District of West Vancouver

Transportation Infrastructure Asset Management Plan

Prepared by:

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Project Number:
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Date:
December 18, 2012

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Phil T. Bates, P.Eng.
Manager, Engineering Services
District of West Vancouver
750 17th Street
West Vancouver, V7V 3T3

Dear Mr. Bates:

Regarding: Transportation Infrastructure Asset Management Plan

We are pleased to provide the revised report for the District of West Vancouver's Transportation Infrastructure Asset Management Plan. As always, it was a pleasure working with you. Special thanks to Raymond Fung, John McMahon, Luke Hillan, Len Dixon, Gary Watt, Norm Wong and yourself for your input and invaluable contributions. If you have any questions please do not hesitate to contact me.

Sincerely,
AECOM Canada Ltd.

Nancy Hill, P.Eng
Nancy.hill@aecom.com

NH:
Encl.

Distribution List

# of Hard Copies	PDF Required	Name
6	yes	Phil Bates, District of West Vancouver

Revision Log

Revision #	Revised By	Date	Issue / Revision Description
1	NH/DM	Sept. 22, 2010	1st complete draft
2	NH/YD	Oct. 5, 2010	Misc. revisions: Street lights service life, 100 year averages
3	NH	December 23, 2010	Revisions based on October 19th meeting and new budget figures.
4	NH	February10, 2011	Revisions based on DWV feedback
5	NH	October 10, 2012	Revisions based on DWV feedback
6	NH	December 18, 2012	Revisions based on DWV feedback

AECOM Signatures

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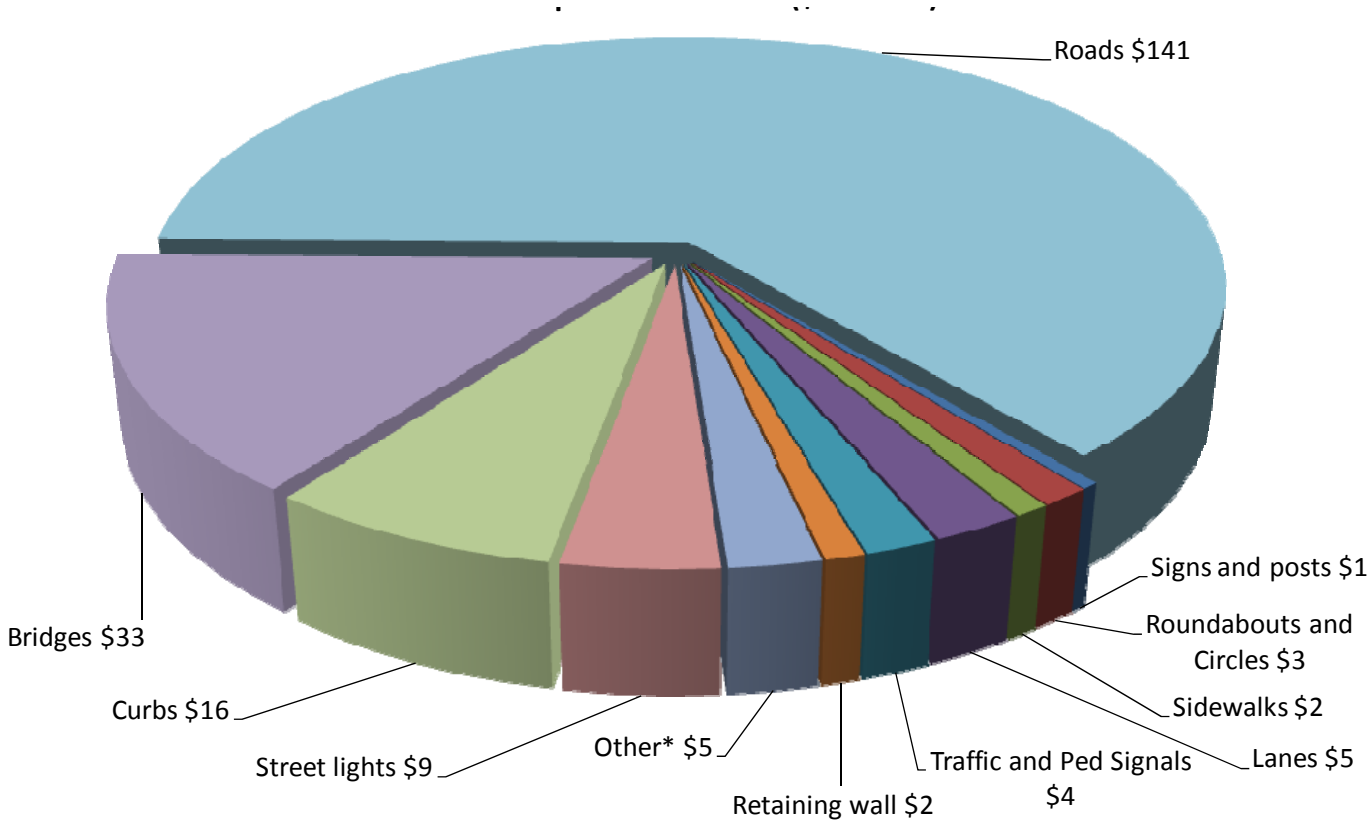
Executive Summary

The District of West Vancouver's Engineering and Transportation Department owns and maintains $222 million worth (as per replacement value) of transportation related assets, which includes: roadways; lanes; bridges; roundabouts; traffic circles; sidewalks; curbs; signals; crosswalks; street lights; signs; ditches; retaining walls; concrete barriers; and a dock. These assets are collectively known in West Vancouver as "above ground" engineering assets. A replacement value based summary of these assets, based on 2012 dollars is provided in **Figure ES.1**.

