Director	CAO

COUNCIL AGENDA

Date: July 12, 2021 Item: 7.

7.

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

COUNCIL REPORT

Date:	June 23, 2021
From:	Phil Bates, Manager, Engineering Services
Subject:	Water Utility System Asset Management Plan 2021
File:	1700-09

RECOMMENDATION

THAT

1. the report dated June 23, 2021 titled "Water Utility System Asset Management Plan 2021" be received for information;
2. staff prepare the water utility rate setting process to account for a phased increase of the annual capital funding program in order to meet and sustain long-term funding requirements for the Districts water distribution and treatment systems;
3. staff develop and incorporate into the water rate setting process, a water utility capital renewal escalation factor that captures construction inflation costs and that this factor be updated and reviewed with Council every three years or as appropriate beginning in 2024; and
4. staff proceed with preparing loan authorization bylaw(s) to fund the reconstruction and updating of the Westmount Pump Station and Reservoir.

1.0 Purpose

The purpose of this report is to provide Council with the most up to date information on the state of the District's water utility system infrastructure.

Information will be presented on the water system's replacement costs, condition, servicing and replacement deficits, funding constraints, and will present options for funding to address the existing and future needs of the utility.

2.0 Legislation/Bylaw/Policy

The Provincial *Drinking Water Protection Act* – An act establishing regulations governing water suppliers in British Columbia.

Metro Vancouver Drinking Water Management Plan 2011 – A plan which sets the direction and priority for provision of safe clean drinking water,

ensures sustainable use of water resources, and ensures efficient supply of water.

District of West Vancouver Waterworks Regulation Bylaw No. 4490, 2006 and amendments - A bylaw to regulate the Waterworks system and establishes a water utility that is funded entirely through user rates. The water utility funds the operations, maintenance, capital renewal and new acquisitions of all water utility assets including vehicles and equipment associated with water utility work. The water utility funds all staff time, equipment charges, contracting, consulting charges, and professional planning that is needed to maintain the District's water system and the service levels it provides for.

The District's first Asset Management Plan (AMP) for water utility assets was completed and adopted by Council in 2010. This AMP provided for the creation of a water utility capital renewal escalation factor (CREF). This was initially set at a dollar value to achieve an annual sustainable funding value for the utility that was determined as part of the AMP. This value increased annually over several years and then, once funding reached a certain level it was reduced and applied at an increase of $300k per year. The CREF applies to all assets paid for by water utility rates, it is separate from the general fund Asset Levy established in 2016 for funding non-utility asset renewal.

3.0 Council Strategic Objective(s)/Official Community Plan

Section 2.5 Municipal Operations and Infrastructure of the 2018 Official Community Plan outlines a number of key policies related to water conservation:

2.5.6 Monitor water usage and revise rate structures as necessary to continue reliable and equitable services.

2.5.7 Encourage use of development practices, landscape designs and built systems that reduce water demand and consumption.

2.5.8 Encourage water conservation through leak detection, water metering and communitywide education programs.

Council's Strategic Plan (2020-2021) includes the following relevant Strategic Goal and Objective:

- Strategic Goal 5: Deliver municipal services efficiently.

4.0 Background

4.1 Previous Decisions

Council, at its November 20, 2020 meeting, adopted rates for 2021, and reviewed the Five Year Financial Plan for the Water Utility. The financial plan forecasted annual revenue increases of 5.0% from 2021 thru to 2025;

Section 6.1 of that report refers to this study as being underway at that time.

4.2 History

A summary of the District's history on water system asset management:

2008 – The Eagle Lake Filtration plant commissioned

2010 – The first AMP for the Water System developed and adopted by Council

2015 – A significant drought confirmed some deficiencies within the water system

2016 – Water Master Servicing Study completed

2017 – Dam Safety Review for Eagle Lake East and West Dams completed

2018 – District of West Vancouver Fire Underwriters Survey

2021 – The second AMP completed

5.0 Analysis

5.1 Discussion

The process of developing an AMP for a sizeable municipal utility is an involved and lengthy one. A typical duration can be from 12 to 18 months depending upon the complexity of the information examined. The District's water utility has been operating under the guidance of the original AMP developed in 2010. The 2010 plan was a large step forward in terms of strategic management of the District's potable water system, but it has become outdated and less relevant to current conditions.

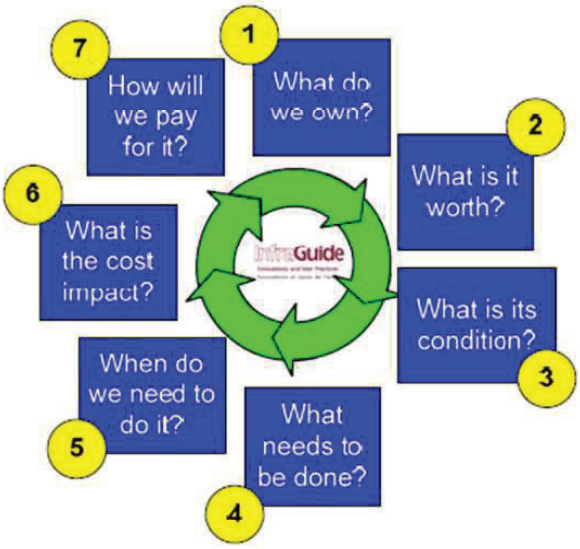
The 2021 AMP integrates significant improvements and new information over the first plan developed in 2010, this includes:

- a decade of construction cost escalation which outpaced predictions,
- augmenting a pure like-for-like replacement approach with advanced, fully calibrated computer modelling of the water system, and the addition of functional condition measures, and
- the effects of climate change on water supply and demand.

The steps to develop an AMP have not altered appreciably since they first emerged. During 2001 through 2006, the Federal Government established and set forth asset management recommendations for municipal governments to follow. Branded as InfraGuide[1] the work addressed

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

infrastructure deficits at all levels of government in Canada, and was covered extensively by the media at the time.

