City of Richmond

Report to Committee

To:	Public Works and Transportation Committee	**Date:**	August 16, 2019
From:	Jason Ho, P.Eng. Manager, Engineering Planning	**File:**	10-6060-01/2019-Vol 01
Re:	**Ageing Utility and Road Infrastructure Planning – 2019 Update**		

Staff Recommendation

That the staff report titled, "Ageing Utility and Road Infrastructure Planning – 2019 Update", dated August 16, 2019, from the Manager, Engineering Planning be utilized as input in the annual utility rate review and budget process.

Jason Ho, P.Eng.
Manager, Engineering Planning
(604-244-1281)

Att. 6

REPORT CONCURRENCE		
ROUTED TO:	**CONCURRENCE**	**CONCURRENCE OF GENERAL MANAGER**
Finance Department	☑	
Roads & Construction	☑	
Sewerage & Drainage	☑	
Water Services	☑	
Transportation	☑	
REVIEWED BY STAFF REPORT / AGENDA REVIEW SUBCOMMITTEE	**INITIALS:**	**APPROVED BY CAO**

Staff Report

Origin

Staff have previously reported to Council on the estimated long-term capital requirements for age-related infrastructure renewal on a biennial basis. The last report was brought forward in 2017. This report updates those estimates to reflect current inventory, new inspection data, evolving theory on infrastructure service life, and changing infrastructure replacement pricing.

This report supports Council's Strategic Plan 2018-2022 Strategy #1 A Safe and Resilient City:

> *Enhance and protect the safety and well-being of Richmond.*
>
> *1.2 Future-proof and maintain city infrastructure to keep the community safe.*

This report supports Council's Strategic Plan 2018-2022 Strategy #4 An Active and Thriving Richmond:

> *An active and thriving community characterized by diverse social and wellness programs, services and spaces that foster health and well-being for all.*
>
> *4.2 Ensure infrastructure meets changing community needs, current trends and best practices.*

Background

This report outlines the current and long-term financial requirements for maintaining and replacing the City's ageing infrastructure. The goal is to ensure the City has the capacity to meet the financial challenges of today and the future, while maintaining current levels of service.

The ageing utilities and roads infrastructure analysis is based on typical or standard service life for specific types of infrastructure, modified based on the City's experience. There are a number of local factors that can impact the actual useful life of a piece of infrastructure, such as soil type and quality of original installation. The long-term analysis is essential for long-term budget projections, but has limited use for identifying exact replacement dates for specific pieces of infrastructure. The 5-year capital plan identifies near-term infrastructure requirements through field observation and inspection results and is a better gauge of short-term infrastructure needs. The graphs that predict long-term infrastructure requirements are basic guides on what the City should anticipate for long-term infrastructure costs, while the 5-year capital plans more accurately identify short-term budget requirements.

Existing Infrastructure

In managing the City's extensive network of infrastructure services, staff have developed sanitary, drainage, water and pavement management computer models to predict infrastructure performance, upgrade needs, replacement cycles, and replacement costs. Coupled with field-verified condition inspection and performance review, model data plays a key role in determining the City's infrastructure replacement and upgrade programs.

Table 1 is a summary of the City's inventory of water, sanitary, drainage, diking, and roads infrastructure. The replacement value assumes that infrastructure will be replaced to meet the respective service level defined by Council. For example, the defined service level for drainage infrastructure is the 10-year storm. With climate change, the rainfall volume and intensity of the 10-year storm is increasing; therefore, replacement infrastructure typically needs to be larger to maintain the service levels. Table 2 identifies current capital funding levels, funding sources, and reserve balances.

Staff have reported ageing infrastructure assessments to Council in 2001, 2006, 2011, 2013, 2015 and 2017. The 2001 and 2006 reports to Council identified that infrastructure replacement funding levels were insufficient to maintain existing service levels over the long term. The 2006 report proposed a number of strategies to address funding shortfalls, and a strategy of gradual rate increases to close the identified funding gaps was adopted. Substantial progress has been made since 2006.

Long-term funding requirements have been updated to reflect changes in infrastructure replacement pricing, inventory changes through growth or capacity improvements, new inspection data, and evolving estimates of infrastructure service life.

Table 1. Infrastructure Inventory

Infrastructure	Components	Funding Source	Replacement Value (2019 Dollars)
Water	634 km Pipes 13 PRV Chambers 56 Valve Chambers	Water Utility	$800M
Sanitary	569 km Pipes 153 Pump Stations	Sanitary Utility	$705M
Drainage and Diking	585 km Pipes 39 Pump Stations 61 km Culverts 165 km Watercourses 49 km Dikes	Drainage & Diking Utility	$1,748M[1]
Roads and Road Assets (Non-MRN)	1285 lane km asphalt 12 Bridges[2] 11,551 street lights[3]	General Revenue	$796M
Total			**$4,049M**

[1] Includes the cost to upgrade the City's perimeter dike to maintain flood protection service levels with sea level rise.
[2] Includes only bridge structures managed by the City's Engineering & Public Works department outside of the Major Road Network (MRN). Structures maintained by the City's Parks department are excluded.
[3] Excludes BC Hydro lease lights not maintained by the City.

Table 2. Annual Capital Infrastructure Funding and Reserves

Infrastructure Type	2019 Funding	Funding Source	Uncommitted Reserve Balance (July 31, 2019)
Water	$7.5M	Water Utility	$44.9M
Sanitary	$5.3M	Sanitary Utility	$33.5M
Drainage and Diking	$12.1M[1]	Drainage & Diking Utility	$25.7M
Road and Road Assets (non-MRN)	$5.0M	General Revenue	N/A
Total	**$29.9M**		**$104.1M**

[1] $12.1 million is collected from the Drainage and Diking Utility. $11.6 million is directed towards drainage and diking capital works while $500,000 is directed towards provision accounts to fund the dyke repair and box culvert maintenance programs.

Water, sanitary, and drainage and diking assets have independent utility funding streams. Required funding levels are assessed as part of this report and achieved through the annual utility rate review process. Going forward, staff will continue to present annual budget options to close existing funding gaps and, ultimately, maintain utility funding within the identified target range.

Road and road assets (paving, street lighting and bridges) are not part of a utility and are funded from the City's General Revenue.

Analysis

Total Replacement Value and Schedule

Infrastructure replacement costs for the City's water, sanitary, drainage and road infrastructure over the next 100 years have been estimated and graphed in Attachments 1 to 4. The charts also show current funding levels as well as the estimated long-term average annual funding levels (in 2019 dollars, excluding inflation) that are required to perpetually replace assets. Given the volatility of construction costs, infrastructure projects do not always follow general inflation trends. Therefore, inflation has not been included in the analysis and staff recommend the analysis be reviewed every two years to identify and integrate changes in construction costs.

The current analysis indicates that construction cost increases have been significant in recent years. Recent iterations of ageing infrastructure analysis utilized the consumer price index (CPI) to account for construction cost increases; however, construction cost inflation has been well above CPI and this trend has persisted for several years. As a result, replacement values have been updated to account for this continuing trend.

The funding requirement range represents the estimated level of uncertainty in the long-term annual funding levels, which is due to a number of variables, including:

- potential overlap between capacity-based improvements due to development or climate change;

- variability in the potential service life of the infrastructure;
- variability in the economy and the cost of infrastructure replacement; and
- unanticipated or emergency events that initiate early infrastructure replacement or repairs in excess of operating budget provisions.