Figure ES.1 Replacement Value of West Vancouver's Transportation Infrastructure ($ Millions)

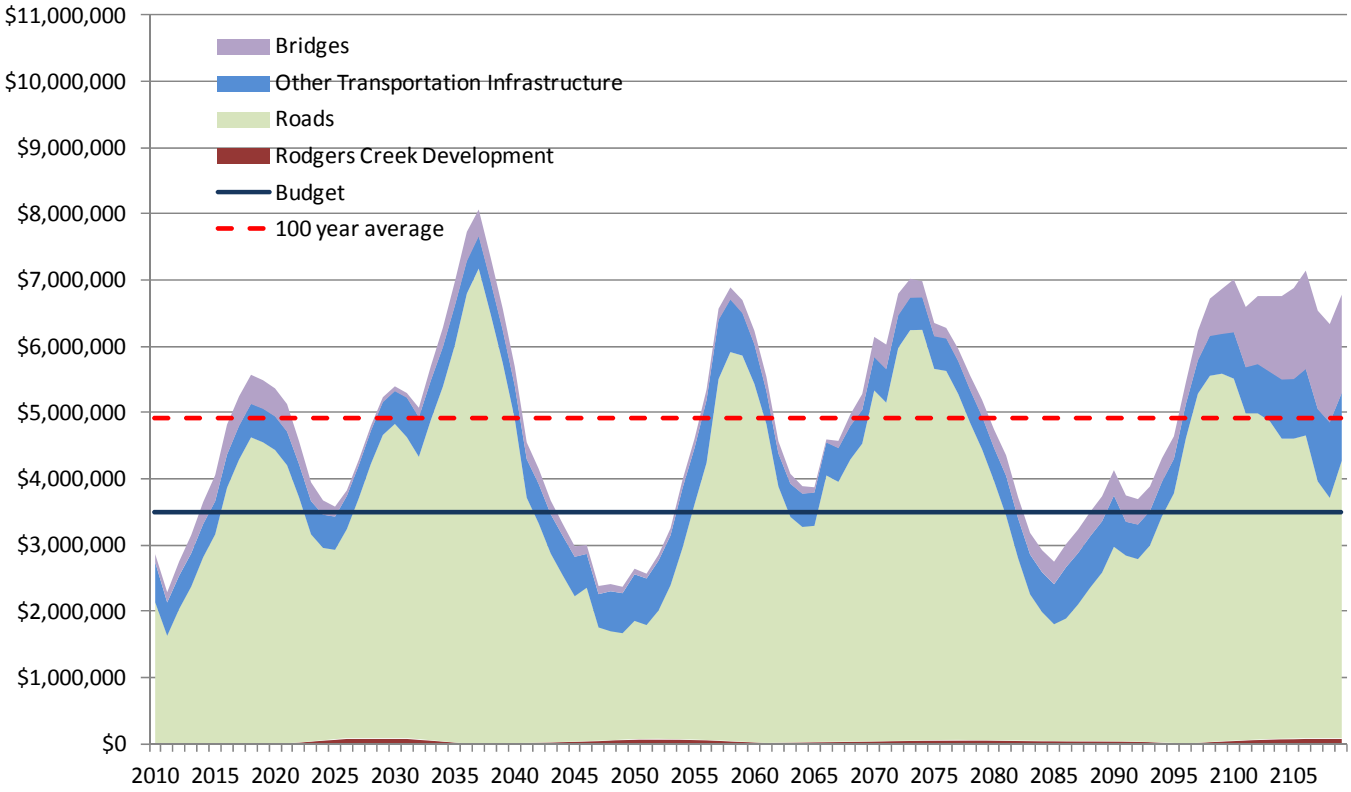


* Other includes ditches (open and culverted), gardens, dock, special cross walks and barriers.

The inventory shown above is based on the best data that is currently available. District staff is currently reviewing its retaining wall inventory as part of the District's asset management program. Further updates will be provided which may increase or decrease the funding requirements identified below.

A 100 year forecast for the estimated cost of renewing these assets so that they can continue to provide the same level of service that they are currently providing is shown in **Figure ES.2**. The average cost of renewing these assets over the 100 year planning horizon is approximately $4.9 million per year, based on 2012 dollars. Currently, West Vancouver spends approximately $3.5 million per year on its transportation infrastructure, which includes renewal of existing infrastructure as well as the installation of new curbs, sidewalks and traffic calming measures.

