City of Richmond

Report to Committee

To:	Public Works and Transportation Committee	**Date:**	June 23, 2017
From:	John Irving, P.Eng. MPA Director, Engineering	**File:**	10-6060-03-01/2017-Vol 01
Re:	**Ageing Utility and Road Infrastructure Planning – 2017 Update**		

Staff Recommendation

That staff utilize the report "Ageing Utility and Road Infrastructure Planning – 2017 Update" report dated June 23, 2017 from the Director, Engineering as input in the annual utility rate review, capital program process and operating budget process.

John Irving, P.Eng. MPA
Director, Engineering
(604-276-4140)

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:** CJ	**APPROVED BY CAO** (ACTING).

Staff Report

Origin

The Engineering Department previously reported to Council the estimated long-term capital requirements for age-related infrastructure renewal in 2001, 2006, 2011, 2013 and 2015. This report updates those estimates to reflect current inventory, evolving theory on infrastructure service life and changing infrastructure replacement pricing.

Background

This report supports Council's 2014-2018 Term Goal #6 Quality Infrastructure Networks:

> *Continue diligence towards the development of infrastructure networks that are safe, sustainable, and address the challenges associated with aging systems, population growth, and environmental impact.*
>
> *6.1. Safe and sustainable infrastructure.*
>
> *6.2. Infrastructure is reflective of and keeping pace with community need.*

This report supports Council's 2014-2018 Term Goal #7 Strong Financial Stewardship:

> *Maintain the City's strong financial position through effective budget processes, the efficient and effective use of financial resources, and the prudent leveraging of economic and financial opportunities to increase current and long-term financial sustainability.*
>
> *7.2. Well-informed and sustainable financial decision making.*

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 capacity to meet the financial challenges of today and the future, while maintaining current level of service.

The ageing utilities and roads infrastructure analysis is based on an approximate 100 year future time frame. The analysis is based on typical or standard design lives 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 useful for long-term budget projections, but has limited use for identifying specific dates for replacement of specific pieces of infrastructure. The five year capital plan identifies near term infrastructure requirements through field observation and inspection results and is a better gauge of current infrastructure need. Therefore the curves that predict long term infrastructure requirements are basic guides on what the City should anticipate for long term infrastructure costs, but the five year capital plans more accurately identify near 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 using the existing size or upgraded where current infrastructure does not meet the City's current minimum size requirement. ***Table 2*** identifies current capital funding levels, funding sources and reserve balances.

Staff has reported ageing infrastructure assessments to Council in 2001, 2006, 2011, 2013 and 2015. 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. The funding gap in the Water Utility was closed in 2011 and the drainage allocation of the Drainage and Diking Utility entered the target range in 2015. Funding levels for Road Paving outside the Major Road Network (MRN) has remained constant since the 2013 Ageing Infrastructure report. The Sanitary Utility funding gap was substantially reduced in 2016.

The 2015 Ageing Infrastructure report included long-term replacement costs for Road Pavement, Water, Sanitary and Drainage Utilities. This report adds bridge and street lighting assets to the Roads asset category. It also adds dike upgrades to meet climate change induced sea level rise to the Drainage and Diking category. Long term funding requirements have been updated to reflect changes in infrastructure replacement pricing, inventory changes through growth or capacity improvements and evolving estimates of infrastructure service life.

Table 1: Infrastructure Inventory

Infrastructure	Other Features	Funding Source	Replacement Value (2017 $)
Water	632 km Pipes 13 PRV Chambers 57 Valve Chambers	Water Utility	$654 M
Sanitary	571 km Pipes 153 Pump Stations	Sanitary Utility	$574 M
Drainage and Diking	581 km Pipes 39 Pump Stations 61 km Culverts 165 km Watercourses 49 km Dikes	Drainage & Diking Utility	$1,451 M
Roads and Road Assets (non-MRN)	1285 lane km asphalt 27 Bridges[1] 11,045 street lights[2]	General Revenue	$592 M
			$3,271 M

[1] Includes bridge structures managed by the City's Engineering & Public Works department outside of MRN routes only. Structures maintained by the City's Parks department are excluded.
[2] Excludes BC Hydro lease lights not maintained by the City.

Table 2: Annual Capital Infrastructure Funding and Reserves

Infrastructure Type	2017 Funding	Funding Source	Uncommitted Reserve Balance (Dec 31, 2016)
Water	$7.5 M	Water Utility	$41.7 M
Sanitary	$5.3 M	Sanitary Utility	$29.4 M
Drainage and Diking	$11.6 M	Drainage & Diking Utility	$29.4 M
Road and Road Assets (non-MRN)	$3.7 M	General Revenue	N/A
Total	**$28.1 M**		**$100.5 M**

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. Improvement requirements for these assets are submitted to Council for consideration through the City's 5-year capital plan and the City's operating budget. Required funding levels for bridge and street lighting assets were not assessed in previous ageing infrastructure reports, but have been incorporated into this report.

Short-term and long-term infrastructure replacements and upgrades are planned utilizing asset management and capacity models developed for Richmond's extensive water, sanitary, drainage and roadway systems. This ensures that when ageing infrastructure deteriorates to the point when it is no longer economical to maintain, or it fails, it is replaced with infrastructure of sufficient size to meet the City's long-term needs.

Analysis

Total Replacement Value and Schedule

Infrastructure replacement costs for the City's water, sanitary, drainage and road infrastructure over the next 75 years have been estimated and graphed in ***Attachments 1 to 4***. The charts also show current 2017 funding levels as well as the estimated long-term average annual funding levels (in 2017 dollars, excluding inflation) that are required to perpetually replace assets. Given the volatility of paving costs, infrastructure projects do not always follow general inflation trends. Therefore, inflation has not been included in the analysis and staff recommends the analysis be reviewed every two years to identify changes in construction costs and integrate those changes in the analysis.