Water

Staff estimate a long-term annual funding requirement of $9.2 million (Attachment 1) for the City's water infrastructure. Since 2001, Council has endorsed increases in annual Water Utility funding from $3.0 million to its current level of $7.5 million. Achieving the long-term annual funding requirement will facilitate proactive management of the City's water assets, reducing overall costs while reaching a high level of service. Proactive replacement programs have mitigated ageing infrastructure issues and maintained a low watermain break rate, minimizing service disruptions and property damage from broken watermains.

The primary focus of the City's watermain replacement program is the replacement of ageing asbestos cement (AC) water pipes with new PVC or HDPE pipes, which offer longer service lives, better seismic resilience, and higher chemical resistance in Richmond's aggressive soil conditions. Approximately 38% of the City's watermains are AC pipes. Since 2011, the watermain replacement program has replaced 59 km of AC pipes, which is approximately 19% of the AC pipe inventory. Replacement of ageing AC pipes will remain the primary focus of the City's watermain replacement programs for approximately the next 30 years. Between 2060 and 2080, replacement costs may exceed the long-term required funding level and, as a result, may require utilization of reserves and borrowing. In the long term, reaching the required funding level will repay debts incurred and allow for continued water infrastructure renewal.

Water pressure management extends the service life of AC watermains. The City introduced a pressure management program in 2014. The program has resulted in a 7% decrease in water losses through reduced pipe cracking and leakage in the water distribution system. This reduction in water losses results in approximately $1.5 million in cost savings to the City each year through reduced Metro Vancouver water purchase costs. Staff will continue to review costs and benefits of additional pressure management strategies to maximize system efficiency.

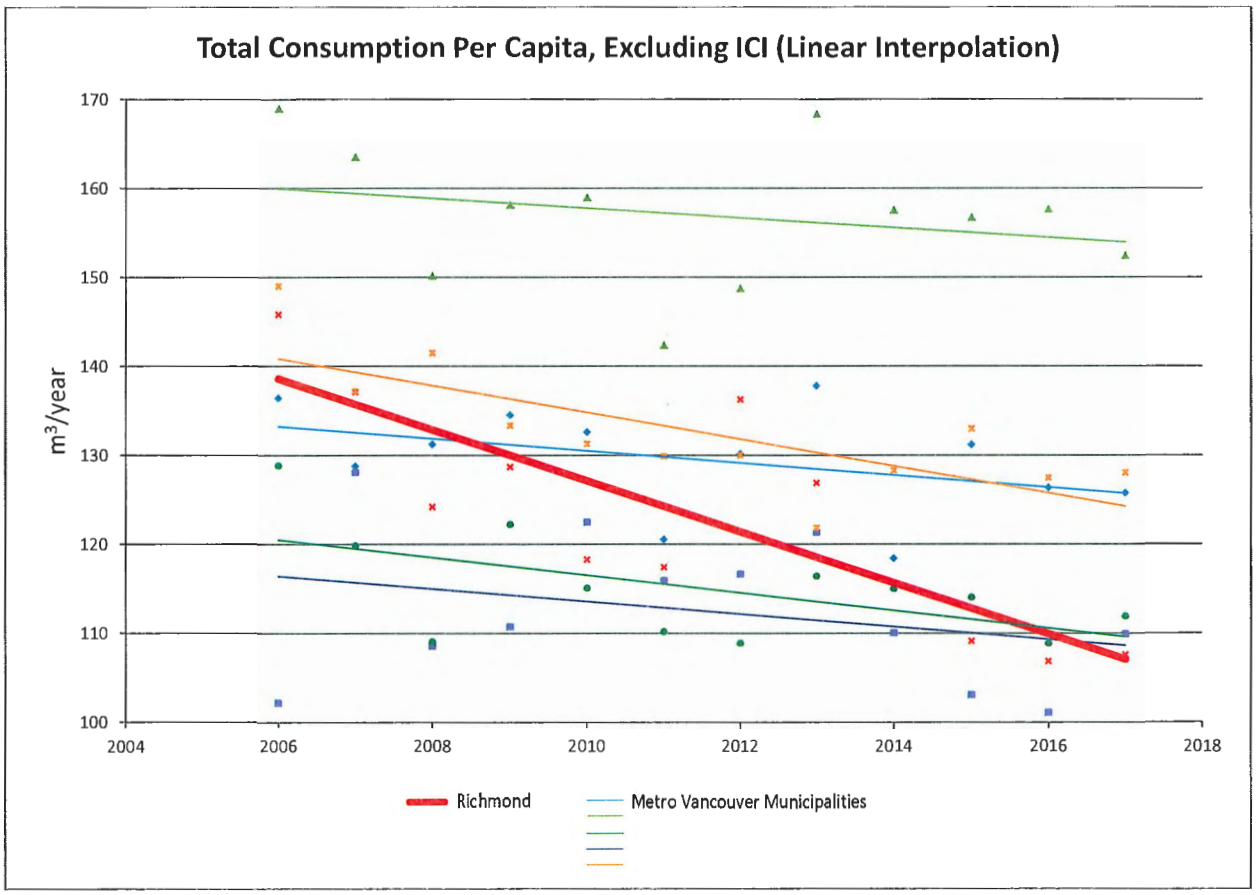
The City's water meter program is funded through the Water Utility and has been very successful. To date, 100% of single-family, 46% of multi-family, and 100% of industrial, commercial and institutional (ICI) properties have been metered. One of the benefits of water metering is the ability to identify property-side water leakage and provide incentives for leak repair. Since 2015, 573 properties have repaired leaks and applied for leak rebates, totalling approximately 940,000 m^3 in annual leak reduction. This represents $683,000 in annual savings on Metro Vancouver water purchases. The fixed base meter reading network will be universally deployed this year to read and gather real-time consumption data from 97% of the City's water meters, further improving the City's ability to detect private-side leakage.

Figure 1 shows the total consumption per capita, excluding ICI, for Richmond and neighbouring (mainly unmetered) municipalities since 2006. ICI consumption has a significant effect on total consumption per capita, typically accounting for one-third of a municipality's total consumption.

An ICI property that reduces or shuts down its production would artificially give the perception that individual water consumption has decreased. The analysis shown in Figure 1 removes the variability of ICI consumption and provides a more accurate illustration of residential consumption and water savings from residential water metering.

As illustrated, Richmond is reducing consumption at a much greater rate than unmetered municipalities. This is strong evidence that water metering is effective for reducing consumption, likely through leak identification and reduction, as well as behavioural changes and conservation.

Figure 1. Comparison of Total Consumption Per Capita, Excluding ICI



As illustrated in Figure 1, Richmond is reducing consumption at a much greater rate than unmetered municipalities. This is strong evidence that water metering is effective for reducing consumption, likely through leak identification and reduction, as well as behavioural changes and conservation.

Sanitary

Staff estimate a long-term annual funding requirement of $8.4 million for the Sanitary Utility (Attachment 2). Sanitary Utility funding has increased from $0.5 million annually in 2001 to a current funding level of $5.3 million annually. While current funding levels are adequate for short- to medium-term sanitary infrastructure replacement needs, the funding shortfall defers the

financial obligation to future years, which will place additional burden on future rate payers. As such, bridging the funding gap will be an important consideration for future utility budgets.