Figure ES.2 Capital Renewal Forecast (100 year view)



Note: Other Transportation Infrastructure includes Traffic signals, Pedestrian signals, Street lights (Ornamental Lamps), Signs, Sign posts, Retaining walls, Dock, Special Cross Walks, Barriers, Roundabouts and Traffic Circles

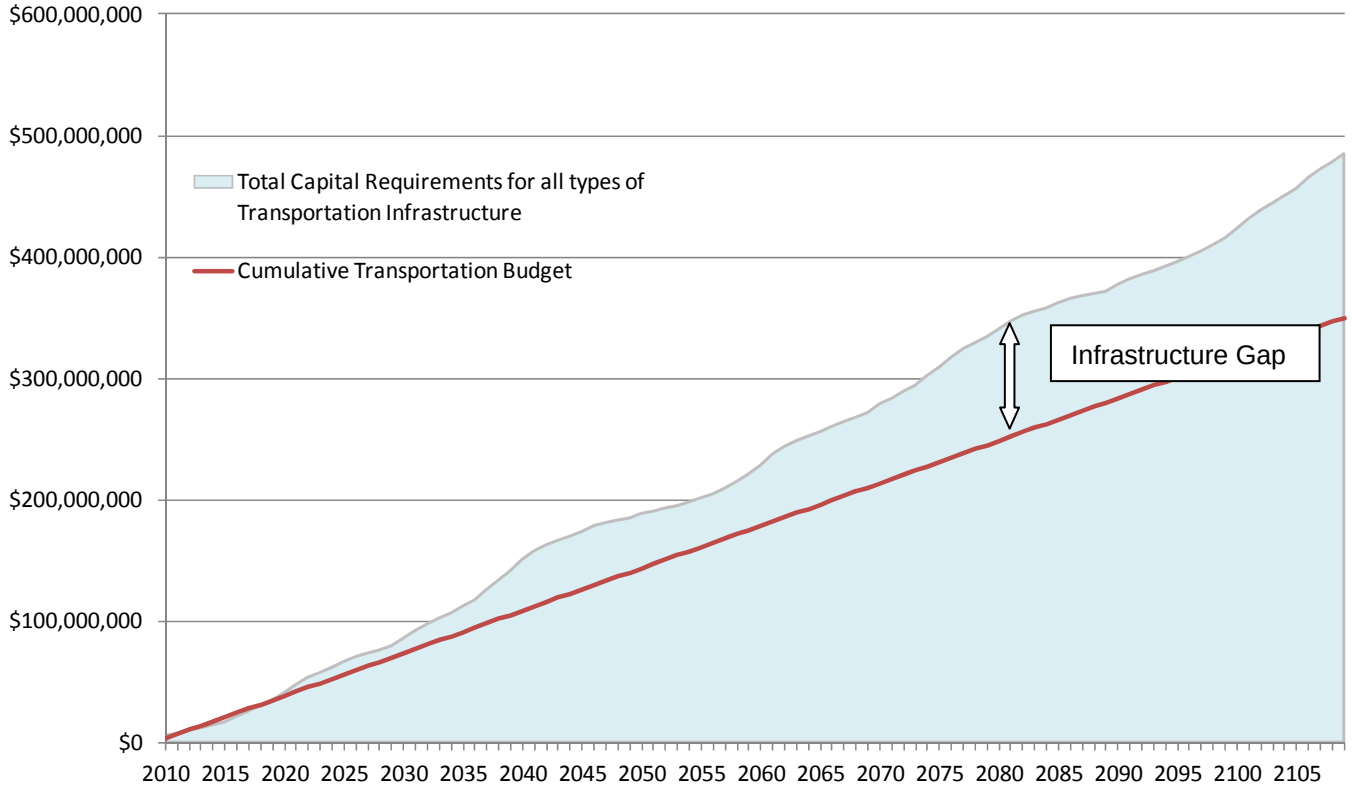
Figure ES.2 shows that the first significant renewal hump is approximately 5 years away and there is an opportunity and a need to begin planning for this funding requirement. In addition to simply seeking additional funding, the District can evaluate the following options:

1. Determine if the current level of service that is provided by the present infrastructure can be feasibly reduced yet still provide infrastructure services that are acceptable to District residents and stakeholders; and
2. Determine if asset life-cycle costs can be reduced by considering alternative asset rehabilitation options to what the District current uses and to assess maintenance practices that affect the lifecycle of the District's transportation assets.

Should one or both of the strategies outlined above offer significant savings it's possible that the District can delay and reduce proposed increases in funding requirements while still sustaining an acceptable level of service with its Transportation infrastructure.

Figure ES.3 shows how the anticipated accumulated renewal requirements compare with the existing renewal budget levels. The infrastructure gap measures the difference between the required capital renewal budget and the current capital renewal budget. Assuming that the transportation capital renewal budget is only raised to keep up with inflation, there is no forecasted infrastructure gap until 2020. However, by 2035 (approx. 25 years) the infrastructure gap is projected to be $21 million and by 2109 (approx. 100 years) it is projected to be $135 million.

Figure ES.3 Projected Infrastructure Gap (100 Years)