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 $7.6 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, which is within the target funding range. Achieving the long-term annual funding requirement has facilitated proactive management of the City's water assets, which reduces overall costs in the long run while maintaining a high level of service. Proactive replacement programs have stayed ahead of 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 offers longer service lives, better seismic resilience and higher chemical resistance in Richmond's aggressive soil conditions. Approximately 40% of the City's watermains are AC pipes. Since the annual funding target for the Water Utility was achieved in 2011, the program has replaced 40 km of AC pipes, which is 13% 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 2037 and 2047, 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, maintaining 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 are reviewing the costs and benefits of implementing an east-west water transmission system that could facilitate further reductions in water pressure that maintains current levels of service including fire flow.

The City's water meter program is funded through the Water Utility and has been very successful. To date, 100% of industrial, commercial and institutional properties have been metered; 93% of single-family dwellings are metered through the volunteer and mandatory water meter program; 44% of multi-family units have been metered through the volunteer and mandatory water meter program. One of the benefits of water metering is the ability to identify property-side water leakage and provide incentives for leak repair. Approximately $144,000 of Metro Vancouver water charges were avoided in 2016 through this program.

Sanitary

Staff estimate a long-term annual funding requirement of $7.3 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 in future utilities 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. In 2016, the City's I&I rate was 60% of the Metro Vancouver design allowance for I&I and the City maintains one of the lowest rates of I&I in the Lower Mainland. The City's low I&I rate is a benefit 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 were address proactively through the capital program.

In the past 10 years, the City has constructed 7 new sanitary pump stations, rebuilt 3 sanitary pump stations, performed upgrades on 13 sanitary pump stations, and installed new pumps at 36 pump stations.

The impact of grease on municipal sanitary sewer collection systems is an ongoing 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 is 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 and emerging early box culvert deterioration issues. 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 life cycle 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 4 years, approximately $5.5 million have been allocated to repairs of failed box culverts on No. 1 Road at River Road, No. 2 Road at Walton Road and No. 2 Road south of Steveston Highway. An additional $3 million has been approved by Council for further repairs on No. 2 Road south of Steveston Highway. As part of the 2017 Utility Budgets and Rates, Council supported the implementation of a box culvert preventative maintenance program that will inspect the box culverts on a five year cycle. Through this program, staff will perform minor repairs and identify culverts that require significant repair, lining or replacement. Information collected through this program will be used to inform future capital programs and update funding levels required to maintain the City's box culverts.

In the past 15 years, the City has rebuilt 10 of its 39 drainage pump stations and has performed significant upgrades on a further four. The No. 2 Road North pump station upgrade will complete by the Summer of 2017 and four additional pump station replacements have approved funding and will be completed in the next two 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 sea level and is protected by 49 kilometers of dike that meet or exceed Provincial standards. Climate change scientists estimate that sea level will rise up to 1.0 m by 2100 and 0.2 meters of subsidence is expected in that same time period. To accommodate climate change induced sea level rise and ground subsidence, the 2008-2031 Richmond Flood Protection Strategy guides the City to raise dike crest elevations. The City's target dike elevation for 2100 is 4.7 m geodetic (approximately 1.2 m above current elevations) with ability to increase to 5.5 m geodetic.

A key action in the 2008-2031 Richmond Flood Protection Strategy is to prepare and implement a comprehensive perimeter dike improvement program. The work is currently underway through various phases of the Dike Master Plan, which identifies a long-term upgrade strategy for the City's dikes. Phase 1 was completed in 2013 and addressed Steveston and the southern West Dike to Williams Road. It indicated that diking improvements required to protect Steveston will cost in the order of $55 million. Structures such as breakwater or barrier islands can potentially be constructed in front of the dike on Sturgeon Bank to dissipate wave energy and reduce wave run-up, thus minimizing required onshore crest level increases. Further analysis, wave modelling and environmental work will be required to confirm the feasibility of this option. The Phase 1 plan was endorsed by Council at the regular Council Meeting on April 22, 2013. Staff is currently engaging consultants to perform geotechnical investigations on Steveston Island to confirm the feasibility of the preferred alignment for the Steveston Dike.

Staff has also been working with the Port of Vancouver on the feasibility of sea berms on Sturgeon Banks. There are synergies between the City's long term use of sea berms and the Port's need for habitat enhancement projects. Staff will bring forward a feasibility project for the proposed sea berms as part of the 2018 capital planning process for Council's consideration. The feasibility level work will identify environmental issues, stakeholder issues and costs that will be required to pursue the sea berms and will inform future decision making regarding utilizing sea berms as part of the flood protection program.

Phase 2 of the Dike Master Plan identified the long-term dike upgrades required for West Dike between Williams Road and Terra Nova Rural Park, and part of the North Dike between Terra Nova Rural Park and No. 6 Road. Council adopted the recommendation for staff to consult with the public and key stakeholders at the regular Council Meeting on January 23, 2017. The feedback collected will be summarized and the finalized plan will be presented to Council in a subsequent report. Staff is currently in the process of developing Phase 3 of the Dike Master Plan which will focus on the South Dike from London Heritage Farm to Boundary Road.

The estimated dike upgrade cost to address the predicted 2100 sea level rise scenario is estimated to be $300 million. As dike master planning proceeds and with dike improvement upgrades scheduled in 2017, more information and financial requirements will be made available to refine the dike upgrading estimate.

The 2008-2031 Richmond Flood Protection Strategy identifies sea level rise as a real phenomenon and indicates that Richmond will need to improve its dike network in advance of

climate change induced sea level rise. There is considerable variability in scientific community regarding how quickly climate change sea level rise will be realized. Latest information from the United States Department of Commerce National Ocean Service Center indicates that there is a 17% probability of 1 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 this 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 (FLNRO) 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 snow packs will decrease in the future, which will reduce freshet levels. 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 the island) is based on freshet, therefore, the City's long term dike raising strategy will largely be based on sea level rise. While the current strategy to address this risk is based on raising the dikes by 1.2 m, the specific timing and scope of this 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 $11.6 million in 2017. The City has currently allocated $10.8 million of this funding to drainage improvements and the drainage component of the Drainage and Diking Utility entered the target funding range in 2015. $0.8 million is currently allocated to diking capital projects. 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.