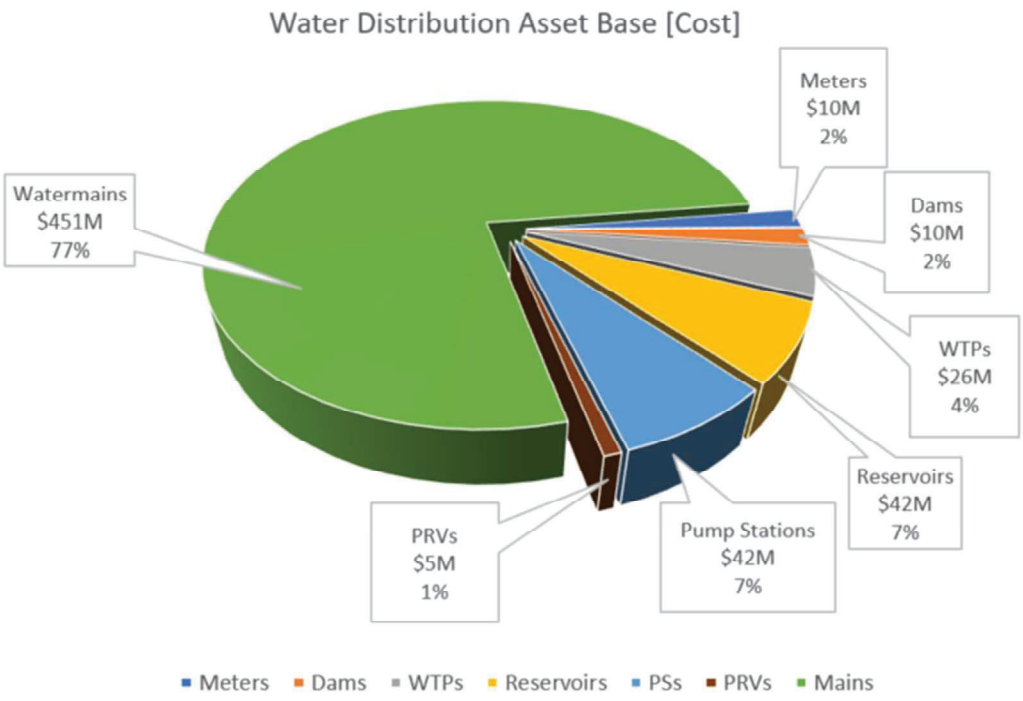


Asset Management Planning Wheel

While the topic of Canada's infrastructure deficit has receded in the last several years from the mainstream news, it remains an important and ongoing concern for owners of systems and those involved in the maintenance, planning, and financial decision making of such systems. A fundamental concept is that multiple cycles through the planning wheel are required to fully understand strategic issues in complex systems such as a municipal water system.

Replacement Cost

Since 2010, the water distribution system has seen growth of only 9 km, yet the replacement value has more than doubled. In 2010, the system was valued at $272M. To replace all of the current existing infrastructure it is estimated to cost $587M. Water mains remain the dominant component of the system constituting 77% of the overall cost. Construction cost escalation over the last decade has outpaced predictions and outpaced our current CREF.



Asset Condition

In the 2010 AMP a single condition measure was used to capture the overall physical condition of the assets within system. Mains represent the dominant component of the system (77%), but they can't be directly tested, assessed, or viewed. Therefore, a large portion of the physical condition measures are estimated based on the expected remaining useful life of the asset. The availability of only a physical condition measure limited the AMP to a like-for-like method of system replacement forecasting. Using this method can result in system capital requirements being underestimated.

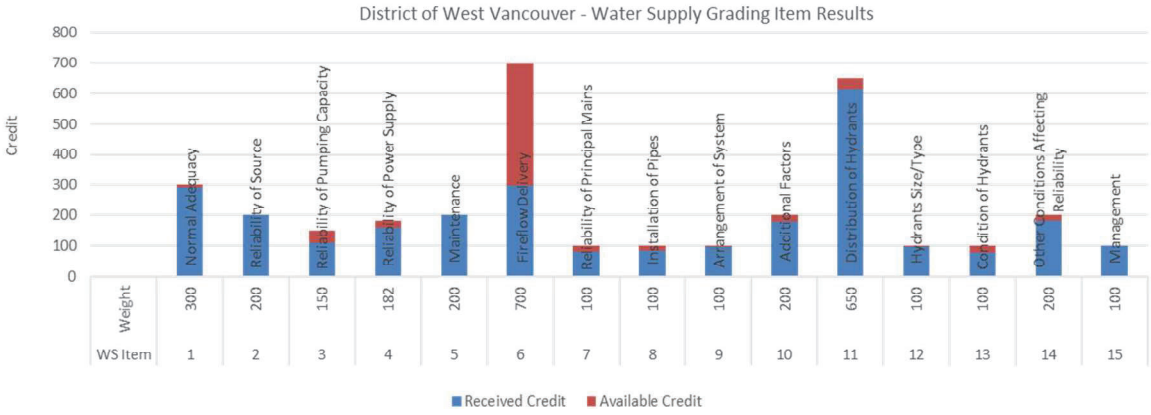
In 2014 a master water servicing study (MWSS) was commissioned and completed in 2016. A major component of the study was the development of a fully calibrated computer hydraulic model. The model allows engineers to understand the system in terms of its ability to deliver adequate service levels including flows, volumes, and pressures. The model can predict pipes that need upsizing, pumping capacity that may require alterations, and reservoirs that may require upgrading. In addition, demand changes were modelled under future condition scenarios. This included considerations around the potential for land use changes as allowed for within the District's Official Community Plan, as well as significant weather events (drought).

Further detailed analysis carried out as part of the 2021 AMP concluded that during peak demand use, approximately 74% of all users have

sufficient fire flow or are within 25% of their fire flow requirements. Implementing the recommended upgrades as outlined in the WMSS will, in part, mitigate these service deficiencies within the system.

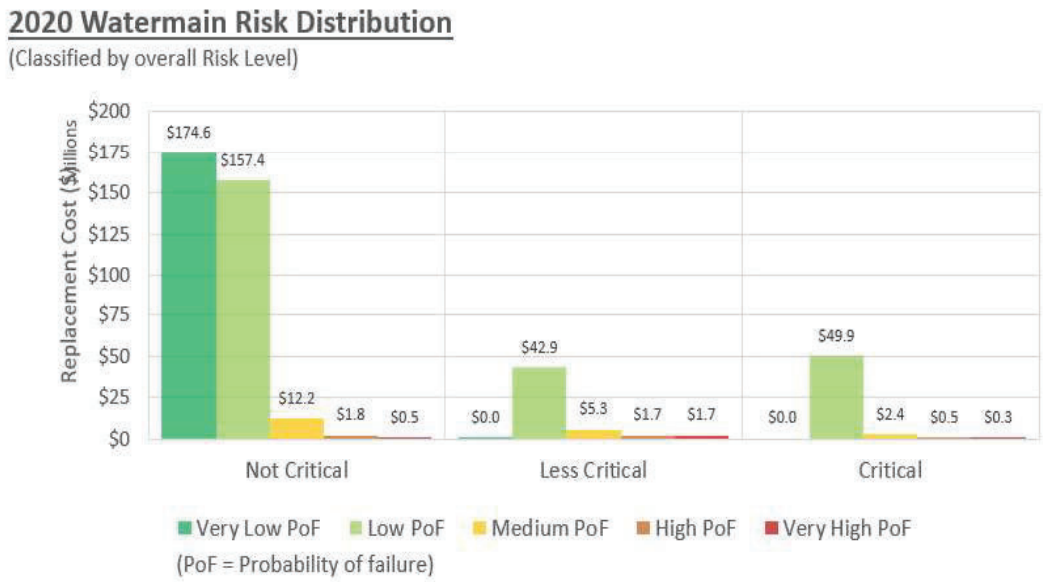
A significant test of the current water system occurred in the summer of 2015. Metro Vancouver experienced a prolonged drought, and significant water restrictions beyond lawn watering regulations were introduced. Despite water conservation measures the District's Eagle Lake water source was drawn down to historically low levels. The water system was fully taxed to deliver sufficient supplies to the western areas of the District. Engineers have since altered the operational draw down procedures for Eagle Lake and began developing strategies to ensure system source redundancy. However, computer modelling still shows a deficiency in the system during times of extended hot weather, high irrigation, and low supplies. These events are anticipated to become more frequent and are linked to climate change.

In 2018, a Fire Underwriters Survey was conducted for the District's water supply system in order to determine adequacy and reliability of the water system where the basis of the assessment was informed by the WMSS. As part of this review, 15 different parameters were assessed and graded, this included considerations such as reliability of source, available power supply, pumping capacity and redundancy, size of water mains, maintenance, distribution of hydrants and so on. Fourteen out of the 15 items assessed received excellent grading, with the delivery of fire flow being identified as the one area that received a poor grading and requiring improvement.

