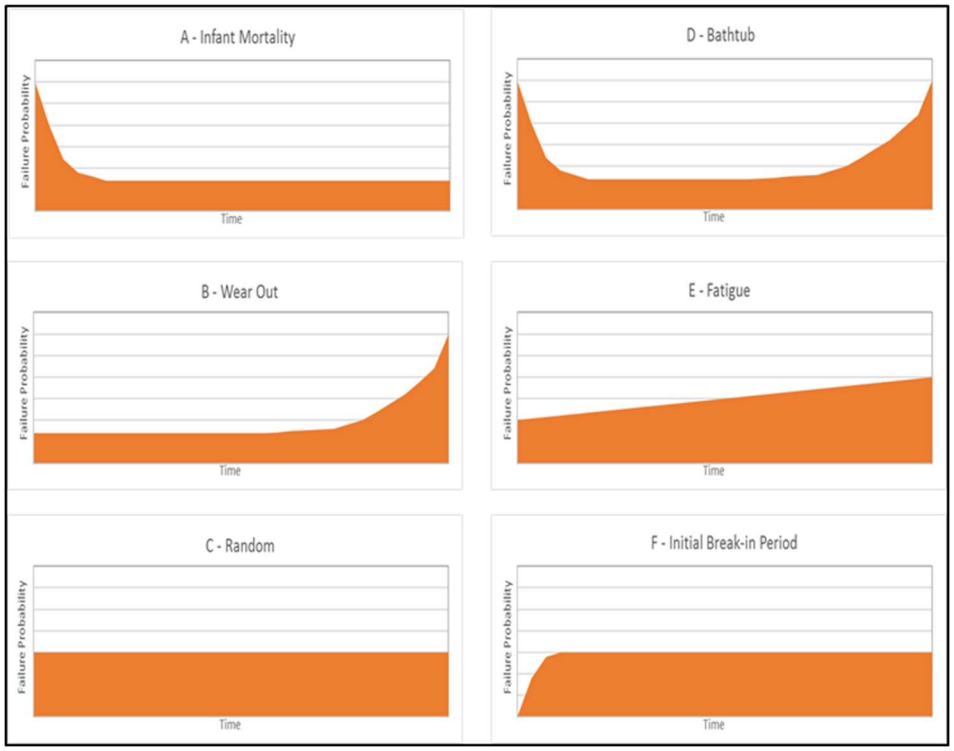


Figure 7-2
Generic Failure Curves

B.5 Risk Framework

The Risk Framework was adopted from the SAMP and is detailed in the Risks & Uncertainties section. The Risk Framework drives the asset risk assessment adopted in the planning methodology, as well as the identification of higher-level strategic and service-related risks to the water service.

There was uncertainty regarding the language around the likelihood bands in the SAMP. After discussion with City of New Westminster staff, the likelihoods given in the SAMP likelihood scoring table were determined to be 1-in-36-month failure likelihoods, not 1-in-12-month failure likelihoods. This interpretation maintains parity with other City of New Westminster AMPs.

B.6 Project Prioritization

Recognizing that operational and political realities will impact the order and timing of projects, a ranked list of recommended projects for the next 10-year period was created. This list bundled assets together into projects, then ranked the potential projects. This gives more flexibility to align water projects with road or utilities projects, new development, or Council priorities. This also allows more flexibility to pick sets of projects on a year-by-year basis if funding varies.

The methodology for creating projects and ranking them is as follows:

1. Identify mains in the capital projects list, mains at the end of their service lives within the 10-year period, or with other criteria that would move up their renewal (e.g. multiple breaks along the same block);
2. Group these mains into 2-4 block areas;
    a. If contiguous mains in this area are due for renewal within 15 years, they are included in the grouping;

3. Include laterals, valves, and hydrants which attach to the mains due for renewal;
    a. Include laterals, valves, and hydrants along contiguous mains due for renewal within 15 years as well; and
4. Rank the project bundles by the average criticality scores of the assets in the bundle.

The prioritized 10-year project list was provided in a separate set of files, including an Excel-based list of proposed bundled projects and a set of GIS files that document the proposed projects spatially.

B.7 Level of Service

A summary of the Level of Service Workshop.

APPENDIX C – GO-FORWARD AMP ASSUMPTIONS

The following represent amendments to AMP assumptions that should be used on a go-forward basis for future iterations of the AMP. These were not incorporated into the AMP analysis for the initial version, as they were defined following the completion of the analysis. These units were used in the State of Infrastructure section but have not been incorporated into AMP analysis.

Asset Replacement Value

Table C-1
Updated Replacement Values

Asset Class	Sub-Class	Estimated Service Life	Fixed Cost	Unit Cost	Notes
PRV		25	$250,000		
Sampling Station		20	$5,000		

Expected Service Life

Expected service life estimates were based on professional judgment and local understanding of Associated Engineering and City of New Westminster staff.

Table C-2
Updated Expected Service Life

Asset Group Identifier	Asset Identifier	Estimated Service Life
Sampling Station	Sampling Station	25

Asset Hierarchy

In future iterations of the AMP, a revised asset hierarchy can be adopted. Compared to the draft asset hierarchy used in the current version of the AMP, the revised asset hierarchy breaks out sub-types for PRVs and introduces, institutional, commercial, and industrial meters (ICI).