Staff estimate that approximately $300 million will be required for dike raising over the next 25 to 75 years to address sea level rise. The 2008-2031 Richmond Flood Protection Strategy indicates that the City should pursue a minimum of 50% funding for dike raising from senior government to assist with this program. Provided senior government grants can be obtained, the City's share of dike raising costs will be $2 million to $6 million per year depending on the realized rate of sea level rise. The City currently allocates $0.8 million per year for dike improvements and has been very successful in procuring senior government grants for flood protection. In 2016, the City received $16.6 million in provincial and federal funding for drainage and diking improvements. Staff will continue to look for opportunities to secure additional funding sources for flood protection work.

Additionally, the City receives dike improvements through development. Development has not been factored into this long term analysis due to its cyclic nature; however, dike improvements

realized through development could potentially reduce the City's overall dike funding requirements by 10% to 20%.

Staff estimate a long-term annual funding requirement of $12.8 million for drainage infrastructure and the City currently allocates $10.8 million from the Drainage and Diking Utility, which is in the target range. Based on the above, it is recommended that the allocation to diking be increased gradually over the long term. Future Ageing Utilities Infrastructure reporting will update Council on the progress of these partnerships and their impact on overall diking improvement funding requirements.

As identified in ***Attachment 3***, the forecast drainage improvement requirement over the next five years is approximately $10 million per year, and approximately $7 million per year for the following twenty years. Therefore, current drainage and diking funding levels will allow $1.6 million per year for diking over the next 5 years and $4.6 million per year over the subsequent 20 years without any drainage project deferrals (***Attachment 3***). This totals to $100 million that is available for diking over the next 25 years without deferring drainage utility upgrades. Within this time frame, 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 hedge for sea level rise scenarios beyond the minimum and meet the long term drainage and diking needs. Staff will bring forward funding options and capital projects for Council's consideration as part of the Utility Rates process and the 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. Since 2006, the program has re-paved 90 lane kilometers of roadways, which is 7% of the City's road inventory.

The long-term annual re-paving funding requirement for the City's non-MRN roads is estimated at $4.9 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*** documents the fluctuating cost of asphalt paving between 2008 and 2016.

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 ongoing climate change weather trends and incorporate the impacts of any identified trends in subsequent infrastructure reporting. Staff is also collecting road condition data this year as part of a program to update the Pavement Management System. Completion of the update will enable staff to refine projections of annual funding levels and results will be incorporated into subsequent ageing infrastructure reporting.

Street Lighting

The City's street lighting system consists of approximately 11,000 streetlights and continues to grow with new development. Approximately 200 street light poles in the Seafair and Richmond Gardens sub-divisions were found to have reached the end of their 40-50 year service life and Council approved $252,000 as phases one and two of a five-year program to replace the ageing Seafair and Richmond Gardens poles through the capital program. Staff notes that the current capital projects represents the first street lighting poles that have reached the end of their service life and there is currently no significant backlog of poles that require replacement.

Since the 2015 Ageing Infrastructure Report, staff has completed an evaluation on the City's street lighting inventory. Staff predicts a long-term annual funding requirement of $1.4 million for the replacement of street lights, based on a service life consistent with the age of the deteriorated poles at Seafair and Richmond Gardens. Staff notes 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 value of the replacement program. Going forward, staff will complete condition assessment on poles nearing the end of their service life 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 27 overpasses and bridges, maintained by Engineering and Public Works that are non-MRN. These include:

- 12 roadway overpasses or bridges;
- 9 pedestrian bridges; and
- 6 waterworks pipeline bridges.

A table listing 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, will be completed in 2017. Results of the inspection will be used to update projections of annual funding requirements. Subsequent to this initial 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 life-cycle costs, as well as enhancing safety and comfort for users.

The No. 2 Road Bridge and Bridgeport Road Overpass are significant pieces of municipal infrastructure with a total replacement value of approximately $76 million. These structures are situated within the region's MRN 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, but does not receive funding to maintain the bridge structure itself. Translink is currently reviewing the MRN Structures Program to consider the inclusion of funding programs for the rehabilitation and seismic retrofit of structures. City staff is 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 benefit from ongoing dedicated funding 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 overpasses and bridges maintenance strategy that highlights the one time nature of bridge upgrades or replacement projects. Staff predict that a long term annual funding of $0.2 million is required for routine maintenance and inspection of bridge assets, and a total of $42 million in the form of one-time projects will required over the next 75 years for major bridge rehabilitation and replacements.

Road and Road Asset Funding

Previous ageing infrastructure reporting included the paved road surfaces only. This report adds bridges and street lighting roadway assets to the analysis and there is a corresponding increase to the long term funding requirements as compared to previous reporting. The total long-term annual funding requirement for road and road assets is currently estimated to be $6.5 million as identified in ***Attachment 4***.

The ongoing roadway re-paving program has largely kept pace with road surface deterioration as paving prices have been relatively low and the winters have been mild prior to this year. However, signs of increasing deterioration, particularly this winter, are starting to appear and will require increased attention in the near future. ***Attachment 4*** anticipates significant road paving requirements over the next five years. This figure is based on the 100 year analysis based on typical design life information and requires verification as part of the five year capital planning. Staff are conducting a City wide asphalt surface condition assessment this year and will utilize the results of that assessment in developing the City's five year capital plan for Council's consideration. Staff will bring forward paving program funding recommendations that will include ongoing 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 $10 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 infrastructures 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, and paving completed through development activities has notable impacts on ageing infrastructure replacement plans. Roadway construction realized through development currently offsets approximately $0.4 million in repaving costs annually.