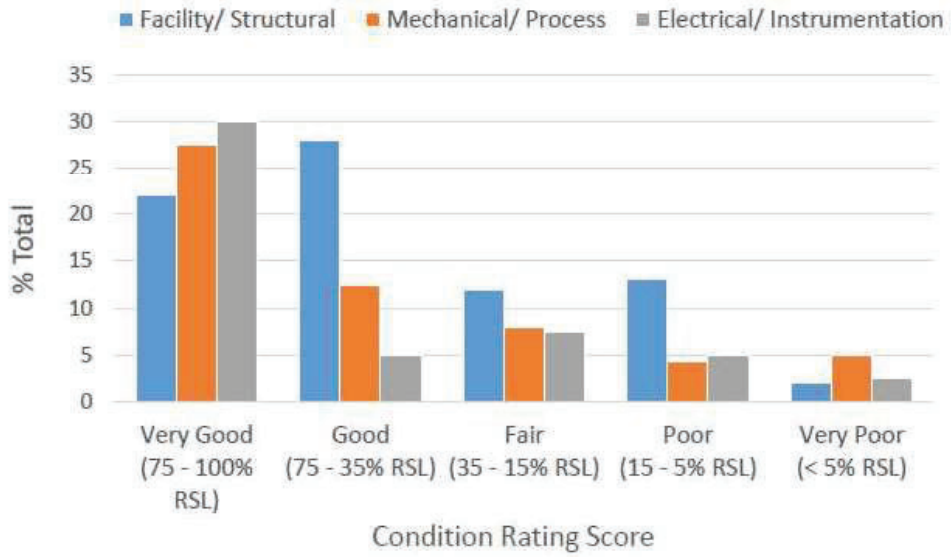


For all of the reasons described above, the new AMP incorporates functional condition as method of capturing system adequacy. This new measure reflects the needs of the system in terms of delivering water at adequate service levels in all areas of the District.

The physical condition of the District's water system has been evaluated as good. As indicated by the following graphs, most mains have a very low to low probability of failure (PoF)[2]. Furthermore, of the mains designated as critical, relatively few of those have a high to very high PoF.



For non-linear assets such as reservoirs, pump stations, and treatment plants, the assets are predominantly designated in very good or good condition. This is illustrated in the graph below.



While the current assets are in good physical condition, it is the functional condition that scores lower. Engineering staff have worked to develop

[2] Staff Engineers use risk modelling measures to focus capital renewal on the most critical assets that also have higher or highest probabilities of failure (PoF.)

strategies to enhance the functional condition of the system. The strategies are predicated around developing conveyance infrastructure for a redundant water source for Eagle Lake and involves two key projects as well as water main replacements throughout the system. Those projects are highlighted in the following section of this report.

System Deficiencies and Backlog

The strategic planning horizon used for the AMP is 100 years, however it is the immediate 20 year forecast that is of key importance. The 20 year horizon uses both a hydraulic model and a risk model to identify a list of recommended projects to enhance the system, maintain or improve service levels as appropriate, and lower risk. Of the projects recommended, several are termed "backlog" to highlight their importance relative to others. The backlog projects are directed at

- building source redundancy, and incorporating resiliency into the system, and
- replacing the critical infrastructure that is rated with a higher probability of failure.

A list of backlog projects and associated Class D level[3] cost estimates appears in Table 1 below:

Table 1

Project Name or Category	Estimate
11st Pump Station	$5.3M
Westmount Pump Station	$6.6M
Westmount Reservoir	$6.8M
Subtotal	$18.7M
Watermains – Capital Upgrades (hydraulic modelling)	$7.8M
Watermains – Priority Renewals (risk modelling)	$6.9M
Other	$0.6M
Subtotal	$15.3M
Grand total	$34M

Major Project Descriptions

[3] Estimate (±50%): A preliminary estimate which, due to little or no site information, indicates the approximate magnitude of cost of the proposed project. This overall cost estimate may be derived from lump sum or unit costs for a similar project. It may be used in developing long term capital plans and for preliminary discussion of proposed capital projects.

The 11th Street pump station is a critical part of the Chartwell pump stack working in tandem with Cross Creek, Burnside, and Vinson pump stations to successively pump to reservoirs supplying flows to the eastern pressure zones of the District. In addition, although the District's water supply system west of Cypress Creek is primarily fed by the Eagle Lake source, the 11th Street Pump Station has the ability to pump and convey Metro Vancouver water from the Mathers connection along the Queens Avenue transmission main to the Westmount pump station.

From Westmount, water is then pumped up to the C2 reservoir and subsequently cascaded down through the lower pressure zones in the western portions of the municipality. The 11th Street pump station is beyond the end of its useful service life and the Westmount pump station and reservoir have been found to have insufficient pumping capacity and supply volumes to meet the requirements of the District's water system. Both stations and reservoir are critical components of the District's long term ability in servicing its residents with full redundancy for the Eagle Lake water supply.

The 2015 drought demonstrated the vulnerability of the water supply servicing available to the western areas of the District. As such, a new Westmount pump station, reservoir and 11th Street pump station are required to ensure a continued supply of potable water to all parts of the District.

5.2 Sustainability

Timely renewal of assets is a key component in maintaining a healthy water utility system.

5.3 Public Engagement and Outreach

The District has engaged with residents on numerous occasions over the years related to utilities asset management and impact on utilities rates. On-going communications include the District web page and an annual "utilities insert", which is provided to all ratepayers with the first quarter utilities statement. The 2021 first quarter utilities insert included information about the forthcoming updated AMPs for water and sewer.

In addition to annual and periodic communications, the District has undertaken several more substantial engagement exercises specific to asset management. In 2009-10, staff initiated a public engagement process to educate residents about findings of the first series of utility asset management plans. This engagement included workshops and presentations to ratepayers associations, where staff received overall support for addressing the anticipated asset funding gap in utilities rate-setting process. This engagement took place prior to Council's adoption of the CREF approach.

In 2017, staff undertook another engagement process to inform ratepayers about proposed utilities rate restructuring for water and sewer resulting from the update to the District's rate model, which is used for rate setting and is different to the hydraulic model referenced earlier within this report. This engagement took place in advance of the District's transition to a four-block structure for metered water, and introduction of separate line items for municipal and regional sewer charges to improve transparency for ratepayers. Engagement included additional utility bill inserts with information about proposed changes, and in-person workshops.

Outside of the municipal utilities, the District has undertaken other efforts to engage and educate residents about long-term management and funding needs of the District's many assets. This includes public engagement associated with the general fund Asset Levy established in 2016 for funding non-utilities assets.

Staff will continue to apply the District's Community Outreach and Engagement Policy when engaging with residents on issues pertaining to the Water Utility.

5.4 Other Communication, Consultation, and Research

This report and the upcoming rate setting process for the Water Utility Fund is a collaborative effort with the Finance Department.

Findings in this report are informed by the Water Utility Asset Management Plan completed in June 2021.

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

6.0 Financial Implications

The District's first AMP for the water system utility assets was completed and adopted by Council in 2010. This AMP gave rise to the establishment of a water utility CREF; the factor applies to all assets paid for by water utility rates. It is separate from the general fund Asset Levy established in 2016 for funding non-utility assets.

Currently, the median single family water cost is $754 per year. Any additions or subtractions from the funding associated with the water utility costs affect water utility user rates. These changes have no effect on taxes or the general fund Asset Levy.