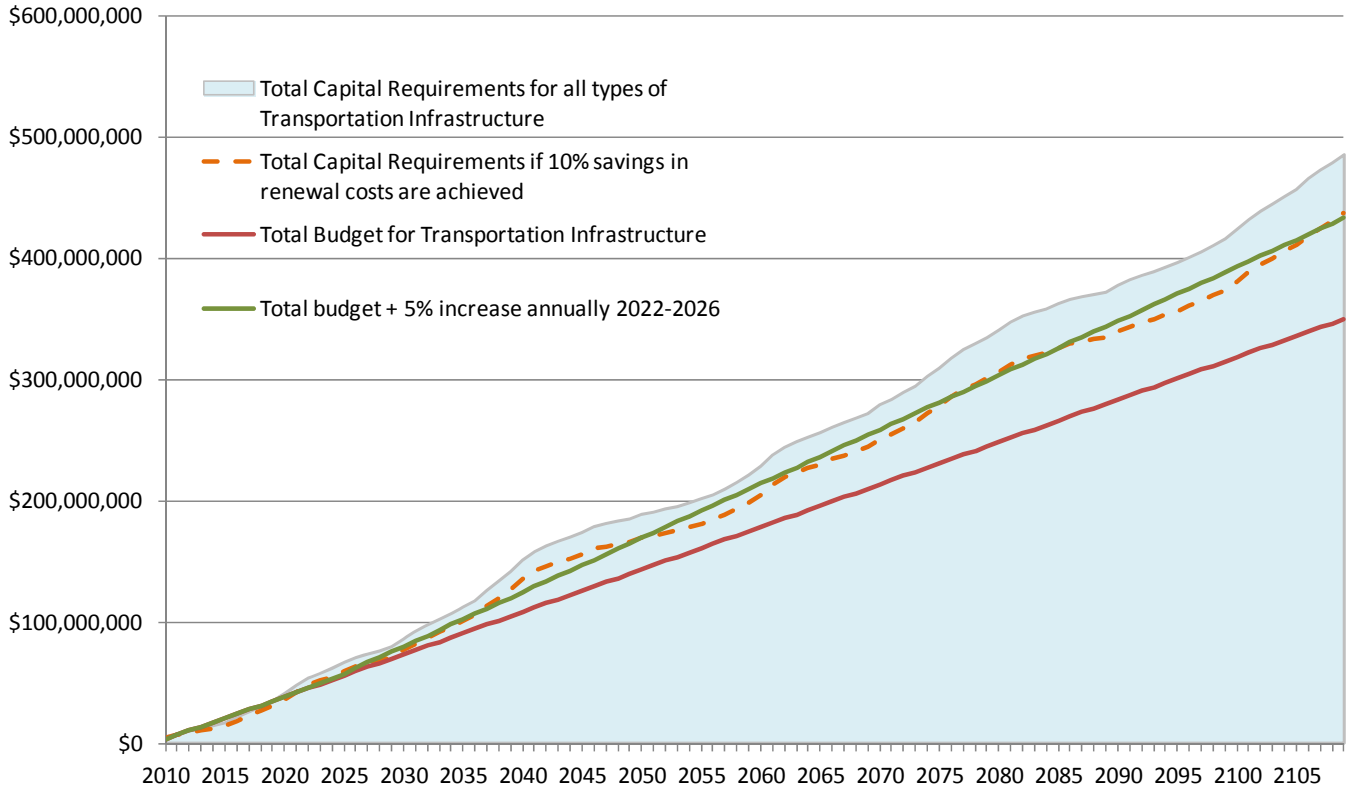
Note: This chart includes all renewal costs related to Bridges, Roads, Lanes, Cul-de-sacs, Sidewalks, Curbs, Traffic signals, Pedestrian signals, Street lights (Ornamental Lamps), Signs, Sign posts, Retaining walls, Dock, Special Cross Walks, Barriers, Roundabouts and Traffic Circles.

Even though it is estimated that the District has sufficient funding until 2020, the District can do things now to reduce the infrastructure gap that is projected beyond 2020. For example, the District can extend the life of its assets by continuing and perhaps enhancing its proactive inspection, maintenance and rehabilitation program and can reduce capital renewal costs by coordinating capital works wherever possible. More specifically, we recommend that the District begin now to take the following actions:

- Review its pavement management system to help identify a true localized needs-based assessment which will be based on the measured/observed results from the road data collection;
- Consult with its Council and residents to determine acceptable level of service associated with its transportation infrastructure;
- Fill in data gaps with respect to the inventory and condition of its transportation infrastructure;
- Develop policy with respect to financing large but infrequent infrastructure projects such as the replacement of a bridge;
- Review its asset maintenance practices to ensure that its assets are inspected and maintained in order to reduce their life-cycle costs while providing the necessary levels of service; and
- Maintain asset information so that it is readily available and facilitates the optimization of West Vancouver's assets.

Figure ES.4 illustrates the benefit of reducing lifecycle costs by 10% and provides a potential funding strategy that satisfies theoretical asset replacement requirements.

Figure ES.4 Eliminating the Infrastructure Gap through Cost-savings and Future Budget Increases



Note: This chart includes all renewal costs related to Bridges, Roads, Lanes, Cul-de-sac, Sidewalks, Curbs, Traffic signals, Pedestrian signals, Street lights (Ornamental Lamps), Signs, Sign posts, Retaining walls, Dock, Special Cross Walks, Barriers, Roundabouts and Traffic Circles.

The funding requirements outlined above are based on the District's best available data with respect to the inventory and condition of their assets. District staff will be reviewing and updating both the inventory and the condition assessment of the assets as part of the District's asset management program. Further updates will be provided which may increase or decrease the funding requirements identified in this plan.

The asset renewal requirements outlined in this report are based on the current level of service. By increasing or decreasing the level of service (such as the frequency of paving roads), the District of West Vancouver would increase or decrease the renewal requirements accordingly. Identifying acceptable levels of service would need to be done in consultation with Council and residents.