The overpasses and 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 totalling $252,000 for the first two years. The asset deterioration model indicates that these projects are the beginning of upgrading 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 $3.7 million. With the inclusion of in-kind contributions to roadway repaving programs through development, 2017 funding levels for road and road asset replacements is estimated at $4.1 million. Roadway paving and street lighting assets are distributed assets that require ongoing dedicated funding, while bridge asset replacements are best funding through one time expenditures. On this basis, roads and road assets will ultimately be funded through a combination of ongoing dedicated funding and one time funding. Both ongoing 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 2017 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	2017 Funding Level	Required Annual Funding Level	Funding Range	Funding Source	Estimated Additional Funding Required
Water	$7.5 M	$7.6 M	$7.0 M - $8.8 M	Water Utility	$0.1 M
Sanitary	$5.3 M	$7.3 M	$6.7 M - $8.0 M	Sanitary Utility	$2.0 M
Drainage	$10.8 M	$12.8 M	$10.8 M - $14.8 M	Drainage & Diking Utility	$2.0 M
Road and Road Assets (non-MRN)	$4.1 M	$6.5 M	$5.3 M - $7.8 M	General Revenue	$2.4 M
Totals	**$27.7 M**	**$34.2 M**			**$6.5 M**

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 Building Canada Plan and BC's Flood Protection 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 the capital program 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 life cycle 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 Solid and Liquid Waste Management plans, 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.