This report recommends that Council direct staff to incorporate and adapt the findings and recommendations identified within the 2021 water AMP into the fall water utility rate setting process. Staff are suggesting two separate strategies to address the backlog projects identified above and to secure the long term future of the utility assets. The first is to increase the

existing CREF, to fund the asset investment required in the watermains. Watermain replacement can be done over time, as finances and capacity allow. However, rebuilding of the pump stations and reservoir require a significant upfront investment, and for this need, staff are recommending borrowing the funding. If Council supports this recommendation, staff will complete the detailed design work for these projects and then prepare a loan authorization bylaw to secure the funds.

Staff have completed some preliminary calculations to determine the resultant effects on the median user bill. These calculations are reserved to the suggested changes contemplated in the AMP only, and do not consider other potential drivers for rate setting such as increase in Metro Vancouver water purchase costs, etc.

The report recommendations that result in a financial impact are:

i. staff prepare the water utility rate setting process to account for a phased increase of the annual capital funding program in order to meet and sustain long-term funding requirements for the Districts water distribution and treatment systems; and

ii. staff proceed with preparing loan authorization bylaw(s) to fund the reconstruction and updating of the Westmount Pump Station and Reservoir.

As illustrated in Table 2, item (i) above will have the effect of increasing the median single family water users bill by $11 to $45 per year, depending upon the time period of the phased increase (and the resulting CREF).

Table 2

Period (yrs)	Description	Annual Rate Increase
5	Rapid	$45
10	Medium	$23
17	Current	$11

Similarly, as illustrated in Table 3, item (ii) above will have the effect of increasing the median single family water users cost by $45 to $49 depending upon the amortization period of the loan selected. This is a one time increase, not an annual increase, and will remain in place for the duration of the loan.

Table 3

Amortization (yrs)	MFA (combined rate)	One time Rate Increase
10	2.41%	$49
15	2.88%	$45
20	3.09%	$45

7.0 Options

7.1 Recommended Option

THAT

1. the report dated June 23, 2021 titled "Water Utility System Asset Management Plan 2021" be received for information;
2. staff prepare the water utility rate setting process to account for a phased increase of the annual capital funding program in order to meet and sustain long-term funding requirements for the Districts water distribution and treatment systems;
3. staff develop and incorporate into the water rate setting process, a water utility capital renewal escalation factor that captures construction inflation costs and that this factor be updated and reviewed with Council every three years or as appropriate beginning in 2024; and
4. staff proceed with preparing loan authorization bylaw(s) to fund the reconstruction and updating of the Westmount Pump Station and Reservoir.

7.2 Considered Options

Council may request additional information on the Water Utility Asset Management Plan and utility finances, or provide alternate direction (to be specified).

8.0 Conclusion

In 2010, the first water utility AMP was completed and since then the utility has been operating under this plan. The 2010 plan is being replaced by the 2021 AMP. The new plan calls for significant investment to ensure that the water system is resilient and can adapt to the effects of growth, climate change, and ensure redundancy for areas serviced primarily by the Eagle Lake source.

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Appendices:

Appendix A – Executive Summary - District of West Vancouver Water System Asset Management Plan 2021

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District of West Vancouver

Water System Asset Management Plan

2021

Document Control

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Executive Summary

Background

In 2010 the District developed its first Water System Asset Management Plan (WSAMP). The plan is referred to as 2010 WSAMP. The 2010 plan represented the first attempt to model the long-term renewal funding requirements for the entire water system and used the asset data that was available at the time, and best practices of the day. At the conclusion of the 2010 WSAMP, District staff spent time discussing the results with Council and the Public in multiple workshops and open houses. Concurrently, there was significant media attention being drawn to the Canadian National Infrastructure Gap which supported the findings of underfunding within the local system. At the conclusion of the consultation process, Council approved a new financial model for the Water System which included a higher level of capital renewal investment.

While the 2010 WSAMP was an important advancement in strategic system planning, it was deficient in several key areas. The 2010 plan used data and limited system models that were available at the time. Data limitations were especially noteworthy around non-linear assets such as the Eagle Lake Filtration Plant, water reservoirs, and pump stations. In terms of modelling, a fully calibrated hydraulic model was not available at that time either. Without a hydraulic model, the District's ability to analyze the system for capacity, working pressures, fire flow availability, and source and system redundancy was limited, and therefore asset upgrades or new assets required to meet the standard level of service criteria which would be required for residents as captured under a Master Water Servicing Study were not included in the 2010 WSAMP. The approach taken in 2010 was to replace assets 'like for like' with no upgrades or new assets envisioned.

In the summer of 2015, the Lower Mainland experienced what was termed a major drought. Metro Vancouver introduced unprecedented levels of water conservation measures. A new trend of warmer and wetter winters followed by longer drier summers consistent with climate change predictions seemed to have emerged. The West Vancouver water system benefits from having two sources: Metro Vancouver and Eagle Lake. However, in 2015 the Eagle Lake supply was drawn down to minimum allowable levels with only approximately one week of water available remaining. It was found in 2015 that relying entirely on Metro Vancouver water supply is not possible due to insufficient District pumping and transmission capabilities to supply the volume of Metro Vancouver water needed for the western regions of the District. In the face of changing climate, further considerations were required to review the previous management approach to water source and system redundancy in the District's water system.

In 2016, a Master Water Servicing Study (2016 MWSS) was completed for the District. The study examined the capacity of the system to deliver sufficient volumes of water at acceptable pressures and fire flows at all locations. Using a calibrated hydraulic model at that time, the study considered the effects of climate change on water supply provision, and future demands on the system due to increased population as projected by the OCP. While increases in population and the associated demands do influence the long-term water supply strategy, it is the level of service provided by the water system in the present day and the effects of climate change that was determined to be the most impactful.

The MWSS ushered in a new management approach to the water system. Planning for climate change with drier summers and decreasing yearly snowpack further stresses and reduces the availability of supply redundancy within the system. Redundancy of supply and improving the ability to supply Metro Vancouver water to the western areas of the District is a significant challenge and requires increased pipe capacities, increased pumping, and storage. Without these alterations to the system, the District increases the risk to its ability to deliver adequate levels of service to its residents during summer high water usage and peak periods.

This latest iteration of the Water System Asset Management Plan, dubbed 2020 WSAMP, is built upon the 2010 WSAMP and the findings and recommendations of the 2016 MWSS.

Comparing the renewal funding requirements of the 2010 and 2020 WSAMP's reveals the new management change in financial terms. The long term 100 year forecast from the 2020 plan is approximately $6.7 Million annually, inclusive of backlog, compared to the 2010 annual average expenditure of $4.8 Million, inclusive of backlog. Allowing for inflation, the numbers are fairly consistent in today's dollars. However, the backlog from 2020 ($34 Million) is significantly different than that described in 2010 ($15 Million). The largest difference is due to the construction cost inflation (>200% in unit cost rates over the last 10 years), as well as immediate needs to address the system deficiencies in capacity to provide system demands, fire flows and source and system redundancies which was not part of the original 2010 WSAMP. The main driver is the upfront costs for building new facilities, or the upgrade and update of non-linear infrastructures which have reached their end of useful life. For example, unlike replacement of a watermain which can be divided up into smaller sections and replaced through multiple years, it is not possible to build half a pump station or a quarter of a storage reservoir. The project must be completed all at once and capital investment cannot not be spread over time. For the WSAMP to be successful, a comprehensive funding strategy must be developed to complement the asset management strategies.