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Appendices

1. Introduction

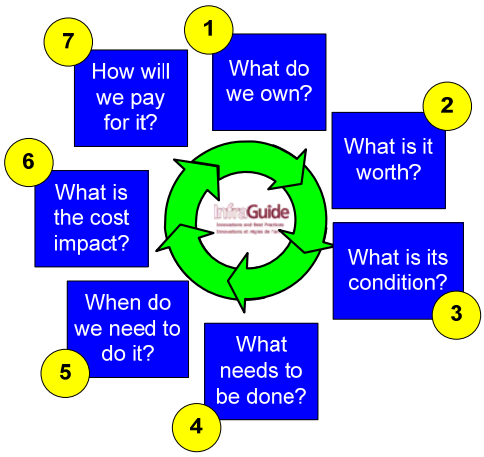
The District of West Vancouver's Engineering and Transportation Department commissioned this study to develop a long range forecast (100 years) of all of its transportation related infrastructure renewal requirements as a starting point to developing a program to ensure the financial sustainability of its infrastructure in perpetuity.

InfraGuide operated from 2001 to 2007 as a partnership between the Federation of Canadian Municipalities, the National Research Council and Infrastructure Canada. InfraGuide's national network of infrastructure experts produced a collection of case studies, best practice reports and tools for municipalities. To help West Vancouver meet its sustainable infrastructure objectives, AECOM developed this Asset Management Plan using the "Seven Questions of Asset Management" approach that is recommended by InfraGuide's "Best Practice for Managing Infrastructure Assets"[1]. The results of each of the seven steps shown in **Figure 1.1** are outlined in this report.

This project leveraged work recently completed to satisfy the Public Sector Accounting Board's (PSAB) reporting requirements for Tangible Capital Assets and is being complemented by similar plans for West Vancouver's water, stormwater and sanitary systems. The results of this plan can be used to assist in developing infrastructure renewal budgets, identifying replacement priorities, determining funding sources and communicating infrastructure needs to stakeholders.

This plan covers all components within West Vancouver's transportation system that are owned and maintained by the Engineering and Transportation Department, namely: 2 million m^2 of roadway; 78,000 m^2 of lanes; 15 bridges; 3 roundabouts; 5 traffic circles; 30,000 m^2 of sidewalk; 300,000 m of curb; 11 traffic signals; 10 pedestrian signals; 2 special crosswalks; 1096 street lights; 2700 m^2 of gardens; 7588 signs; 4582 signposts; 57,400 m of ditches; 5,100 m of ditch culverts, 9300 m^2 of retaining wall; 1450 m of roadside concrete barrier; and 1 dock. Transportation related assets that are owned and maintained by the Parks Department such as the Esquimalt Pedestrian Bridge over Lawson Creek, have not been included in this Asset Management Plan.

The renewal forecast for this study was completed using an MS-Excel based Capital Asset Planning (CAP) model. An electronic version of this model, with instructions for updating it, has been given to West Vancouver. A print out of the transportation system inventory from the model is provided in **Appendix A**. It is important to note that this model and the findings in this report provide a current "snapshot" of West Vancouver's transportation infrastructure. If the system changes, for example by the reconstruction of a bridge, then the model needs to be updated accordingly.



All cost estimates have been prepared using current (2012) dollars in order to facilitate year-to-year comparisons and to avoid the uncertainty of projecting inflation and discount rates far into the future.

The methodology and sources of data used to develop this asset management plan can be found in **Appendix B**.

Figure 1.1 Seven Questions of Asset Management

[1] *"Managing Infrastructure Assets" , October 2005, FCM*
http://fcm.ca/Documents/reports/Infraguide/Managing_Infrastructure_Assets_EN.pdf

2. Asset Inventory: "What do we own?"

2.1 Asset Inventory Summary

This plan covers all transportation related assets that are maintained by the Engineering and Transportation Department, which includes:

- 2 million m^2 (269 km) of roadway;
- 78,000 m^2 of lanes;
- 15 bridges;
- 3 roundabouts;
- 5 traffic circles;
- 30,000 m^2 of sidewalk;
- 300,000 metres of curb;
- 11 traffic signals;
- 10 pedestrian signals;
- 2 special crosswalks;
- 1096 street lights;
- 2700 m^2 of gardens;
- 7588 signs;
- 4582 signposts;
- 57,400 metres of ditch;
- 5,100 m of ditch culverts;
- 9300 m^2 of retaining wall;
- 1450 metres of roadside concrete barrier; and
- 1 dock.

These assets are also known in West Vancouver as "above ground" engineering assets. The data sources for the various asset types are outlined in **Appendix B**. In summary the main data sources are listed below.

- Road Matrix - the District's pavement management system
- Various spreadsheets/documents from the District of West Vancouver
    - DWV-#334767-v1-ASSET_PROJECT_-_ROAD_INVENTORY.XLS
    - DWV-#192274-v1-MARINE_DRIVE_BARRIER_DATA_SHEET.XLS
    - DWV-#388560-v1-ASSET_-_ROADS_MODIFIED_2006_TO_2010.XLS
    - DWV-#389312-v1-Asset_Project_-_Retaining_walls.DOC
- The District's GIS
- Planet GIS – the District's bridge management system
- A Bridge Infrastructure Long Term Plan completed by MMM Group in February 2012

Assets that are maintained by the Parks department such as street trees, trails and piers have not been included in this plan.

In March 2010, AECOM prepared an "Asset Management Information Strategy Report" for the District of West Vancouver which looked at how the District manages its asset data. Key findings and recommendations from this report are referred to within this plan.