Lloyd Bie, P.Eng.
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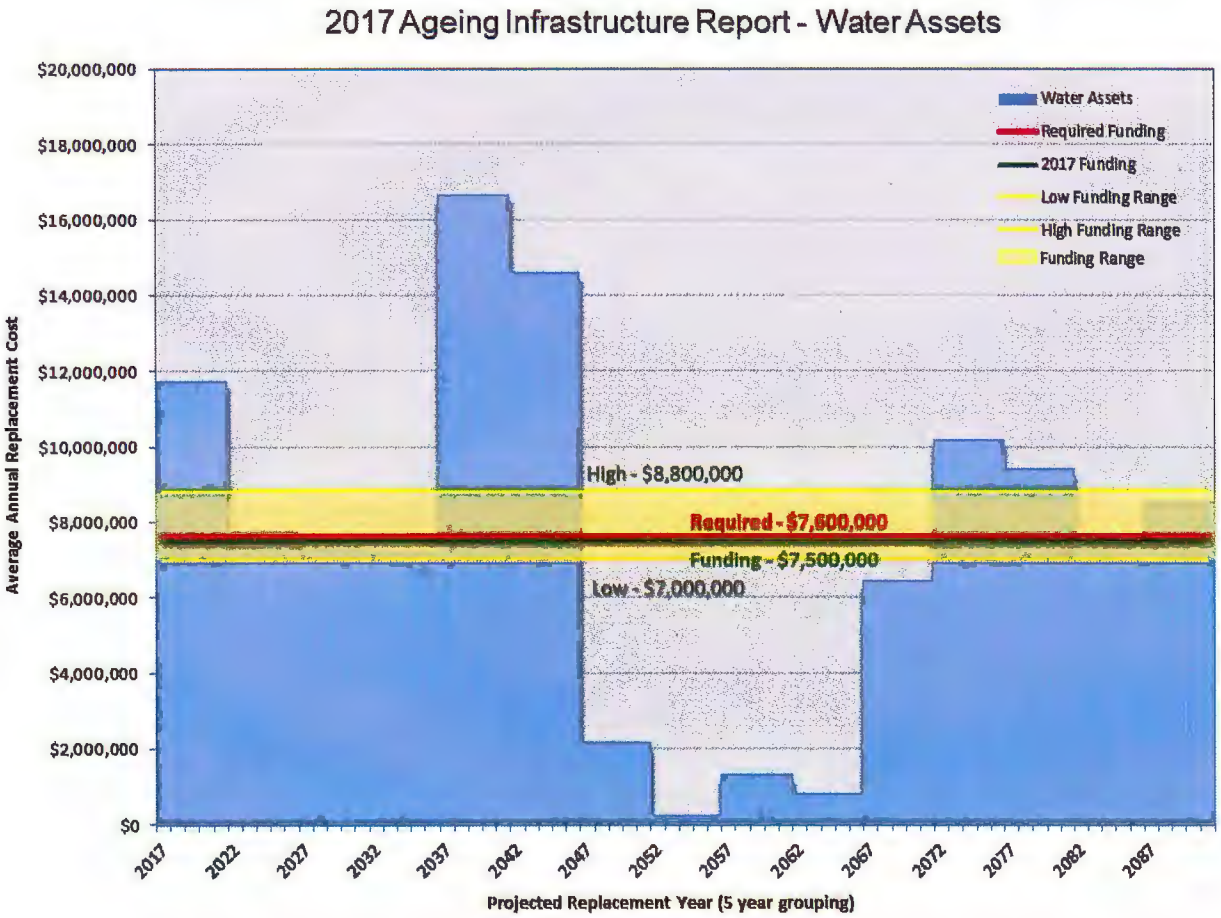
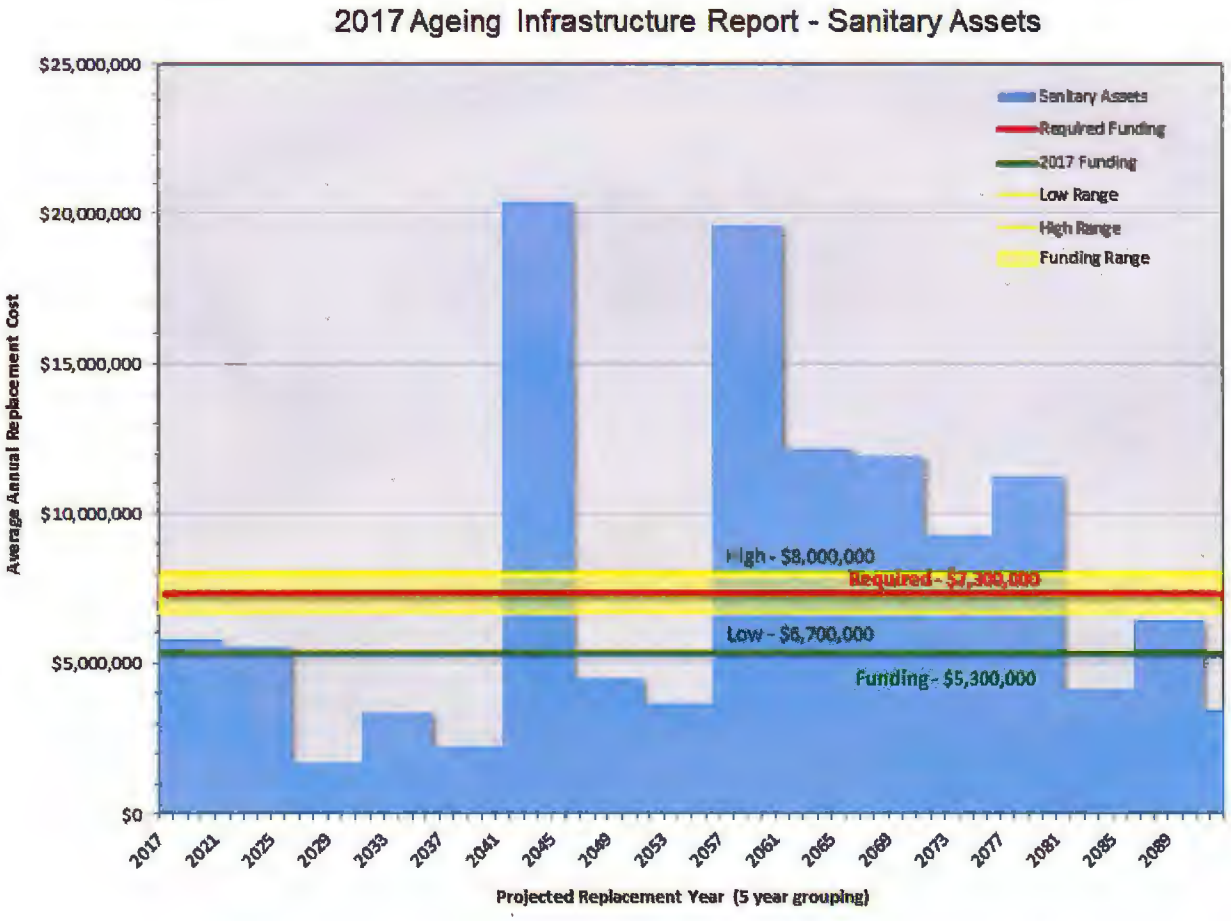
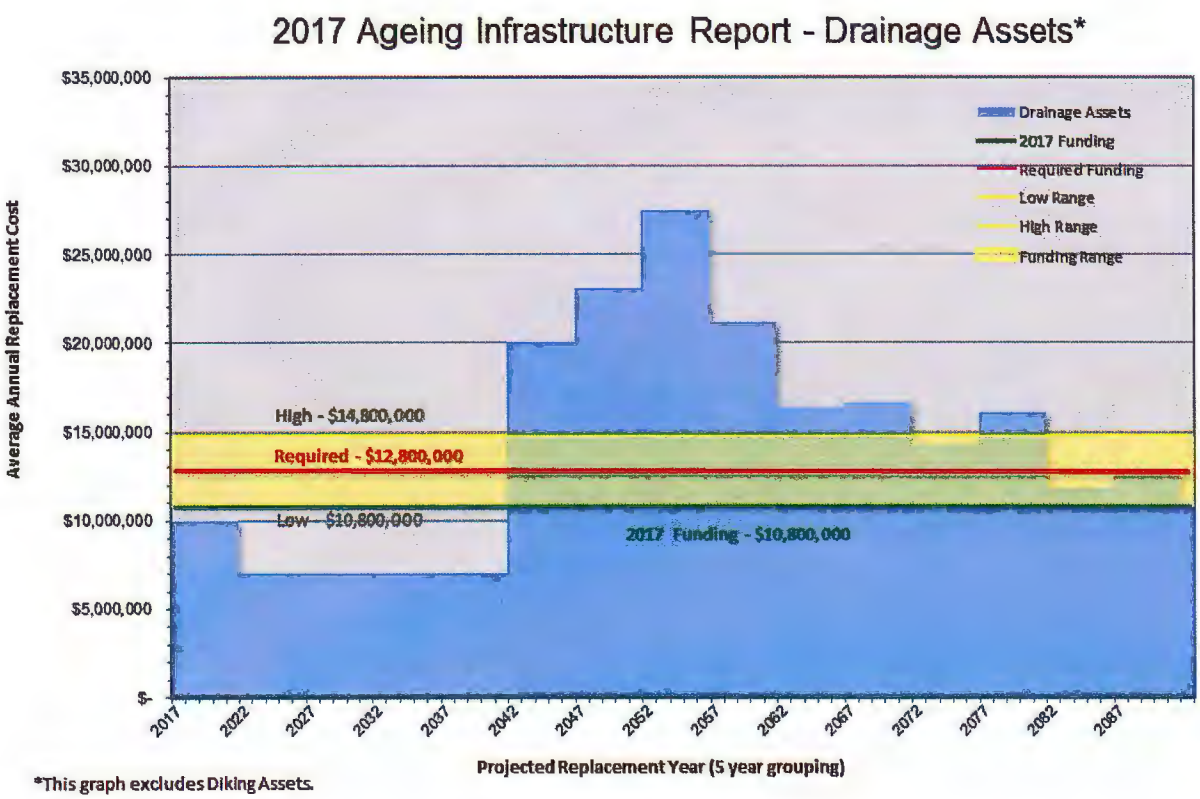
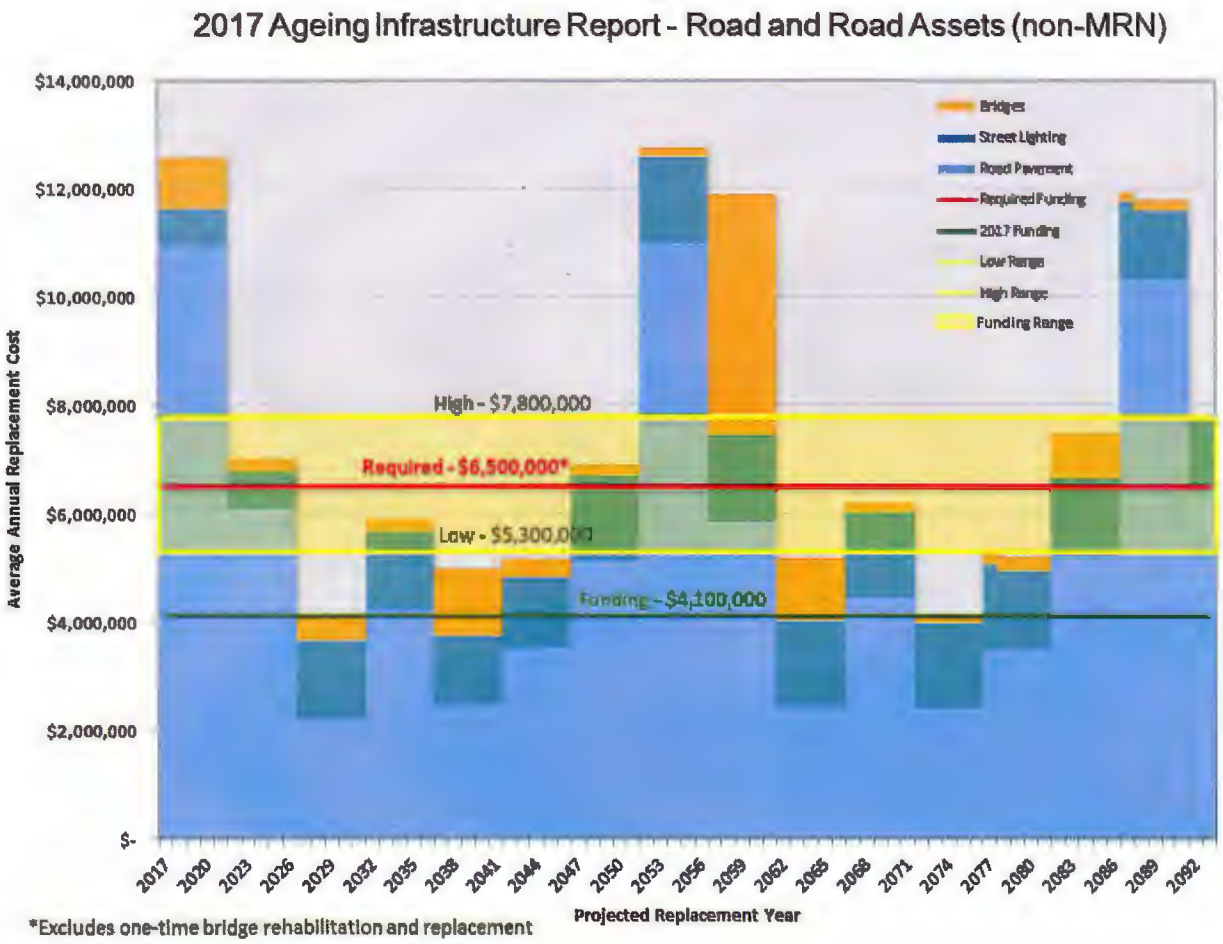
LB:bn/pm