Inflow and infiltration (I&I) of rainwater and groundwater into the sanitary system reduces available system capacity for domestic sewage and municipal growth. I&I management is an important strategy for deferring or avoiding capacity-based system upgrades. The City maintains one of the lowest rates of I&I in Metro Vancouver, and this is a result of proactive sanitary sewer assessment and rehabilitation programs. The City assessed its complete gravity sewer inventory between 2002 and 2015. The assessment indicated the City's gravity sewers are in excellent condition and identified defects that have been addressed proactively through the capital program. The next cycle of assessments will begin in the next few years.

In the past 15 years, the City has constructed seven new sanitary pump stations, rebuilt four sanitary pump stations, performed upgrades on 13 sanitary pump stations and installed new pumps at 69 pump stations.

The impact of grease on municipal sanitary sewer collection systems is an on-going concern for the City. Following the Lansdowne Road sanitary forcemain failure due to a grease blockage in 2011, pressure sensors were installed throughout the sanitary system to identify grease build-up. Identifying grease build-up before it becomes critical facilitates a proactive grease maintenance program for forcemains and maintains a high level of service. Staff are currently reviewing opportunities for implementing grease extraction facilities in the City's sanitary sewer system to address the issues of grease build-up.

Drainage and Diking

Drainage

The required drainage funding level has increased due to inflation, emerging early box culvert deterioration issues, and improved understanding of drainage pump station costs.

The City has approximately 61 km of box culverts, the majority of which are 40 to 50 years in age. The concrete box culverts have a design life of 100 years; however, some joints are failing prematurely which has led to the development of sinkholes, often in highly travelled routes. Failed joints, if left unrepaired, ultimately lead to box culvert and roadway failure. Staff are proactively managing the condition of box culverts by identifying and repairing deteriorating joints early on to extend the lifecycle of the culverts and minimize long-term replacement costs. Council has supported a number of capital projects related to box culvert repairs. Over the past four years, approximately $7.4 million have been allocated to repairs of failed box culverts.

As part of the 2017 Utility Budgets and Rates, Council supported the implementation of a box culvert preventative maintenance program that inspects the box culverts on a 7-year cycle. Through this program, staff perform minor repairs and identify culverts that require significant repair, lining or replacement. Information collected through this program is used to inform future capital programs and update funding levels required to maintain the City's box culverts.

In October 2017, the City was awarded grant funding to be used for flood mitigation planning, which involved a condition assessment for its 39 drainage pump stations. The estimated replacement costs have increased due to increased seismic mitigation and regulatory requirements, along with significant increases in construction costs due to market conditions.

Over the past 15 years, the City has rebuilt and performed significant upgrades for 11 of 39 drainage pump stations. The Horseshoe Slough pump station is currently under construction and is expected to be complete by the end of 2019. The City's capital program includes six additional pump station replacements proposed over the next five years. The remaining Lulu Island drainage pump stations will be rebuilt or receive significant upgrades over the next 20 years provided that funding levels are maintained or improved. Pumping capacity upgrades and requirements are identified using the City's drainage system computer hydraulic model.

The City continues to adapt and mitigate the impacts of climate change through pump station upgrades, storm sewer maintenance and upgrades, laneway drainage, agricultural drainage, agricultural irrigation and implementation of stormwater retention infrastructure.

Diking

The City is on average one meter above mean sea level and protected by 49 km of dike. Climate change scientists estimate that sea levels will rise by 1.0 m by 2100 and 0.2 m of subsidence is expected over the same time period. To accommodate climate change-induced sea level rise and ground subsidence, the Dike Master Plans are used to guide the City's dike raising efforts. The City's target dike elevation for 2100 is 4.7 m geodetic (approximately 1.2 m above current elevations) with the ability to increase to 5.5 m geodetic.

The Flood Protection Management Strategy 2019 (FPMS 2019), endorsed by Council on June 24, 2019, provides updated information on climate change science and strategies to further improve Richmond's flood protection program. A key action in the FPMS 2019 implementation program is to continue upgrades to the City's perimeter diking system. Dike Master Plan Phases 1, 2, 3 and 5 have been completed, and Dike Master Plan Phase 4 is anticipated to be completed and presented for Council consideration within the next year.

Following the recommendations from Dike Master Plan Phase 1, staff utilized grant funding to complete preliminary geotechnical and concept assessments to inform the Steveston Island dike alignment. Findings from this assessment were presented to Council for information and staff will continue to work on acquiring land tenure, completing detailed assessments and establishing strategic partnerships.

The FPMS 2019 addresses anticipated climate change impacts and further indicates that Richmond will need to improve its dike network in advance of sea level rise. There is considerable variability in climate change science on the rate of sea level rise. Latest information from the United States Department of Commerce National Ocean Service Center indicates that there is a 17% probability of 1.0 m of sea level rise by 2100 in the business-as-usual scenario (continued greenhouse gas generation) and a 96% chance that 0.5 m of sea level

rise will be realized under the same scenario. It also indicates that significantly lower levels of sea level rise can be facilitated through global reductions in greenhouse gas production.

The Ministry of Forest, Lands and Natural Resource Operations and Rural Development identifies a range of 0.5 m to 1.4 m of sea level rise by 2100 in their 2011 Climate Change Adaptation Guidelines for Sea Dikes and Coastal Flood Hazard Land Use. Forecasts generally agree that the City can expect a minimum of 0.5 m of sea level rise by 2100 but have less certainty regarding more rapid levels of sea level rise.

Climate change science also indicates that while snow packs may decrease in the future, there is uncertainty in the melting rates and subsequent impact on river flows. The high water design event for 80% of Richmond's dikes is based on king tide and storm surge, while the remaining 20% (eastern end of Lulu Island) is based on freshet; therefore, the City's long-term dike raising strategy will largely be based on sea level rise. The current strategy to address this risk is based on raising the dikes by 1.2 m, and the specific timing and scope of work will adjust as climate change science advances and new information becomes available.

Drainage and Diking Funding

In 2003, Council endorsed the introduction of the Drainage and Diking Utility. Since 2003, Council has approved increasing annual funding levels for Drainage and Diking from $0.6 million to its current level of $12.1 million in 2019. However, climate change-induced sea level rise is an emerging issue and implementation of the Dike Master Plan will require additional allocations to dike improvements. Drainage and diking improvements are interconnected and, while there are synergies, additional funding to meet long-term needs is required.

The high-level estimated cost to upgrade the dike to address the predicted 2100 sea level rise scenario is $420 million. This value is higher than previously noted, as more detailed assessments have been completed, and reflects increased seismic mitigation and regulatory requirements, as well as construction cost inflation due to current market conditions. Consistent with previous reports and the current funding strategy, a minimum of 50% in funding assistance from senior government grants and partnerships is being pursued to perform the upgrades in the required timespan.

Provided senior government grants can be obtained, the City's share of dike raising costs will be $2.5 million to $7.6 million per year, depending on the realized rate of sea level rise. In 2019, the City received $13.8 million in grant funding from the Disaster Mitigation and Adaptation Fund for multi-year drainage and diking improvements. Staff will continue to look for opportunities to secure additional funding sources for flood protection work.

Historically, the City has seen significant cost savings and effective dike improvements through development along the dike corridor. An estimated 10% of dike improvements through development has been included in the funding calculations, and increasing the amount of development-assisted dike upgrades would reduce the required funding from the City.

Staff estimate a long-term annual funding requirement of $19.5 million for drainage and diking infrastructure and the City currently allocates $12.1 million from the Drainage and Diking

Utility, which is below the target range. Based on the above, it is recommended that the Drainage and Diking Utility be increased gradually over the long term. Future Ageing Utilities Infrastructure reporting will continue to update Council on the progress of grant funding, developments and their impact on overall diking improvement funding requirements.