System Description (Inventory, Value, Condition)

As of 2020, the system is comprised of dams, water treatment plants, storage reservoirs, pump and PRV stations, transmission and distribution mains, service connections, fire hydrants and water meters, as summarized in the table below. Watermains are the largest asset group and represent 77% of the asset base. Pressure Reducing Valve (PRV) Stations are the smallest asset group by replacement cost. While the growth of West Vancouver is comparatively small, the length of water mains has increased by 9 km since 2010. Additionally, over the last decade, construction costs for main renewals have effectively doubled. Since watermains make up the majority of the system, the replacement value of the water system has also doubled since the 2010 WSAMP.

Water System Assets

Asset Group	Quantity	Total Estimated Replacement Value
Dams	2	$ 10,058,000
Water Treatment Plant	2	$ 26,428,000
Reservoirs	23 (1)	$ 41,889,000
Pump Stations	10	$ 42,222,000
Pressure Reducing Valves (PRV)	35	$ 4,655,000
Watermains (2)	329 km	$ 451,330,000
Water Services (2)	12,410	-
Fire Hydrants (2) (3)	1,427	-
Water Meters (4)	12,372	$ 10,200,000
Total		$ 586,782,000

(1) This total includes 3 reservoirs that are out of service: Cypress 1 (C1), Westmount, and Montizambert South Reservoirs.
(2) Hydrants, services and appurtenances costs have been included in the estimated Watermains cost of $451,330,000.
(3) Owned by the District, excludes any and all private hydrants.
(4) Meter information based on the data from the Meter Replacement Program supplied by the District.

Understanding asset condition is a critical step towards predicting what the future needs of an asset will be. Condition also reflects how well the asset can provide the services it supports. An asset in poor condition is likely to be less reliable and may not achieve service-level targets. Condition can also help to quantify and understand service risk.

In the context of the 2020 WSAMP, asset condition can be considered in three ways:

- Physical condition – i.e. is the asset fit for use and in a state of good repair, or is it near the end of its estimated service life?
- Functional condition – i.e. can the asset meet current requirements for levels of service, such as fire-fighting capacity and minimum service pressures?
- Demand condition – i.e. is the asset fully utilized, or not used at all?

To illustrate the difference between the three types of asset condition, consider a storage reservoir. It provides potable water to local residents and carries some emergency volume of water in the event of a fire. Physically, it might be in great shape if it has had regular upkeep and inspections. Functionally, it might now be considered poor if it can't meet more stringent firefighting requirements for some recently constructed high rises in the area. From a demand perspective, the day-to-day water usage might be low or there might be a pump station also supplying the area that does a sufficient job of meeting residential water consumption needs; in this case the reservoir has a poor demand condition rating. This example illustrates that while an asset might be in good physical shape and have a long remaining service life, it might not meet the changing needs of the area it services and therefore requires upgrades or operational changes to be useful.

In terms of functional condition, the 2016 MWSS recommended capital upgrade projects which have been carried forward and updated for this 2020 WSAMP. As noted, there is an approximate $34 Million backlog which represents high priority projects which are yet to be addressed. The backlog includes storage and pumping improvements to the District's major transmission system which pumps Metro Vancouver water to the western portions of the District. These projects are essential for improving water system resiliency to meet existing and future needs, providing water system redundancy to the western portions of the District. In addition, the backlog includes numerous watermain capacity upgrades required to improve available fire flows throughout the distribution network. There are also several priority renewals of high risk watermains (aged watermains in poor condition in high impact areas) included in the backlog. A full breakdown of the $34 Million backlog is presented in the Financial Forecast Section of the Executive Summary.

While the backlog indicates substantial improvement efforts are required, it is worth noting that the District has made significant strides to improve the water system network. Since the 2016 MWSS, the District has upgraded critical portions of the transmission mains supplying pumped water to the west. As well, the effective upsizing of key distribution mains along with recommended operational changes has drastically increased the available fire flows in some of the most heavily populated and vulnerable areas in the southeast portions of the District.

An independent 2018 Fire Underwriters Survey concluded that the District's Public Fire Protection Classification (PFPC) grading is 3/10, a 1 being the highest possible rating. The PFPC grading system is a measure of a community's overall fire defenses against fire hazards and safety risks present within the community. The overall grading considers a community's fire departments, fire safety controls, fire service communications, and the state of the water supply system. The District received grades of 1's and 2's in most of the categories except for the water supply system which received a grade of 4 which brought the overall grade to a 3. The water supply evaluation indicated shortfalls in fire flow delivery and pumping capacity; however, the District ranked exceptionally well in most other areas including source reliability, maintenance, distribution of hydrants, system management and other key factors.

In terms of physical and demand condition ratings, the District's water system assets are in good shape. In general, the District's water system assets (excluding watermains) are in Very Good to Fair physical condition. However, there are a few facilities such as the 11th Street Pump Station which are in Poor or Very Poor condition that require repairs and/or upgrades. Additionally, there are facilities in otherwise fair condition that have subcomponents which require major upgrades or repairs such as the membranes at the Eagle Lake Water Treatment Plant and the piping and valving at the Cross-Creek Pump Station. For watermains, determining physical condition is difficult given that they are buried infrastructure. Proxy measures of condition (i.e. age, break history, material type, method of installation, maximum

service pressures) were used to estimate the physical condition of watermains, expressed as a probability of failure. The majority of watermains were found to have Very Low or Low probability of failure. Only 1% of the watermain network is rated at Very High failure probability requiring immediate repairs/upgrades, which is represented in the backlog.

Levels of Service and Demand Management

A key objective of asset management is to match the levels of service that the District plans on delivering, given its available resources, with the levels of service expected by its customers. This involves understanding customer expectations and the trade-offs they are willing to make between costs and services. The services provided by District assets must also meet the legislative requirements at the municipal, provincial and federal levels. Therefore, levels of service must be written in terms that the end user can understand, and the District can effectively communicate.

The current levels of service measured in this Plan are:

- Quality – Does the service meet users' needs?
- Reliability – Is the service maintained in a state of good repair and functionality?
- Capacity – Does the service have adequate capacity?

The 2010 WSAMP recommended a bottom up assessment of the water system to determine infrastructure renewal priorities. The District followed up the 2010 WSAMP with the 2016 MWSS which through hydraulic modelling, condition assessments, and risk-based renewal planning provided the District with a Capital Projects List identifying and prioritizing renewals and upgrades to the water system to meet existing and future levels of service.

The demand on District infrastructure can impact how the infrastructure is managed and maintained. The demand drivers that may impact the District's service delivery include changes in population, land use, per capita usage, and climate change. Demands for increased services due to population growth or densification will be addressed through a combination of upgrading existing assets and providing new assets. System resiliency and redundancy will remain a key strategic focus moving forward, especially due to uncertainties in future service delivery due to potential impacts from climate change.

Managing Risk

The importance of risk assessment at both the service level and the asset level is to provide early warning of potential issues that could adversely affect delivering levels of service. When risks are known and have a rating, District staff can focus on the high risks and adapt the management of those assets to reduce the risk level (i.e. design and implement appropriate mitigation measures). The results of asset level risk assessments are considered when reviewing lifecycle strategies to determine the most appropriate treatments, planned maintenance, and inspection frequencies for a particular asset or group of assets. Both asset level risk and service risks were considered in prioritizing capital works projects and other funding decisions.