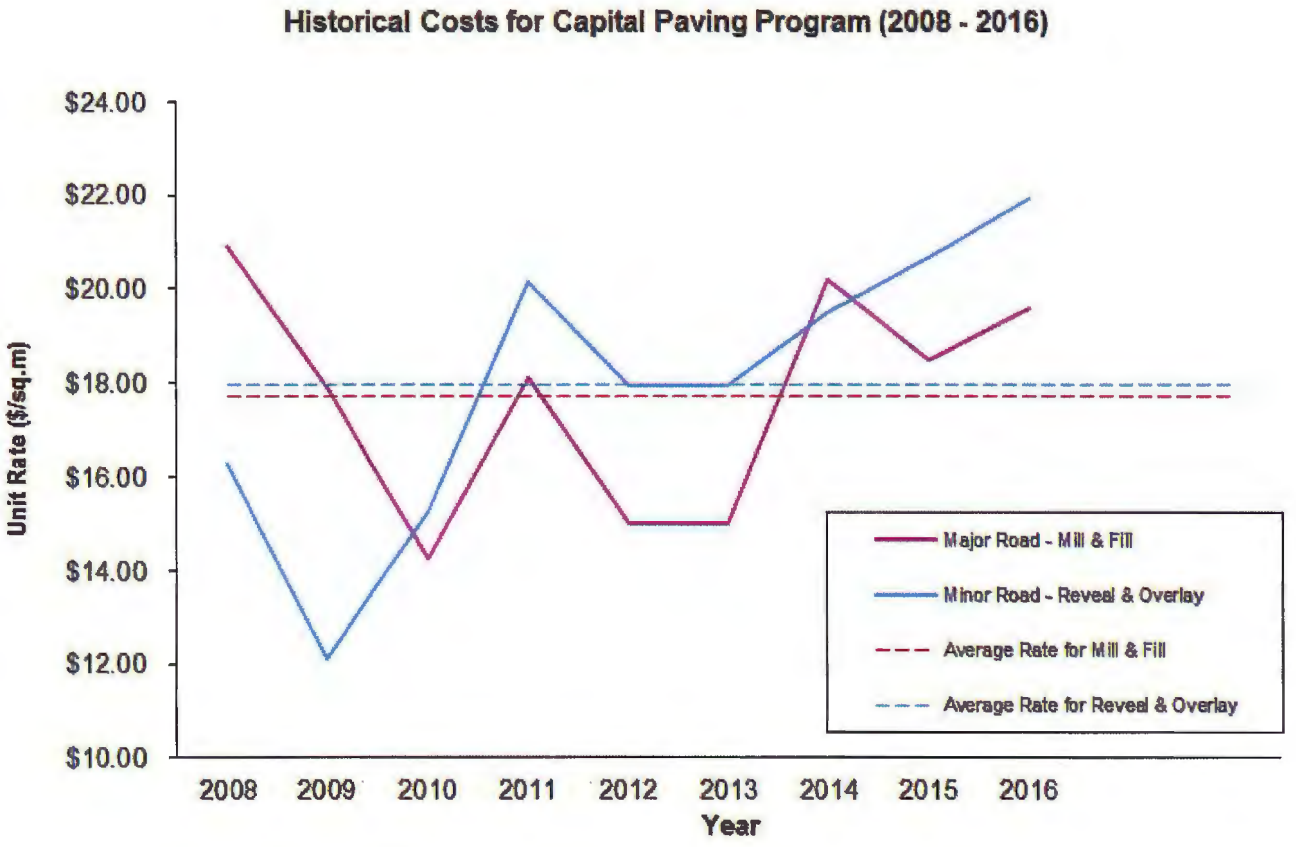
Att.1: 2017 Ageing Infrastructure Report – Water Assets
Att.2: 2017 Ageing Infrastructure Report – Sanitary Assets
Att.3: 2017 Ageing Infrastructure Report – Drainage Assets
Att.4: 2017 Ageing Infrastructure Report – Road and Road Assets
Att.5: Historical Costs for Capital Paving Program (2008 – 2016)
Att.6: Overpasses and Bridges