As identified in Attachment 3, the forecasted drainage and diking improvement requirement over the next ten years is approximately $14.2 million. Within this timeframe, the City will gain more certainty regarding the rate of sea level rise. However, Council should consider incremental increases to the Drainage and Diking Utility Rate to prepare for sea level rise scenarios beyond the minimum and meet the long-term drainage and diking needs. This would correspond with strong feedback received through the public consultation process for the FPMS 2019, where there was strong support for increasing flood protection fees to accelerate the flood protection program. Staff will bring forward funding options and capital projects for Council's consideration as part of the utility rates process and capital planning process that address the long-term dike funding gap and facilitate implementation of the Dike Master Plan ahead of predicted sea level rise.

Road and Road Assets

Road Pavement

The City's Asphalt Re-Paving Capital Program re-paves sections of City-owned non-MRN roads on an annual basis. The long-term annual re-paving funding requirement for the City's non-MRN roads is estimated at $5.0 million, using average paving prices and predictions of road re-paving needs from the City's computerized Pavement Management System. Paving prices are heavily influenced by oil prices, which have had significant fluctuations over the past years. The fluctuating price of paving has a significant impact on the long-term funding requirements of the City's road network. Attachment 5 shows the fluctuating cost of asphalt paving between 2008 and 2018.

As identified in the March 29, 2017 report to Council titled "Post Winter Roads and Paving Program Update", harsh winter conditions can have significant impacts on the condition of the City's roadways. Staff will continue to monitor on-going climate change weather trends and incorporate the impacts of any identified trends in subsequent infrastructure reporting. The results from the road condition data collected in 2017 have been used to refine both projections of annual funding levels and paving program priorities for capital planning.

Street Lighting

The City's street lighting system consists of approximately 11,500 streetlights and continues to grow with new development. In 2017, approximately 200 street light poles in the Seafair and Richmond Gardens subdivisions were found to have reached the end of their 40-50 year service life and were replaced through phases 1 and 2 of the LED Replacement Capital Program. Phase 3 of the program was approved by Council in 2018 and Phase 4 is scheduled to be brought forward for Council's consideration in the 2020 – 2024 Roads Capital Plan. Staff note that there is currently no significant backlog of poles that require replacement.

Since the 2017 Ageing Infrastructure Report, staff have completed an evaluation on the City's street lighting inventory. The long-term annual funding requirement is approximately $2.4 million for the replacement of street lighting systems, based on a service life consistent with the age of the deteriorated poles at Seafair and Richmond Gardens. Staff note that there could be significant variability in the deterioration of street lighting infrastructure and that the current analysis based on identified deterioration may be conservative. Additionally, decorative street lighting replacement is significantly more expensive than standard street lighting and adding decorative street lighting to the City's inventory will increase the cost associated with the replacement program. Going forward, the condition of street lighting systems nearing the end of their service life will be assessed to refine the recommended replacement strategy. Replacement projects will be brought forward through the capital program when poles requiring replacement are identified. Results of this assessment will be incorporated into future ageing infrastructure reporting.

Overpasses and Bridges

The City owns 12 overpasses and bridges, maintained by Engineering and Public Works that are non-MRN. These include:

- 5 roadway overpasses or bridges; and
- 7 pedestrian bridges.

A table listing of overpasses and bridges is included as Attachment 6.

Staff completed inspections on six of the City's non-MRN overpasses and bridges in 2013. Results of the inspection were used to update the City's capital program. In 2015, Council endorsed capital projects to rehabilitate the Bridgeport Road Overpass, Fraserside Gate Bridge and Woodwards Slough Bridge. Inspection of the remaining structures, which consists primarily of smaller pedestrian bridges, was completed in 2017. Results of the inspection have been used to update projections of annual funding requirements. Following this inspection cycle, it is recommended that bridge structures be inspected every one to five years, depending on the material, age and condition of the bridge. The completion of regular inspection and maintenance will extend the lifespan of the structure, thereby reducing overall lifecycle costs, as well as enhancing safety and comfort for users.

The No. 2 Road Bridge, Bridgeport Road Overpass, and Cambie Road Overpass at Knight Street are significant pieces of municipal infrastructure with a total replacement value of approximately $88 million. These structures are situated within the region's MRN, which is designed to connect provincial highway systems with local road networks, and are eligible for regional maintenance and replacement funding. The City receives regional funding for the operation, maintenance and rehabilitation of pavement and bridge decks within the MRN. TransLink has approved the MRN Structures Funding Program for the rehabilitation and seismic retrofit of structures for 2017 to 2019. City staff are participating on Translink's Operation, Maintenance and Rehabilitation Sub-Committee and will continue to work with TransLink to secure adequate bridge maintenance and rehabilitation funding.

Distributed assets, such as roadway paving and street lighting, require annual funding from General Revenue, which allows a percentage of the asset to be replaced each year. The bridge assets, however, are point assets that require short, intense rehabilitation or replacement and are better completed on a one-time basis as required. Attachment 6 outlines an overpass and bridge maintenance strategy that highlights the one-time nature of bridge upgrades or replacement projects. Staff predict that a long-term annual funding of $0.1 million is required for routine maintenance and inspection of bridge assets, and a total of $63 million will be required over the next 100 years for major bridge rehabilitation and replacements.

Road and Road Asset Funding

The total long-term annual funding requirement for road and road assets is currently estimated to be $8.4 million, as identified in Attachment 4.

Based on typical roadway design life information, significant road paving will be required over the next five years. Area-specific verification will be completed as part of the 5-year capital planning process. The results from the City-wide asphalt surface condition assessment in 2017 have been utilized by staff to confirm and inform paving recommendations for the City's existing and future capital paving programs. Staff will continue to bring forward paving program funding recommendations that will include on-going funding combined with one-time allocation of surpluses to meet the five year capital needs of the roadway paving program.

Private development servicing agreements contributes significantly to the City's re-paving needs. Over the past five years, the City has secured an average of approximately $9 million per year in roadway assets through servicing agreements. While parts of this involve the introduction of new assets through new road construction, some of this work rebuilds or expands existing roadways that would otherwise require repaving through the City's annual paving program. Unlike utility infrastructure where development-driven replacement work does not typically coincide with infrastructure that is beyond its useful life and hence does not significantly impact long term funding requirements, road pavement has a much shorter lifespan of 15 to 35 years. As such, paving completed through development activities has notable impacts on ageing infrastructure replacement plans.

The overpasses, bridges and street lighting assets have begun to require re-investment as they are starting to show signs of deterioration and have been the focus of recent capital upgrade and replacement programs. These re-investments include a $1.1 million Bridgeport Road Overpass renovation project and two years of a five-year street light replacement program totaling $252,000 for the first two years. The asset deterioration model indicates that these projects are the beginning of upgrade and replacement projects for overpasses bridges and street lighting assets.

Road and road assets are not part of a utility and are funded from the City's General Revenue. Since 2006, Council has endorsed increases in annual roadway funding levels from $2.6 million to its current value of $4.3 million. With the inclusion of in-kind contributions to roadway repaving programs through development, 2019 funding levels for road and road asset replacements is estimated at $5.0 million. Roadway paving and street lighting assets are distributed assets that require ongoing dedicated funding, while bridge asset replacements are

best funded through one-time expenditures. On this basis, roads and road assets will ultimately be funded through a combination of annual funding and one-time funding. Both on-going re-paving and street lighting programs, and one-time bridge repair projects will be included in capital and operating programs for Council's consideration.