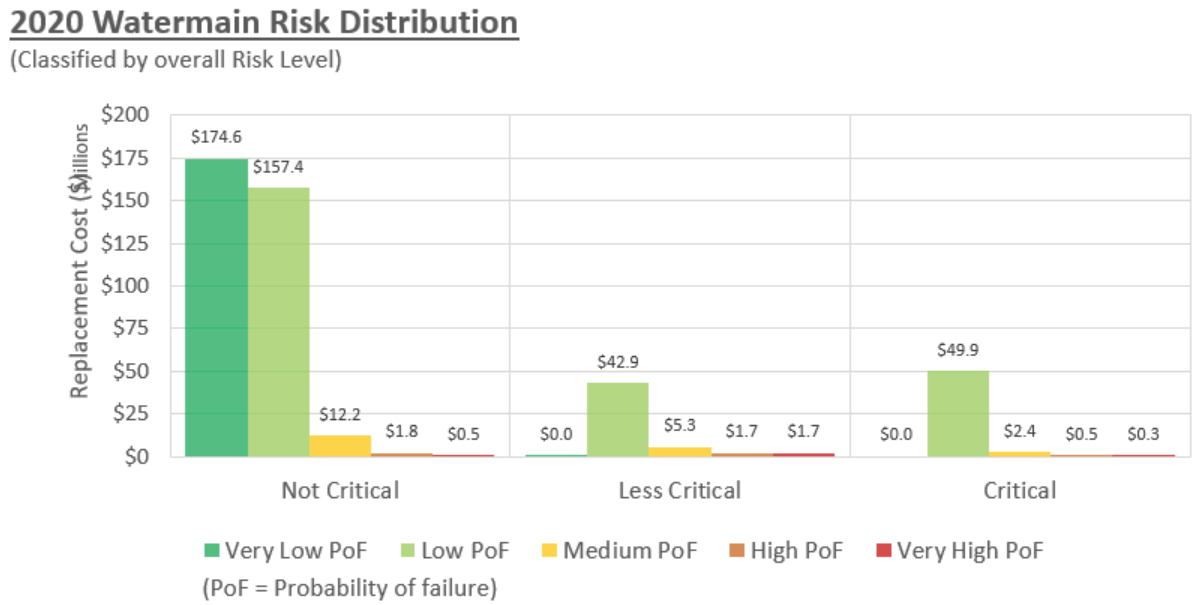
A high-level assessment of risks associated with service delivery was developed at the water asset level, and included consideration towards planning, management, and hazards/environmental risks. The next step would be to refine the process and assign ratings for the likelihood and potential impact, to identify the high priority service risks for further action and mitigation.

The District has collected and continues to collect condition and risk data on the non-linear assets in the water network through maintenance activities, regular studies and risk assessments. Non-linear assets by their nature do not tolerate failures and outages in their service areas for prolonged period of times, therefore reinvestment in non-linear assets is typically prioritized by their likelihood of failure which is tied to estimated service lives. That is not to say that a risk-based approach is untenable; a ranking of the criticality of non-linear assets based on their service areas and levels of redundancy would help the District prioritize reinvestment needs for non-linear assets of similar vintages, and for some assets this has already been considered through priority upgrades over the next 20 years identified in

the 2016 MWSS Capital Projects List. For this Plan, the financial reinvestment outlook for the next 100 years considers regular renewals of major non-linear asset subcomponents, with prioritized replacements and upgrades based on previous studies and assessments.

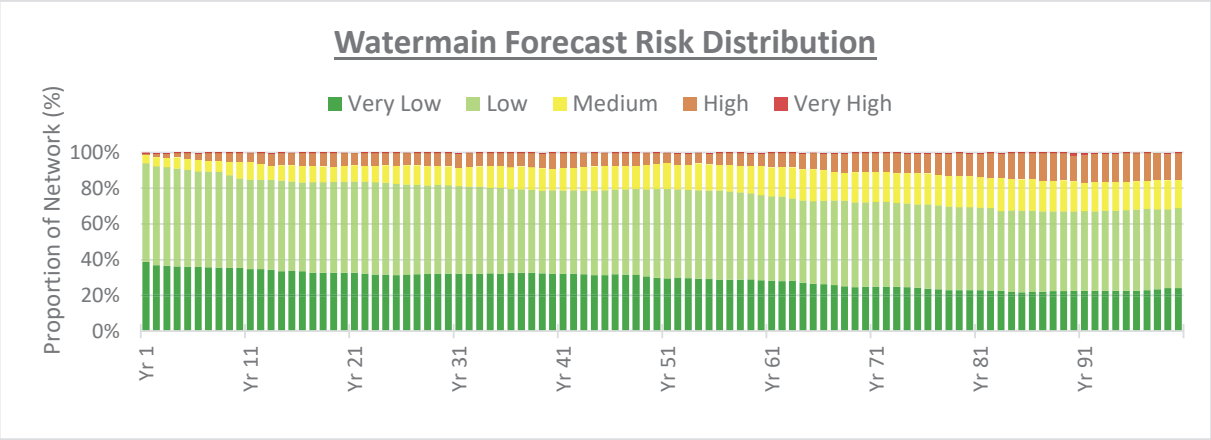
Watermains are the largest asset group in the District's water utility and represent 77% of the total water utility asset base. By virtue of being largely buried, direct measurement of their physical condition is difficult and cost-prohibitive, therefore watermains as an asset group across all municipal utilities present a challenge to managers responsible for assigning capital expenditures to their replacement or rehabilitation. The watermain risk model developed as part of the 2016 MWSS and updated for this Plan was designed to support informed management decisions about replacement programming. The tool helps to focus resources and efforts on critical watermains by standardizing assessments and decision criteria for watermains. The model uses a risk framework built around evaluating the consequence of failure relative to three primary types of impact (Social, Economic, and Environmental).

The following figure below shows the current condition of the District's watermain network, expressed as risk of failure probability (very high to very low) for pipes in critical, less critical and not critical categories. The majority of watermains have Very Low or Low probability of failure, and the replacement costs for higher risk critical pipes is a small fraction of the total asset base.



The current risk profile of the watermain network indicates that the majority of the mains are in Very Good to Fair physical condition. Therefore, there appears to be some capacity for the network to absorb some deterioration to within acceptable risk levels over the next twenty to sixty years. This would provide some opportunity to finance other projects such as the capital upgrades from the 2016 MWSS targeting improved firefighting capacity and system redundancy, which make up the bulk of the necessary projects in the next twenty years including most of the costs associated with the $34 Million backlog.