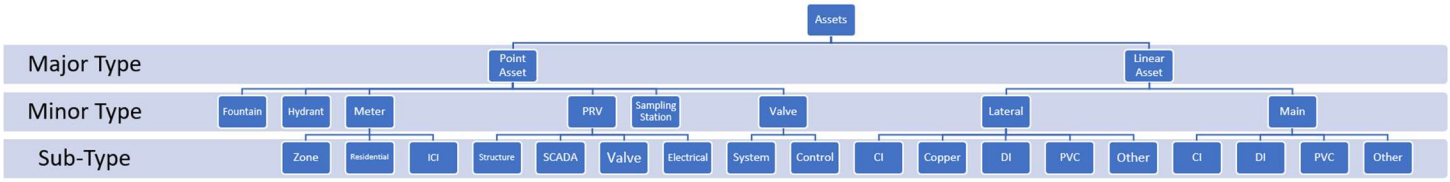


Figure C-0-1
Revised Asset Hierarchy

APPENDIX D – 2021 CAPITAL BUDGET DETAILS

The following is an outline of the programs and business units included in the draft 2021 Water CAPITAL budgets.

Table D-1
2021 Capital Budget Details

Line #	Projects (BU)	Description	Revised Carry Forward	Revised 2021 New Ask
677	**Water Infrastructure**			
678	**Hydrants**			
679	10209 Water New Hydrants	Ongoing yearly program to replace old hydrants and install additional ones to meet current standards.	**10,800**	**15,000**
681	**Water System Additions**			
682	10758 Water Trench Restoration	To carry out water main trench pavement restoration.	**-**	**150,000**
683	11649 Zone Meters Installation	To test and calibrate zone meters over 10 years old for accuracy. 550 Zone: 1st Street 16 years old, 504 Zone: Moody Park 12 years old and 504E: Victoria Hill 12 years old	**28,900**	**-**
684	11767 Watermain Replacement Program	Annual replacement program of aging water mains and to add new water mains to improve system efficiency, reliability level of fire protection and water quality enhancement. Asset management requires average of 3 km renewal annually (1.4% of system). Budget to gradually increase to this level of $4.5M.	**2,000,000**	**2,100,000**
685	12094 Duncan St. Watermain	Reimburse Developer for extending Duncan St across other parcels. QW1	**220,000**	**92,000**
686	12096 Watermain Inspections	To carry condition investigation (incl. CCTV inspection, flow testing, field excavation) on watermains to assist in establishing future years replacements	**15,500**	**25,000**
687	A0650 Blackley Street DCC Watermain	Reimburse Developer for installing Blackley Street DCC watermain from Stanley to Mercer	**-**	**171,000**
		SUM		**$4,828,200.00**

The budgeted amount in Project 685 (Duncan St. Water Main) includes the $312,000 to be funded by DCC.
The budgeted amount in Project A0650 (Blackley Street) includes the $171,00 to be funded by DCC.

APPENDIX E – STANDING WORK ORDERS

The following are categories and descriptions of standing work orders in JD Edwards (the core financial system) used for Water Operations. These categories were used to conduct an analysis of operational spend in Section 6.3.

Category*[25]	Work Order Descriptions (As per JDE)
Hydrants	Hydrant Maintenance
	Hydrant Painting
	Hydrant Servicing
	Hydrant Thawing
Mains	Watermain Flushing
	Watermain Locating
Meters	Commercial Industrial Meters
	Water Meter Box Repair
	Water Meter Box Replacement
	Water Meter Reading
	Water Meter Replacement
	Water Meter Request
Other Dep	Water-Fire Dept
	Water-Police
	Work for Recreation
Overhead	Acting Supervisor - Water
	Fire Extinguisher Mtce.-Water
	Medium Term Sick Leave
	MONTH CHG OUT RATE WATER (Fleet costs)
	Other - Dr. Appt Etc.
	Railway Crossing Permits-Water
	Short Time
	Standby
	Statutory Holidays

[25] *Category indicated below were determined as part of this AMP. This category is not used in JDE.

Category*[25]	Work Order Descriptions (As per JDE)
	Tools & Supplies - Water
	Training - Water
	Union Recoverable
	Vacation
	Water Training
	Water Truck 678 Float
	Water Truck 683 Float
	Water Truck 684 Float
	WCB
	WORKSYARD ALLOCATION - WATER
Programs	Water Community Events
PRVs	Inspect PRVs
Services	Water Service Leak Locating
	Water Service Repair
	Water Service Request
System	Leak Detection Program
Valves	Water Valve Box Painting
	Water Valve Box Replacement
	Water Valve Exercising
	Water Valve Repacking

APPENDIX F – MAINTENANCE MANAGEMENT SYSTEM WATER SYSTEM PILOT (EDMS #1157958)

To be attached as a separate PDF.

APPENDIX G – WATER RISK MODEL (2007)

To be attached as a separate PDF.