Required Funding Levels

Table 3 summarizes current and required annual infrastructure replacement funding levels, in 2019 dollars, as well as the current ageing infrastructure funding gaps. The City has made considerable infrastructure funding gains since initiating its strategy to close the funding gap in 2006.

Table 3: Infrastructure Funding Levels

Infrastructure Type	2019 Funding Level	Required Annual Funding Level	Funding Range	Funding Source	Estimated Additional Funding Required
Water	$7.5M	$9.2M	$8.6M - $10.4M	Water Utility	$1.7M
Sanitary	$5.3M	$8.4M	$7.8M - $9.1M	Sanitary Utility	$3.1M
Drainage & Diking	$12.1M	$19.5M[1]	$17.3M - $20.4M	Drainage & Diking Utility	$7.4M
Road and Road Assets (non-MRN)	$5.0M	$8.4M	$7.5M - $9.5M	General Revenue	$3.4M
Totals	**$29.9M**	**$45.5M**			**$15.6M**

[1]Required funding may decrease upon the award of senior government grant funding.

Funding Strategies

Adequate annual funding levels will allow the City to implement proactive and sustainable infrastructure replacement programs. The proactive replacement of infrastructure enables the City to sequence utility replacement and use competitive bidding to ensure the best value for money. Replacing failed infrastructure has proven to be considerably more expensive and disruptive to residents and City services than proactive replacement.

Staff have pursued available federal and provincial grants from programs such as the Community Emergency Preparedness Fund and National Disaster Mitigation Program and will continue to do so. While grant funding has been helpful over the last few years, as a funding source, grants will always be unpredictable and therefore non-sustainable.

Development also facilitates significant infrastructure replacement that has a positive impact on the City's overall ageing infrastructure picture. However, development is subject to external forces such as the economy and does not always coincide with infrastructure that is beyond its

useful life. Therefore, development is not considered as a sustainable resource for ageing utility infrastructure replacement.

Staff will present funding options and make a recommendation to Council as part of the annual utility rate review and budget process. Significant progress has been made over the last decade in closing the funding gap, and continuation on this path will allow the City to effectively mitigate the challenge of ageing infrastructure.

Financial Impact

None.

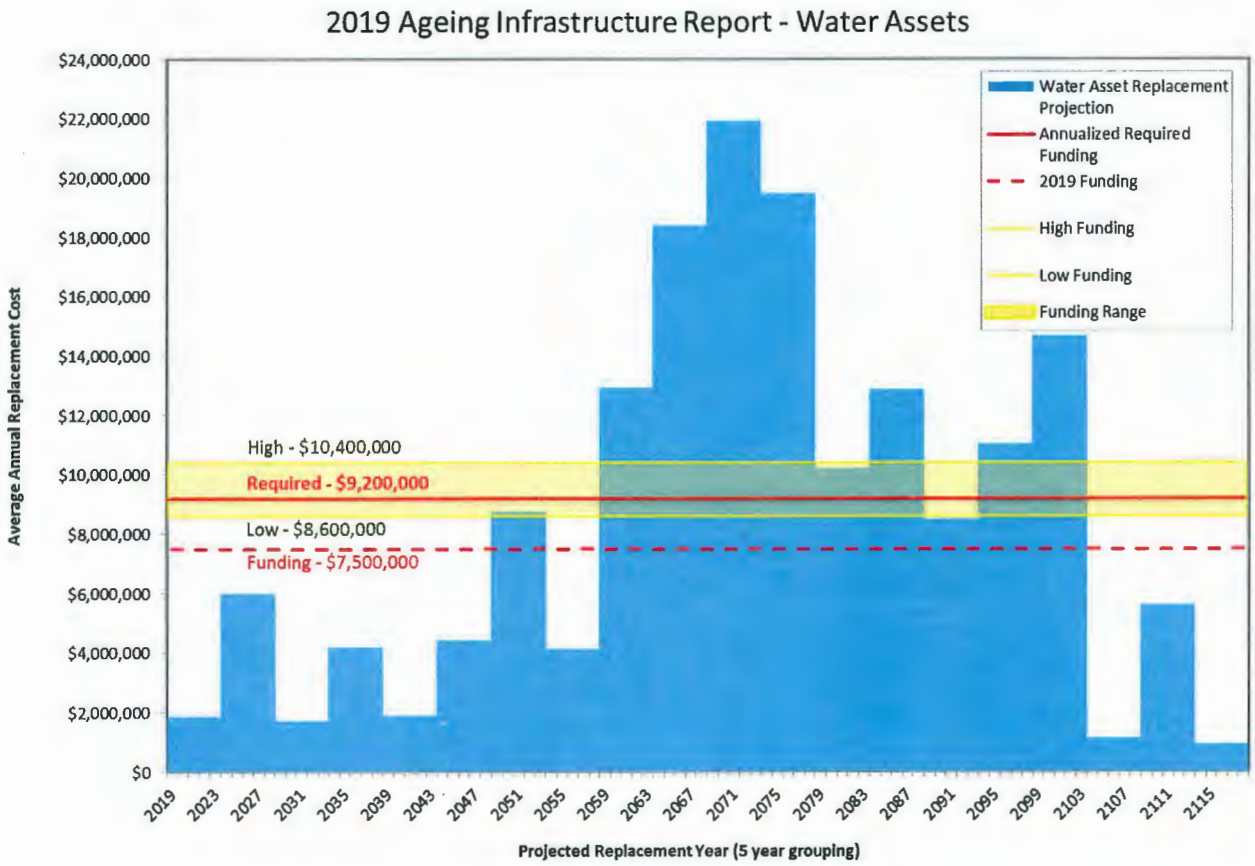
Conclusion

Staff will continue to gather information to further refine and update infrastructure replacement requirements and will continue to explore new technologies and best practices that will positively impact lifecycle infrastructure costs. Staff will continue to address utility funding gaps through annual budgeting processes. The rate of increase and timeframe to close the funding gaps will be impacted by Metro Vancouver's regional charges for water and sewer, which are non-discretionary costs imposed on the City. The funding shortfalls outlined in this report should be considered in conjunction with the City's Long-Term Financial Management Strategy.

Jason Ho, P.Eng.
Manager, Engineering Planning
(604-244-1281)

JH:cc/jc

Att.1: 2019 Ageing Infrastructure Report – Water Assets
Att.2: 2019 Ageing Infrastructure Report – Sanitary Assets
Att.3: 2019 Ageing Infrastructure Report – Drainage & Diking Assets
Att.4: 2019 Ageing Infrastructure Report – Road and Road Assets (non-MRN)
Att.5: Historical Costs for Capital Paving Program (2008 – 2018)
Att.6: Overpasses and Bridges