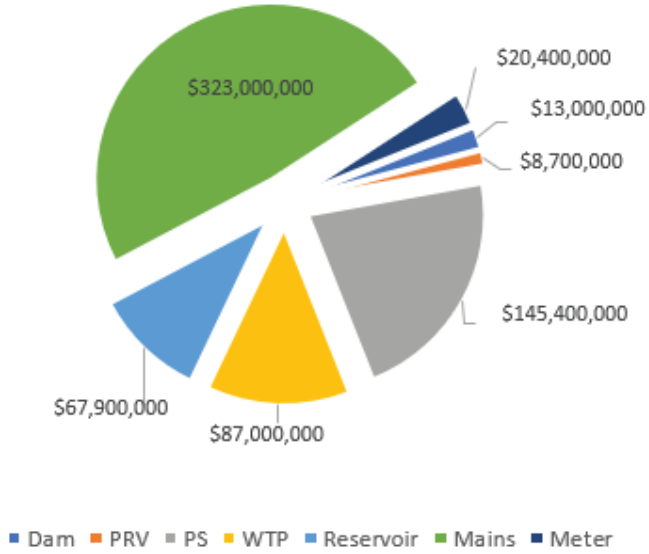
As illustrated in the following figure, a fixed annual budget of $3 Million for watermain renewals was found to be required to maintain most of the network in Very Good to Fair physical condition for the next 60 years with steady and gradual deterioration (increase in risk). The $34 Million backlog and the financial forecast presented in the following sections would be inclusive of this baseline $3 Million watermain renewal level. Beyond the 60-year horizon, annual watermain renewal budgets will need to increase to continue to manage risk at this level without further deterioration. In the next iteration of the WSAMP, as the District works toward completing all anticipated capital and upgrade projects in the next twenty years, consideration should be given towards a future shift in funding towards increased watermain renewals to mitigate undesired watermain network degradation in the long-term.



Watermain Forecast Risk Distribution for 100 Year Investment Timeline

Financial Forecast

The long-range financial forecast for the 2020 WSAMP indicates a 39% increase to the overall 2010 WSAMP forecast adjusted for today's dollars. This result may seem surprising considering the degree to which watermain construction in the District has increased in the last decade. However, significant increases in construction costs which have been a major factor in driving this gap wider have been partially offset by the refined approach to asset replacement as a function of a better understanding of asset conditions and total useful life estimates as captured in this 2020 WSAMP. By looking at the existing condition of the District's assets, estimated service lives have increased across the board which has reduced the number of renewals required over the 100-year period.



Forecasted Capital Expenditures by Asset Type – 100 Year Horizon

Where there are significant cost differences between the 2010 WSAMP and the current Plan is in the first twenty years, particularly to address the funding gap identified to address front-loaded high priority upgrade projects aimed at improving current levels of service requiring significant financial investment. The following table breaks down the total expenditures estimated over the entire planning horizon.

Period	Total Expenditures	Average Annual Expenditures (1)
Backlog (2021)	$34 M	-
5 Years (2021-2025)	$71 M	$14.2 M
10 Years (2021-2030)	$111 M	$11.1 M
20 Years (2021-2040)	$208 M	$10.4 M
100 Years (2021-2120)	$665 M	$6.7 M

(1) Average annual expenditures over each period assume pay-as-you-go funding, with no provisions towards borrowing, DCCs, grant-funding, or other funding mechanisms.

While an average annual expenditure of $6.7 Million over the entire 100 year planning horizon might be reasonably achieved, bridging the gap between the current annual capital budget of approximately $4.8 Million and expenditures over the next 20 years to 2041 will require significant planning, effort, and discussion on how much and how fast to increase water utility rates and/or pursue other funding sources. The 2010 WSAMP identified a significant funding gap at the time which the District was able to drastically improve by increasing capital spending five-fold, going from a capital budget of approximately $1 Million in 2010 to almost $5 Million in the present day.

The current estimated backlog is approximately $34 Million compared to a backlog of $15 million in the 2010 WSAMP. The 2010 WSAMP provided a high-level top-down overview of funding requirements and used limited data and system models that were available at the time. Construction cost inflation (>200% in unit cost rates over the last 10 years) also affects the increase in overall projects costs. The approach taken in 2010 was to replace assets 'like for like' with no upgrades or new assets envisioned. The increase in the current backlog reflects the need for increased system resiliency, capacity upgrades, and risk-based priority renewals based on the comprehensive modelling analysis from the 2016 Master Water Servicing Study.

The following table breaks down the $34 Million backlog of high priority projects.

Asset Group	Description	2020 Estimated Cost
Pump Stations	11th St	$ 5.3 M
	Westmount	$ 6.6 M
Reservoirs	Westmount	$ 6.8 M
Watermains	Capital Upgrades (1)	$ 7.8 M
	Priority Renewals (2)	$ 6.9 M
Other		$ 0.6 M
Total	Various renewals (3)	$ 34.0 M

(1) Watermain capital upgrades capture new or upsized watermains proposed in the 2016 MWSS which are required for increasing available firefighting capacities and improving system redundancies. They are prioritized and sized to the 2041 OCP horizon to meet future population needs as well as current levels of service.

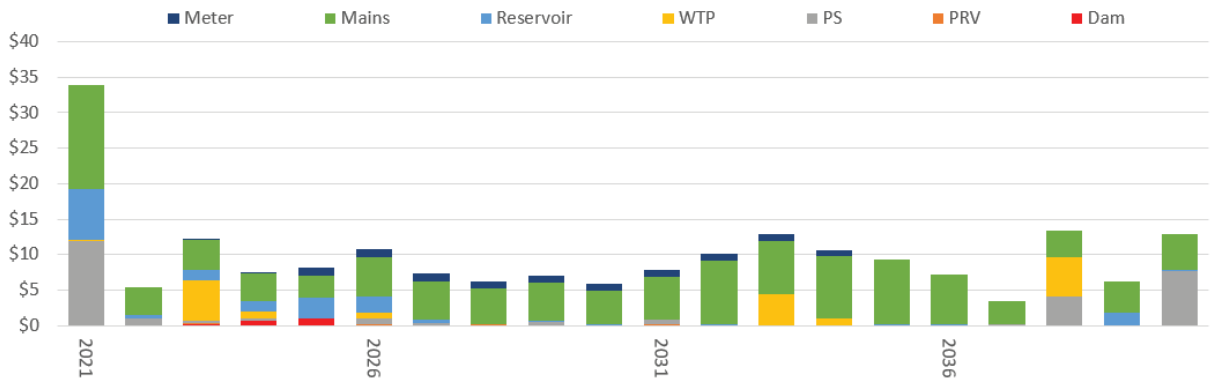
(2) Watermain priority renewals are size-on-size replacements determined by the watermain risk model using a $3 Million annual reinvestment budget. Renewal timelines were compared and aligned with the watermain capital upgrades to determine the most appropriate intervention periods and sizing requirements. Beyond the 2041 horizon, all watermain works are size-on-size renewals prioritized based on risk ratings.

(3) Include various facility renewals, chiefly mechanical upgrades at reservoirs.

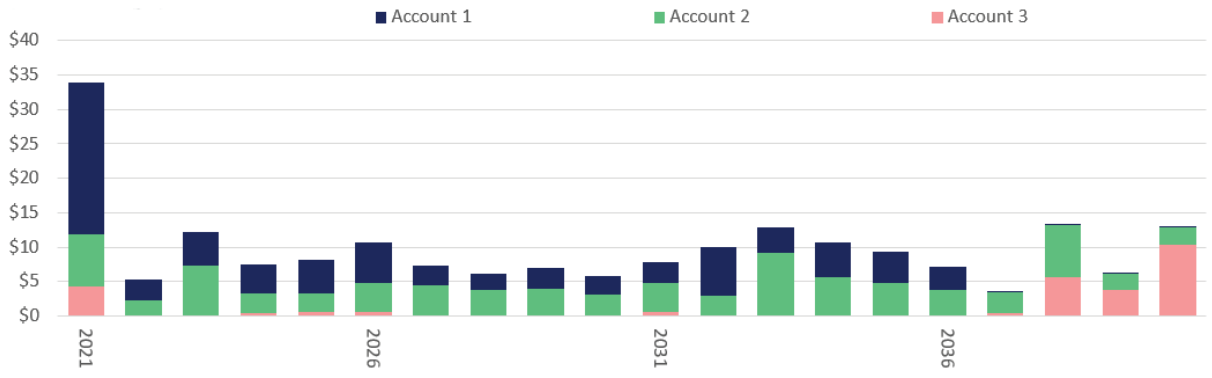
Per the table above, the 11th Street Pump Station, Westmount Pump Station, and Westmount Reservoir projects account for 50% of the backlog. All three assets are currently undersized to meet existing and future water conveyance, water supply redundancy, and fire fighting needs, based on the latest hydraulic modelling studies available. They form the critical backbone of the supply system that pumps Metro Vancouver water to the western portions of the District. Without the upsizing of these critical assets, there is significant risk towards the future uninterrupted supply of potable water to the western portions of the District during hot summer periods when there is a limited water supply at the District's Eagle Lake source. As these projects benefit future growth, there is opportunity for cost-sharing with developers.