2.2 Roads, Sidewalks and Curbs

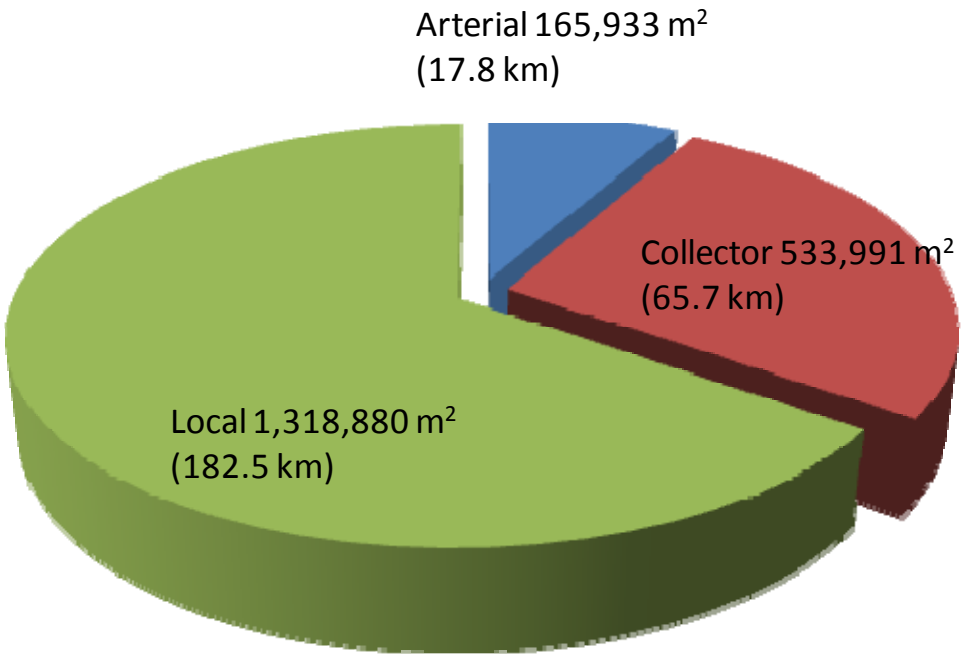
An inventory of the District's roads, sidewalks and curbs can be found within the District's geographic information system (GIS) as well as their Road Matrix pavement management system. An export of the data from the District's

Road Matrix pavement management system was provided to AECOM. At that time, the data in the Road Matrix program had been last updated in 2006. Any changes to the road inventory since 2006 was determined from the District's GIS. The data within the Road Matrix program is currently being updated based on recent pavement inspection results and will be available for future analysis.

The Road Matrix system does not include any cul-de-sacs less than 100 metres in length. From GIS it was determined that there are approximately six (6) kilometres of cul-de-sacs less than 100 metres in length. These cul-de-sacs were included in this study. It was assumed the cul-de-sac roadways are, on average, eight (8) metres wide.

The District has a total of 2 million m^2 of pavement within its roadways which corresponds to 269 km of 2 lane roadway. The District's roads are classified as local residential, local collector and arterial. As can be seen in **Figure 2.1**, 64% of the roads (by road surface area) are local, 27% are collectors and 9% are arterials.

Figure 2.1 Area of Roadway by Classification



West Vancouver's roadways have been constructed gradually over the last 100 years as the municipality has grown. West Vancouver's Road Matrix program lists the year that each roadway's base and pavement were installed. However, due to the lack of infrastructure construction records, the data should be considered as a "best estimate".

Within the Road Matrix system West Vancouver has four types of curbs: asphalt curb with sidewalk, rollover curb and gutter with sidewalk, concrete curb with sidewalk, and barrier curb and gutter with sidewalk. Except for the asphalt curb with sidewalk, it has been assumed that all other curb types are constructed with concrete.

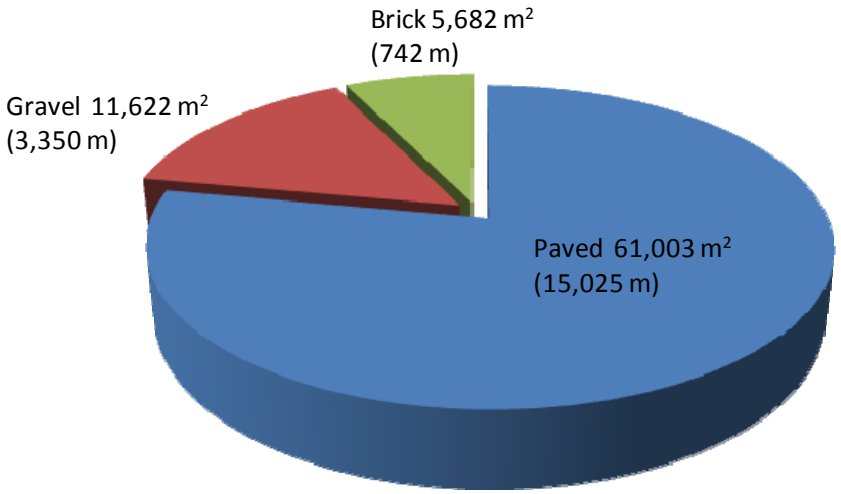
West Vancouver currently has approximately 30,000 m^2 of sidewalk. Each year West Vancouver constructs approximately 2 km (or 3,000 m^2) of new sidewalk to improve pedestrian accessibility within West Vancouver.

2.3 Lanes

West Vancouver's GIS has the centre line for the District's laneways but no additional information such as lane width or material. To complete their Statement of Tangible Capital Assets, West Vancouver staff measured each lane and entered the information into a spreadsheet. This spreadsheet was uploaded to the accounting access data-base. It has not been determined how and when the lane database will be updated.