2019 Ageing Infrastructure Report - Water Assets
Average Annual Replacement Cost
$24,000,000
$22,000,000
$20,000,000
$18,000,000
$16,000,000
$14,000,000
$12,000,000
$10,000,000
$8,000,000
$6,000,000
$4,000,000
$2,000,000
$0
2019
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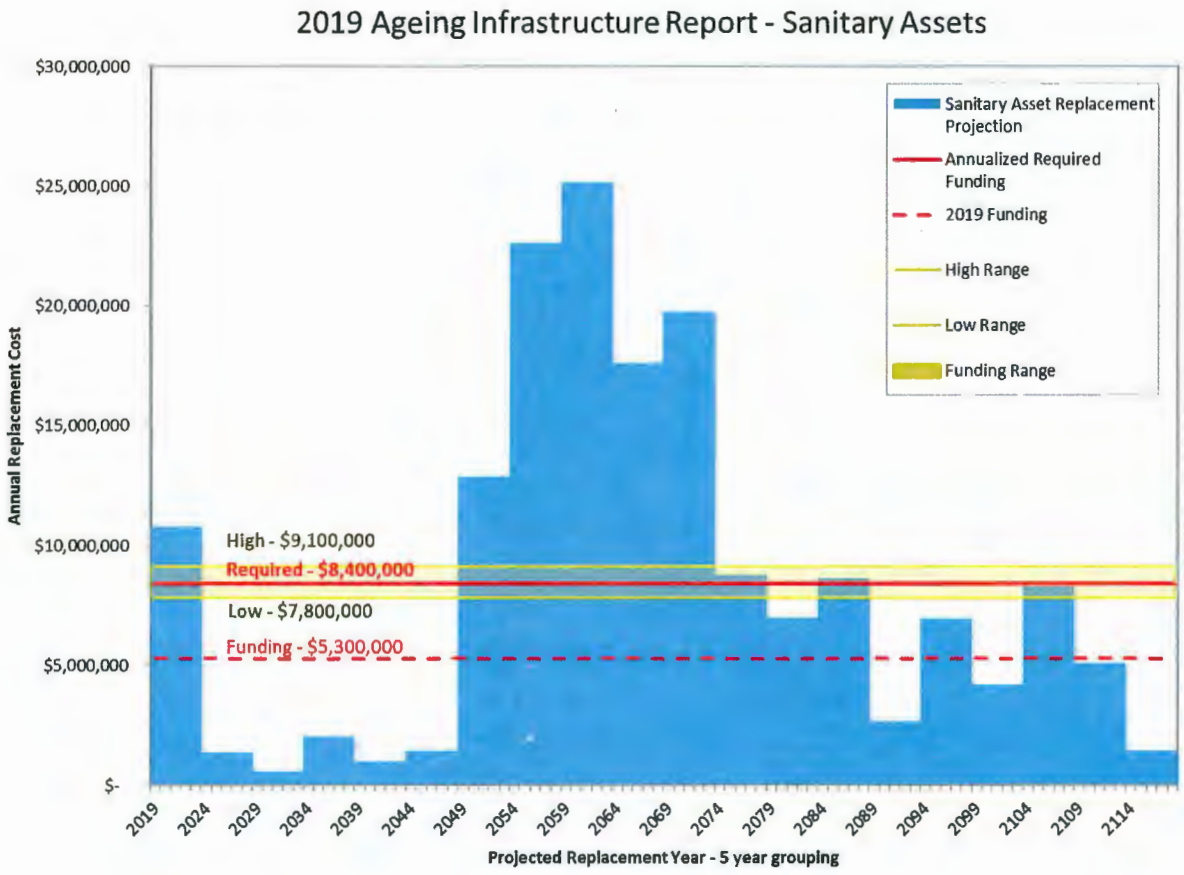
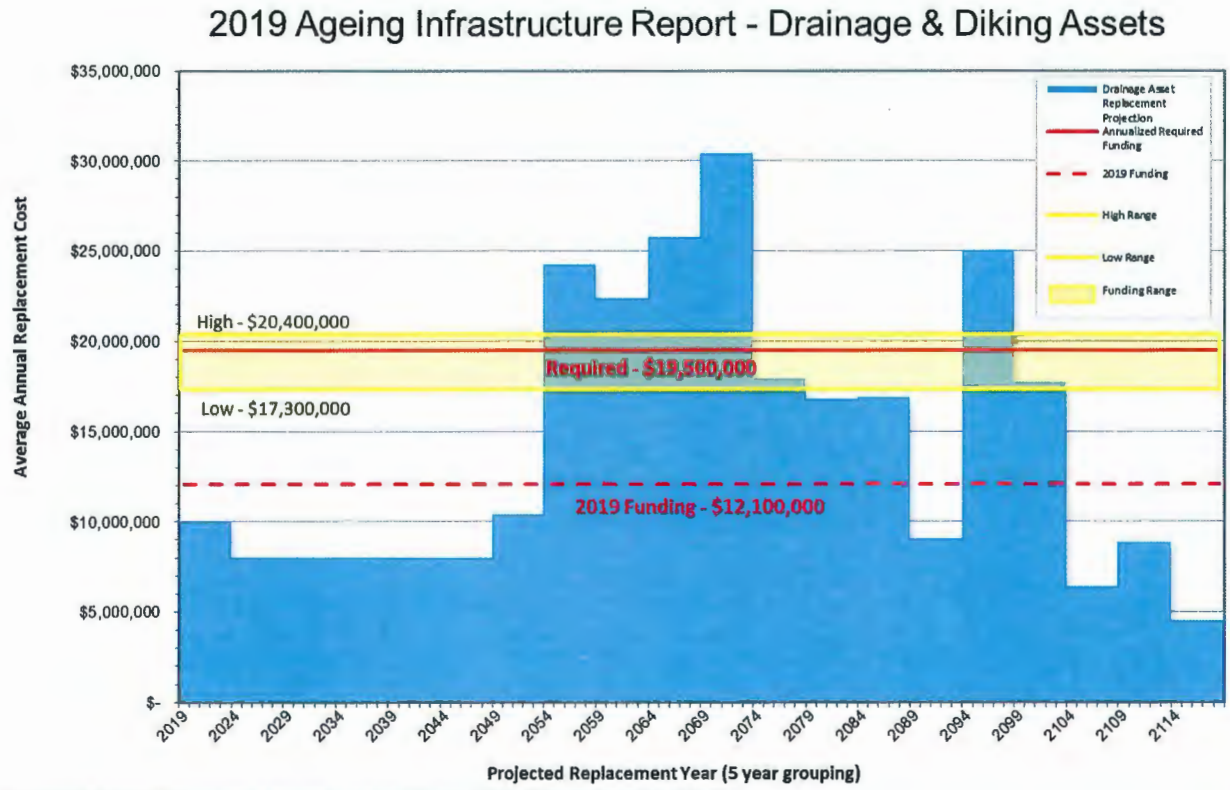
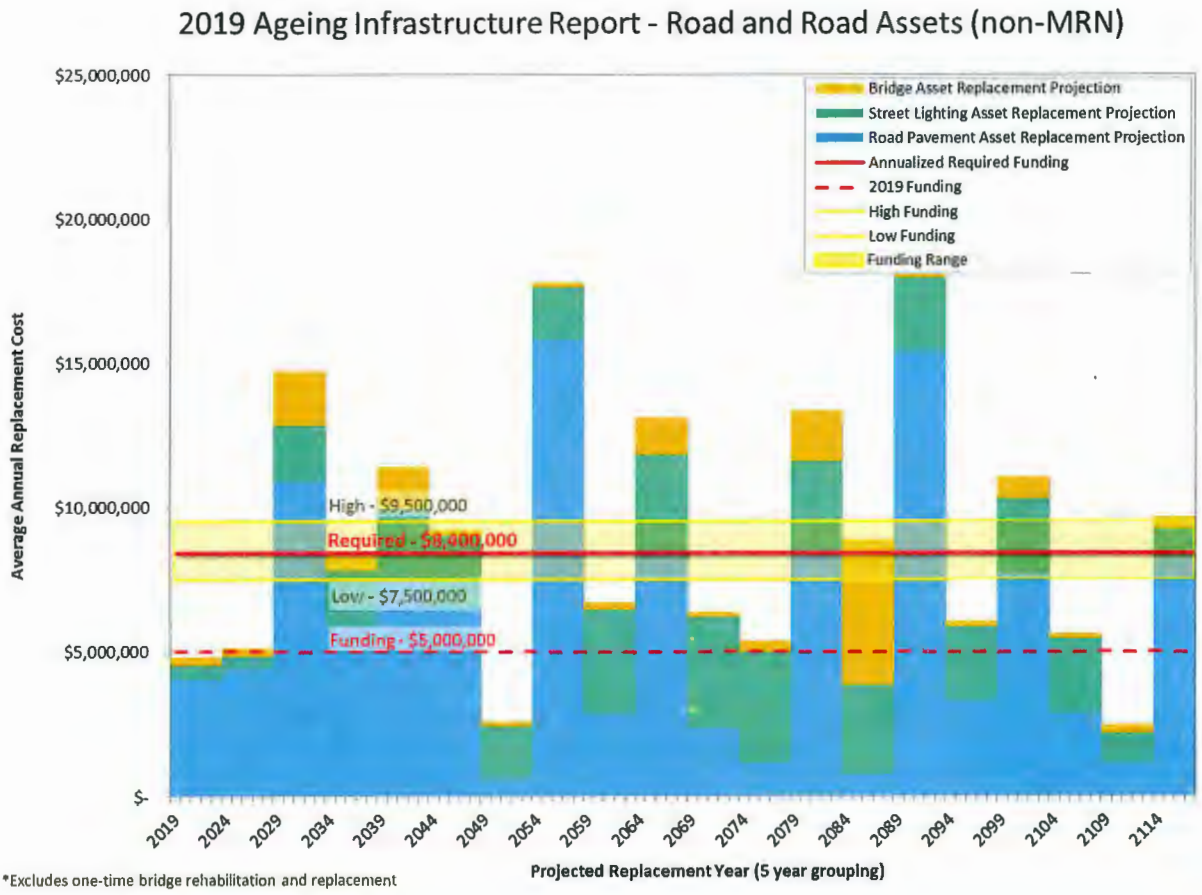
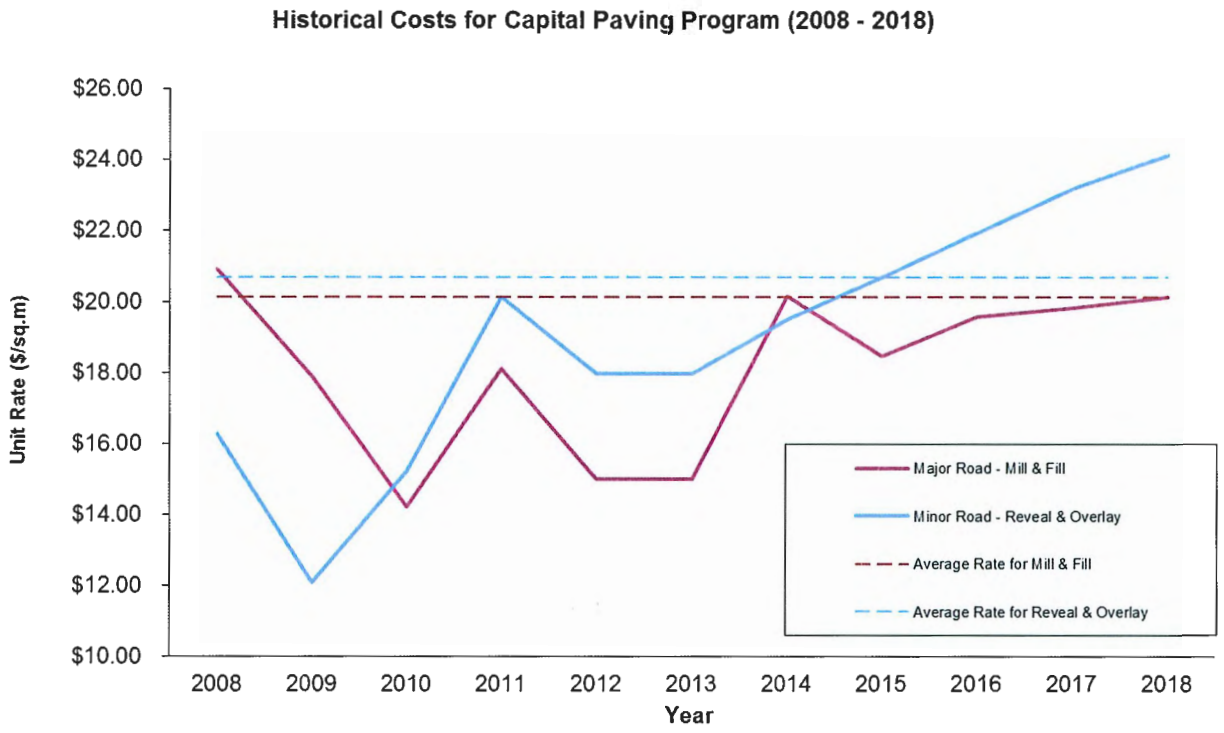
2083
2087
2091
2095
2099
2103
2107
2111
2115
Projected Replacement Year (5 year grouping)
Water Asset Replacement Projection
Annualized Required Funding
2019 Funding
High Funding
Low Funding
Funding Range
High - $10,400,000
Required - $9,200,000
Low - $8,600,000
Funding - $7,500,000