2017 Ageing Infrastructure Report - Water Assets
Average Annual Replacement Cost
$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
Water Assets
Required Funding
2017 Funding
Low Funding Range
High Funding Range
Funding Range
High - $8,800,000
Required - $7,600,000
Funding - $7,500,000
Low - $7,000,000
2017
2022
2027
2032
2037
2042
2047
2052
2057
2062
2067
2072
2077
2082
2087
Projected Replacement Year (5 year grouping)


2017 Ageing Infrastructure Report - Sanitary Assets
$25,000,000
$20,000,000
$15,000,000
$10,000,000
$5,000,000
$0
Average Annual Replacement Cost
Sanitary Assets
Required Funding
2017 Funding
Low Range
High Range
Funding Range
High - $8,000,000
Required - $7,300,000
Low - $6,700,000
Funding - $5,300,000
2017
2021
2025
2029
2033
2037
2041
2045
2049
2053
2057
2061
2065
2069
2073
2077
2081
2085
2089
Projected Replacement Year (5 year grouping)


2017 Ageing Infrastructure Report - Drainage Assets*
$35,000,000
$30,000,000
$25,000,000
$20,000,000
$15,000,000
$10,000,000
$5,000,000
$-
Average Annual Replacement Cost
Drainage Assets
2017 Funding
Required Funding
Low Range
High Range
Funding Range
High - $14,800,000
Required - $12,800,000
Low - $10,800,000
2017 Funding - $10,800,000
2017
2022
2027
2032
2037
2042
2047
2052
2057
2062
2067
2072
2077
2082
2087
Projected Replacement Year (5 year grouping)
*This graph excludes Diking Assets.


2017 Ageing Infrastructure Report - Road and Road Assets (non-MRN)
$14,000,000
$12,000,000
$10,000,000
$8,000,000
$6,000,000
$4,000,000
$2,000,000
$-
Average Annual Replacement Cost
Bridges
Street Lighting
Road Pavement
Required Funding
2017 Funding
Low Range
High Range
Funding Range
High - $7,800,000
Required - $6,500,000*
Low - $5,300,000
Funding - $4,100,000
2017
2020
2023
2026
2029
2032
2035
2038
2041
2044
2047
2050
2053
2056
2059
2062
2065
2068
2071
2074
2077
2080
2083
2086
2089
2092
Projected Replacement Year
*Excludes one-time bridge rehabilitation and replacement


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

Overpasses and Bridges

Listing of Overpass and Bridge Inventory

Name	Location	Feature Crossed	Type
Fraserside Gate Bridge	Fraserside Gate & Westminster Hwy	Watercourse	Roadway
No 8 Road Overpass	No 8 Road over Highway 91	Highway 91	Roadway
No 7 Road Overpass	No 7 Rd over Highway 91	Highway 91	Roadway
Cambie Road Overpass	Cambie Road over Knight Street	Knight St	Roadway
Jacombs Road Overpass	Jacombs Road over Highway 91	Highway 91	Roadway
Blundell Road Overpass	Blundell Road over Highway 99	Highway 91	Roadway
Horseshoe Place Bridge	Horseshoe Place south of Horseshoe Way	Watercourse	Roadway
Woodward Slough Bridge	No. 4 Rd and Finn Rd	Watercourse	Roadway
No 5 Road Overpass	No 5 Road and Highway 99	Highway 99	Roadway
Hollybridge Way Bridge	River Rd & Hollybridge Way	Watercourse	Roadway
Finn Road East Bridge	13020 Gilbert Rd	Watercourse	Roadway
River Road Bridge at Hollybridge Way	5111 Hollybridge Way	Watercourse	Roadway
Bird Road Bridge	11040 Bird Road & Shell Road rail crossing	Watercourse	Pedestrian
Luton Road Bridge	8271 Luton Rd	Watercourse	Pedestrian
Chatsworth Road Bridge	6380 Chatsworth Rd	Watercourse	Pedestrian
Lancing Road Bridge	5440 Lancing Rd	Watercourse	Pedestrian
Clifton Road Bridge	8200 Clifton 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
River Road Bridge 5	15900 River Rd south	Watercourse	Pipe
River Road Bridge 4	15800 River Rd	Watercourse	Pipe
River Road Bridge 3	15700 River Rd	Watercourse	Pipe
River Road Bridge 2	15600 River Rd	Watercourse	Pipe
River Road Bridge 1	15500 River Rd	Watercourse	Pipe
Shell Road Trail Bridge	Granville Ave & Shell Rd dedication	Watercourse	Pipe