As can be seen in **Figure 2.2**, 78% of the lanes are paved, 15% have gravel surfaces and 7% have a brick surface. Gravel lanes will remain as gravel unless residents go through the LIP/LAS (local area service lane paving) process, where they will be responsible for the paving costs.

Figure 2.2 Area of Lane by Surface Type



2.4 Bridges

The District of West Vancouver's Roads and Transportation Department currently owns and maintains 15 bridges. The District uses a bridge management system titled Planet GIS, which is kept offline and maintained by an external service provider. A summary of the bridge inventory, as of November 2008, was provided by the District. This inventory was updated with bridges recently constructed or currently under construction based on conversations with District staff and the Bridge Infrastructure Long Term Plan developed by MMM Group in February 2012.

This report only addresses bridges that are maintained by West Vancouver's Roads and Transportation Department. Pedestrian bridges that are part of West Vancouver's trail system are typically maintained by the Parks Department, and as such, their renewal will not be considered as part of this plan. One such bridge is the Lawson Creek Bridge at the 2000 block of Esquimalt. In contrast, the Nelson Creek Bridge is currently only being used by pedestrians/cyclists, but was once a vehicular bridge and is still owned and operated by the Roads and Transportation Department. Therefore, it has been included in this analysis. In the future, the bridge may be officially designated a pedestrian/cyclist bridge and ownership may be passed to the Parks Department.

2.5 Other Assets

In 2008, the District compiled an inventory of its traffic signals and street lights. In 2005, the District developed an inventory of its signs and signposts. West Vancouver maintains its inventory of signalisation assets within a custom-made database. Since this database does not have the required functions to effectively manage the maintenance of these assets, it is considered a temporary holding place for the asset inventory until a permanent solution is developed.

The District of West Vancouver developed an initial inventory of its roadside barriers and retaining walls and provided it to AECOM for this study. This initial inventory includes a total of 1450 metres of roadside barriers and 9300 m^2 of retaining wall but the retaining wall inventory does not appear to be extensive enough to contain a true representation of the total inventory. We recommend that the District review their retaining wall inventory as the cost and risk associated with managing its retaining walls could be significant.

The District of West Vancouver's Roads and Transportation Department owns and maintains one dock at Eagle Harbour, as it is considered an extension of the transportation network. The remainder of the docks owned by the District of West Vancouver are maintained by the Parks Department.

The Roads and Transportation Group maintains 57,400 metres of open ditch, 5,100 m of ditch culverts and 2700 m^2 of garden associated with engineering infrastructure such as traffic circles, medians and bioswales. The length of ditches was determined from the District of West Vancouver's GIS shapefiles obtained in 2009. A summary of the garden inventory was provided within the spreadsheet titled "DWV-#334767-v1-ASSET_PROJECT_-_ROAD_INVENTORY.XLS".

3. Replacement Costs: "What is it worth?"

The replacement value of each asset (in 2012 dollars) can be found in the asset inventory in **Appendix A**. The unit replacement value for each asset type can be found in **Table 3.1** below. The table also shows the unit replacement value that was developed for PSAB Reporting at the end of 2007.

Table 3.1 Unit Replacement Costs by Asset Type

Asset Type	Unit Replacement Value	Unit Replacement Value (PSAB)	Explanation for New Unit Replacement Value
Roads	$70/m^2	$50	New value considers the cost of the road sub-grade.
Lane - paved	$70/m^2	$36	Recommended by DWV
Lane – gravel	$25/m^2	$7	Includes cost for re-grading
Lane - brick	$100/m^2	$36	
Sidewalk - asphalt	$35/m^2	$63	Considered cheaper material and installation cost of asphalt
Sidewalk - concrete	$65/m^2	$63	
Curb – asphalt	$30/m	$26	
Curb - concrete	$60/m	$67	
Traffic signal – flashing beacon	$40,000/unit	$40,000	
Traffic signal – full	$250,000/unit	$180,000	Recommended by DWV as PSAB value too low
Pedestrian signal	$150,000/unit	$50,000	Recommended by DWV as PSAB value too low
Street lights (ornamental lamps)	$8,000/unit	$6,688	
Gardens	$150/m^2	$142	
Signs	$65/unit	$25-$85	
Sign post	$107/unit	$107	
Ditch - culverts	$500/m	Not included	Based on AECOM experience
Ditch - open	$25/m	Not included	Based on AECOM experience
Retaining wall – concrete	$600/m^2	Not included	Based on AECOM experience
Retaining wall – dry stacked rock	$200/m^2	Not included	Based on AECOM experience
Retaining wall – Allan block	$650/m^2	Not included	Based on AECOM experience
Dock	$500,000/unit	Not included	Recommended by DWV
Special crosswalks	$50,000/unit	$40,000	Recommended by DWV
Barriers	$110/unit	Not included	
Roundabout	$500,000/unit	Not included	Recommended by DWV
Traffic circle	$250,000/unit	Not included	Recommended by DWV

The replacement values for the roadways include the pavement surface, the base and the sub-base, but do not include sidewalks or curbs. Curbs and sidewalks have been considered separately as not all roads have curbs and sidewalks. The value of the land that the roadways occupy has not been considered as part of the replacement cost.