2019 Ageing Infrastructure Report - Sanitary Assets
$30,000,000
$25,000,000
$20,000,000
$15,000,000
$10,000,000
$5,000,000
$-
Annual Replacement Cost
Sanitary Asset Replacement Projection
Annualized Required Funding
2019 Funding
High Range
Low Range
Funding Range
High - $9,100,000
Required - $8,400,000
Low - $7,800,000
Funding - $5,300,000
2019
2024
2029
2034
2039
2044
2049
2054
2059
2064
2069
2074
2079
2084
2089
2094
2099
2104
2109
2114
Projected Replacement Year - 5 year grouping



*Annualized Required Funding level may decrease upon the award of senior government grant funding.


2019 Ageing Infrastructure Report - Road and Road Assets (non-MRN)
$25,000,000
$20,000,000
$15,000,000
$10,000,000
$5,000,000
$-
Average Annual Replacement Cost
Bridge Asset Replacement Projection
Street Lighting Asset Replacement Projection
Road Pavement Asset Replacement Projection
Annualized Required Funding
2019 Funding
High Funding
Low Funding
Funding Range
High - $9,500,000
Required - $8,000,000
Low - $7,500,000
Funding - $5,000,000
2019
2024
2029
2034
2039
2044
2049
2054
2059
2064
2069
2074
2079
2084
2089
2094
2099
2104
2109
2114
Projected Replacement Year (5 year grouping)
*Excludes one-time bridge rehabilitation and replacement


Historical Costs for Capital Paving Program (2008 - 2018)
Unit Rate ($/sq.m)
$26.00
$24.00
$22.00
$20.00
$18.00
$16.00
$14.00
$12.00
$10.00
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
Year
Major Road - Mill & Fill
Minor Road - Reveal & Overlay
Average Rate for Mill & Fill
Average Rate for Reveal & Overlay