The $7.8 Million in watermains capacity upgrades are to improve the availability of fire flows throughout the network. These upgrade projects were identified and prioritized during the 2016 MWSS using the latest hydraulic water model, which was not a tool available during the development of the 2010 WSAMP. The remaining $6.9 Million in watermain projects address priority renewals for high-risk watermains. These are borne out of a watermain risk model developed for the 2016 Master Water Servicing Study and updated for the 2020 WSAMP.

The financial forecast depicted in the following figure illustrates the current level of tolerance for risk and service levels over the next 20 years.



20-year Forecast Expenditure by Asset Group



20-year Forecast Expenditure by Account Type

Note:

- Account 1 describes upgrades to the network to improve firefighting capabilities and system redundancy
- Account 2 describes size-on-size renewals and replacements, based on estimated theoretical service lives of assets and their components
- Account 3 describes infrastructure upgrades that are associated with OCP growth, which the developer would be partially or wholly funding

Many large projects identified in the 20-year financial forecast are critical infrastructure with limited redundancies that cannot tolerate prolonged outages or reduced service levels due to failure or increased loading on the network, which makes deferring key projects difficult. Therefore, being explicit about the risk of pursuing or not pursuing critical projects will require a dialogue on balancing additional funding needs and resources in the immediate future with safe and reasonable adjustments to current risk tolerances and levels of service provided.

As construction costs, population growth, and climate trends towards longer, drier summers continue to rise, a "business-as-usual" approach to water utility reinvestment poses significant risks to the District's ability to deliver adequate levels of service. This includes risks to supply redundancy and the ability to supply Metro Vancouver water to the western areas of the District, as well as risks to adequate firefighting supply to all users within the District, especially during summer high water usage and peak periods.

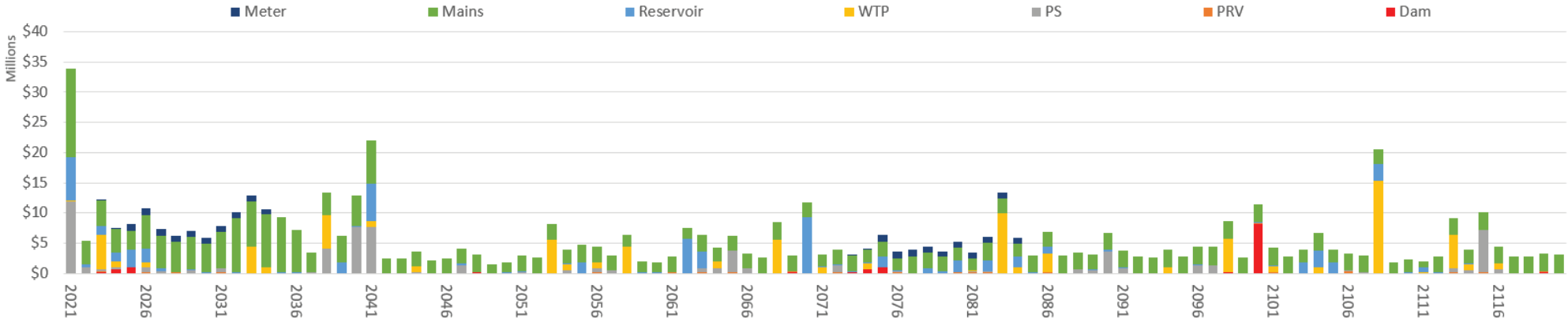
Mitigative Measures / Next Steps

There are mitigative measures to reduce risk and strain on the water utility which may allow deferral of some project costs, and could include, but are not limited to: tighter summer watering restrictions, more punitive tiers in the water rate system, provisions for pumper trucks to haul water in the summer from the Montizambert Creek system/Metro Vancouver for firefighting and general consumption, and revisiting firefighting design criteria (i.e. shifting from

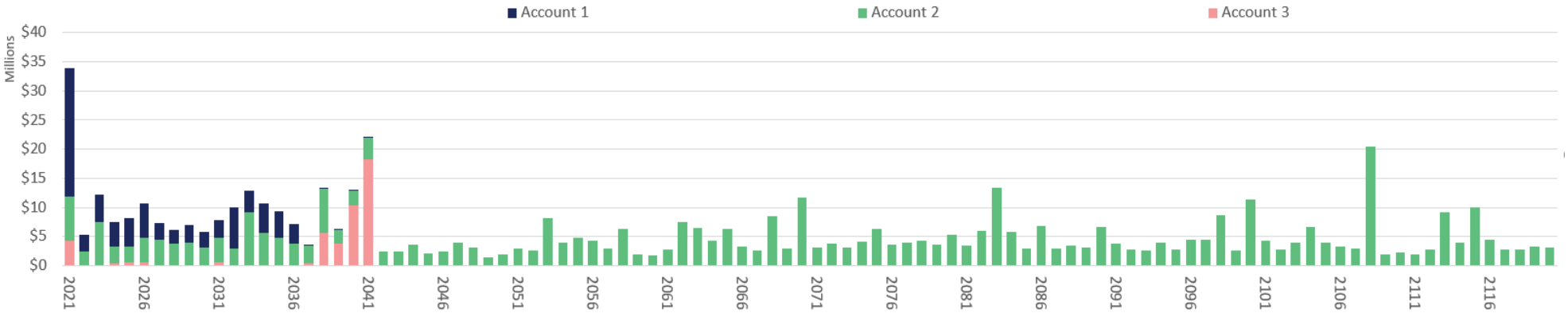
conservative/insurance-based FUS fire flow requirements, which is a popular metric in BC, towards NFPA design criteria which could generally provide lower fire flow requirements based on modern building and sprinkler system designs; a precedent is currently being developed in the City of Ottawa).

Mitigative measures should be considered along with the development of a comprehensive funding strategy. A “pay-as-you-go” approach to utility funding will not adequately bridge the gap between current and required funding levels without steep utility rate increases. Considerations towards grant funding, debt servicing, DCC’s, and any other possible funding mechanisms should be considered for the District’s ultimate funding strategy moving forward.

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



100-year Forecast Expenditure by Asset Group



100-year Forecast Expenditure by Account Type

Note:

- Account 1 describes upgrades to the network to improve firefighting capabilities and system redundancy
- Account 2 describes size-on-size renewals and replacements, based on estimated theoretical service lives of assets and their components
- Account 3 describes infrastructure upgrades that are associated with OCP growth, which the developer would be partially or wholly funding