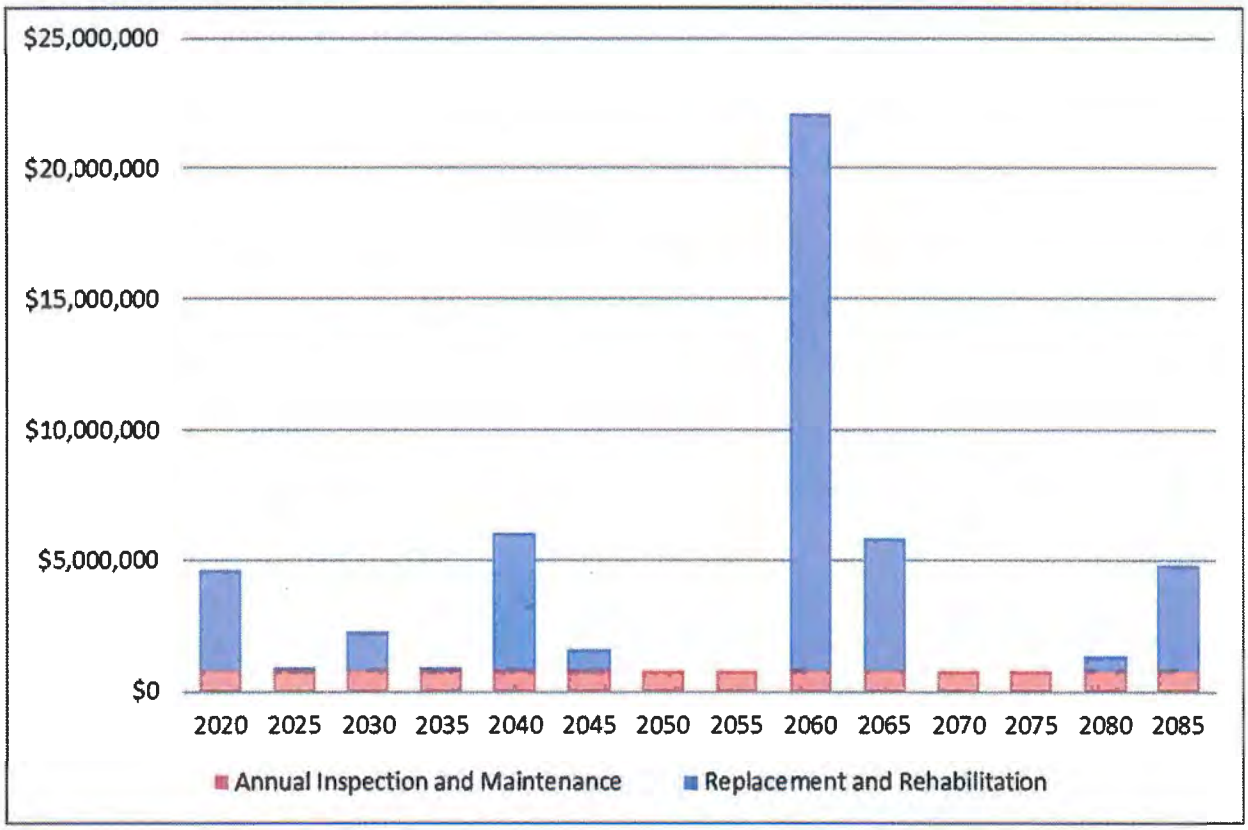
Bridges and Overpasses Maintenance Strategy

The table below illustrates a high-level rehabilitation and replacement strategy for the City's bridge inventory over the next 75 years. The strategy involves routine inspection and maintenance of the structures at an annualized cost of $162,000 each year, replacement of the structure at the end of its service life, and one major rehabilitation to extend the service life for larger bridges.

Name	Estimated Replacement Cost	Estimated Rehabilitation Cost	Replacement Year	Rehabilitation Year
Blundell Road Overpass	$2,850,000	$570,000	2020	2060
Woodward Slough Bridge	$340,000	$70,000	2020	2060
Luton Road Bridge	$20,000	$0	2020	N/A
Chatsworth Road Bridge	$50,000	$0	2020	N/A
Lancing Road Bridge	$30,000	$0	2020	N/A
Clifton Road Bridge	$20,000	$0	2020	N/A
River Road Bridge 5	$90,000	$0	2020	N/A
River Road Bridge 4	$110,000	$0	2020	N/A
River Road Bridge 3	$100,000	$0	2020	N/A
River Road Bridge 2	$110,000	$0	2020	N/A
River Road Bridge 1	$110,000	$0	2020	N/A
Shell Road Trail Bridge	$30,000	$0	2020	N/A
West Dyke Trail Bridge 3	$110,000	$0	2025	N/A
Horseshoe Place Bridge	$910,000	$180,000	2030	2065
Finn Road East Bridge	$550,000	$110,000	2030	2080
Bird Road Bridge	$120,000	$40,000	2035	2060
Fraserside Gate Bridge	$1,160,000	$360,000	2040	2080
No 8 Road Overpass	$1,750,000	$350,000	2060	2040
No 7 Road Overpass	$2,480,000	$500,000	2060	2040
Jacombs Road Overpass	$4,840,000	$970,000	2060	2040
No 5 Road Overpass	$11,540,000	$2,310,000	2060	2040
Cambie Road Overpass	$3,900,000	$780,000	2065	2045
West Dyke Trail Bridge 2	$170,000	$30,000	2065	2045
Princess Street Bridge	$90,000	$20,000	2080	2030
Hollybridge Way Bridge	$2,610,000	$520,000	2085	2065
River Road Bridge at Hollybridge Way	$800,000	$160,000	2085	2065
West Dyke Trail Bridge 1	$630,000	$130,000	2085	2065
TOTAL	**$35,520,000**	**$7,100,000**		

The annual funding level requirement of $730,000 for bridges and overpasses is calculated as the total rehabilitation and replacement cost averaged over 75 years and includes the annualized inspection and maintenance cost. 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 Blundell Road Overpass must be carried out as a one-time expenditure of approximately $3 million. The delivery of the replacement program over 75 years is illustrated in the figure below.



Based on the high level strategy established, it is recommended that annualized funding of approximately $162,000 be allocated towards routine inspection and maintenance of bridge assets, and that requests for one-time expenditures for rehabilitation or replacement of bridge structures be submitted to Council for consideration in 2020, 2030, 2040, 2045, 2060, 2065, 2080 and 2085. Where replacement of multiple structures is required within the same year, such as in 2060, 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 remaining lifespan of the structures.