Overpasses and Bridges

Listing of Non-MRN Overpass and Bridge Inventory

Name	Location	Feature Crossed	Type
Fraserside Gate Bridge	Fraserside Gate & Westminster Hwy	Watercourse	Roadway
Horseshoe Place Bridge	Horseshoe Place south of Horseshoe Way	Watercourse	Roadway
Woodward Slough Bridge	No. 4 Rd and Finn Rd	Watercourse	Roadway
Finn Road East Bridge	13020 Gilbert Rd	Watercourse	Roadway
Hollybridge Way Bridge	River Rd & Hollybridge Way	Watercourse	Roadway
Chatsworth Road Bridge	6380 Chatsworth Rd	Watercourse	Pedestrian
Bird Road Bridge	11040 Bird Road & Shell Road rail crossing	Watercourse	Pedestrian
Lancing Road Bridge	5440 Lancing Rd	Watercourse	Pedestrian
Princess Street Bridge	Dyke Rd fronting Princess St	Watercourse	Pedestrian
West Dyke Trail Bridge 1	West end of Francis Rd (West Dyke Trail)	Watercourse	Pedestrian
West Dyke Trail Bridge 2	West end of Williams Rd (West Dyke Trail)	Watercourse	Pedestrian
West Dyke Trail Bridge 3	10431 Springhill Cres	Watercourse	Pedestrian

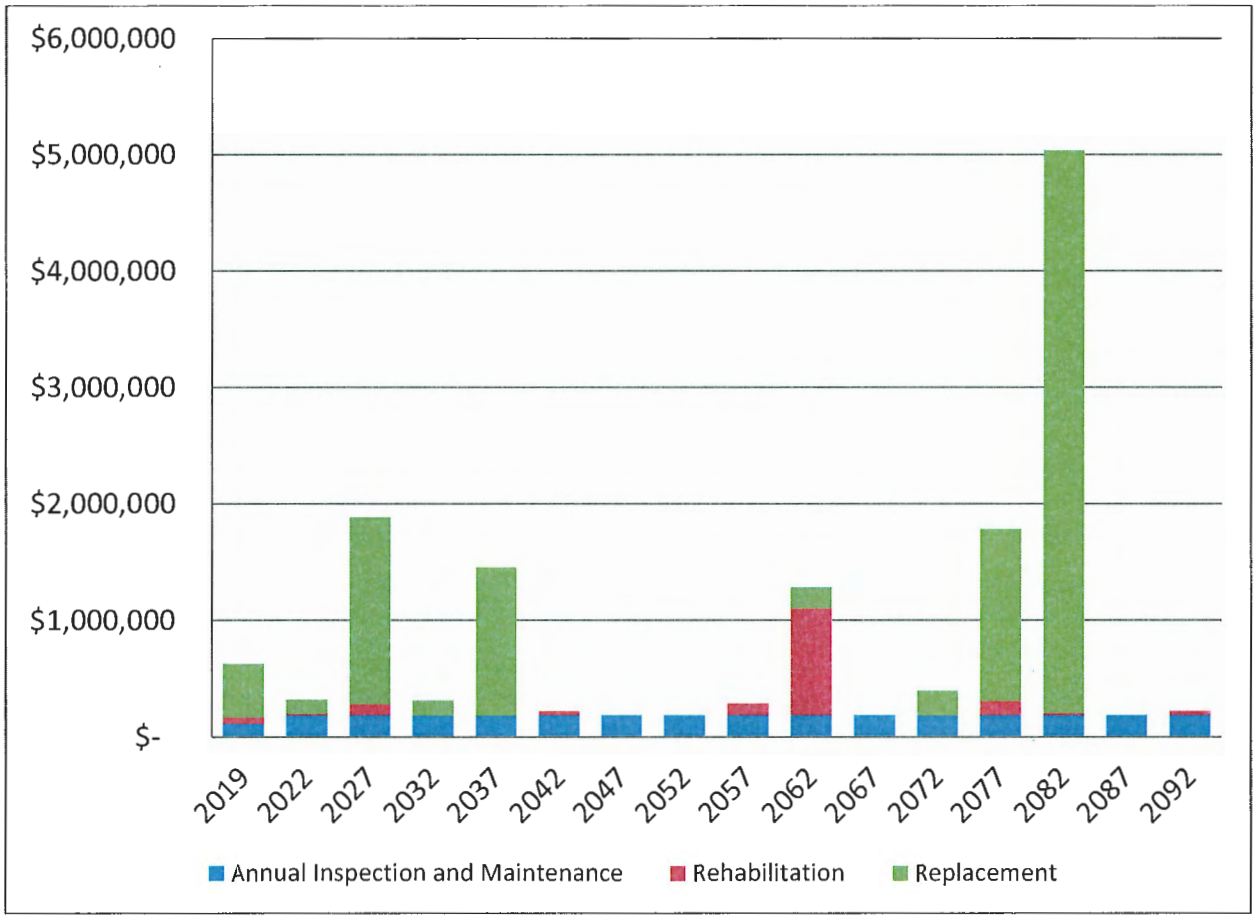
Bridges and Overpasses Maintenance Strategy

The table below illustrates a high-level rehabilitation and replacement strategy for the City's bridge inventory over the next 100 years. The strategy involves routine inspection and maintenance of the structures at an annualized cost of $38,000 each year, replacement of the structure at the end of its service life, and a major rehabilitation to extend the service life for larger bridges.

Name	Estimated Replacement Cost	Estimated Rehabilitation Cost	Replacement Year	Rehabilitation Year
Fraserside Gate Bridge	$1,270,500	$137,500	2040	2080
Horseshoe Place Bridge	$1,003,200	$200,640	2030	2065
Woodward Slough Bridge	$374,330	$74,866	2020	2060
Finn Road East Bridge	$602,855	$120,571	2030	2080
Hollybridge Way Bridge	$2,871,000	$574,200	2085	2065
Chatsworth Road Bridge	$49,500	-	2020	N/A
Bird Road Bridge	$126,720	$44,000	2035	2060
Lancing Road Bridge	$35,640	-	2020	N/A
Princess Street Bridge	$99,000	$22,000	2080	2030
West Dyke Trail Bridge 1	$693,000	$138,600	2085	2065
West Dyke Trail Bridge 2	$184,470	$36,894	2065	2045
West Dyke Trail Bridge 3	$125,510	-	2025	N/A
Total	**$7,435,725**	**$1,349,271**		

The annual funding level requirement of $160,000 for bridges and overpasses is calculated as the total rehabilitation and replacement cost averaged over each asset's service life. This value presents an average annual expenditure only and does not reflect actual recommended annual funding levels. Unlike linear infrastructure such as piping or road pavement, replacement of each bridge structure must occur as a singular project and cannot be divided into annual components. For example, replacement of the Hollybridge Way Bridge must be carried out as a one-time expenditure of approximately $2.8 million. The delivery of the replacement program over 100 years is illustrated in Figure 1 below.

Figure 1. Delivery of the replacement program over 100 years



Based on the high level strategy established, annualized funding of approximately $38,000 should be allocated towards routine inspection and maintenance of bridge assets, and requests for one-time expenditures for rehabilitation or replacement of bridge structures would come forward in 2020, 2030, 2040, 2060, 2075, 2080, 2085. Where replacement of multiple structures is required within the same year, such as in 2080, staff will review the potential to distribute work over several years. The maintenance strategy will continue to be refined as ongoing inspection work is completed to assess the remaining lifespan of the structures.