It should be noted that the unit replacement costs for the different road types in **Table 3.1** account for full replacement of each asset type by the exact same asset to give a sense of the "worth" of the District's transportation

infrastructure inventory. In reality, as the District replaces its infrastructure at the end of each asset's life it may cost more or less than the unit replacement cost in **Table 3.1**. For instance, when the District repaves a street it may not need to replace the base and sub-base, so the cost of renewing that road will be less than the unit costs presented in **Table 3.1**. This will be discussed more in **Section 7** "How much will it cost?"

The estimated replacement costs for each of the District's bridges are listed below. The values for the Rodgers, Pipe Creek and Almondel bridges were provided by District staff based on recent construction costs and the Bridge Infrastructure Long Term Plan prepared in February 2012 (see **Appendix D**). The values for the other bridges were based on an appraisal conducted in 2006 and then increased by 13% to account for inflation.

Table 3.2 Estimated Replacement Cost for West Vancouver's Bridges

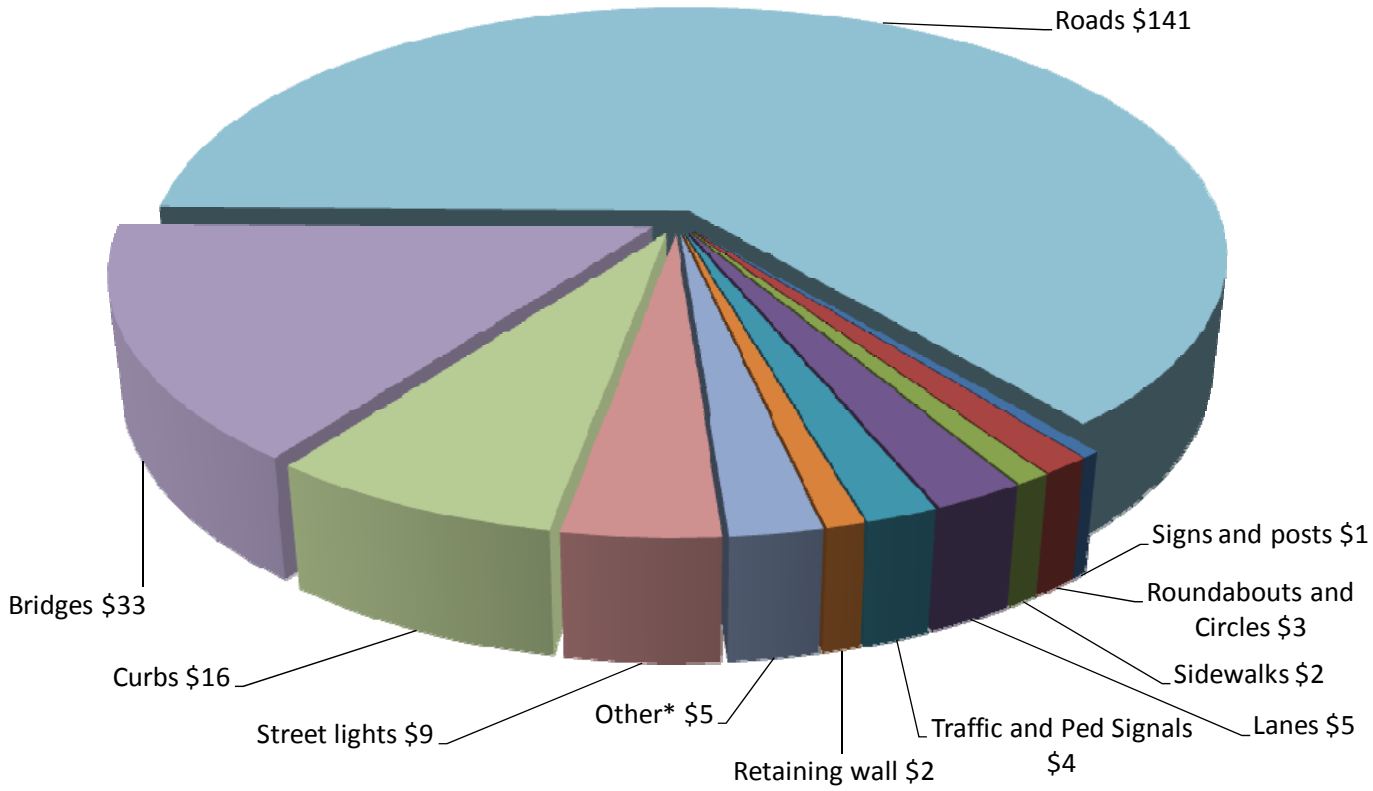
Bridge Name	**Estimated Replacement Cost (2012 dollars)**	**Bridge Type**
400 Block Keith Road - Brothers Creek	$2.6 million	Vehicular
500 Block Inglewood - Brothers Creek	$1.3 million	Vehicular
3900 Block Marine Drive - Sandy Cove	$2.1 million	Vehicular
4300 Block Marine Drive - Cypress Creek	$2.9 million	Vehicular
Nelson Canyon - Nelson Creek	$3.9 million	Pedestrian/Cyclists only
300 Block Keith Place - Brothers Creek	$1.7 million	Vehicular
1100 Block Millstream Rd. - Brothers Creek	$0.5 million	Vehicular
McCrady - Eagle Lake - Cypress Creek	$0.5 million	Vehicular
1800 Block Sinclair Court - Lawson Creek	$0.7 million	Vehicular
Whitby - Vinson Creek	$5.0 million	Vehicular
Chippendale/MacDonald	$2.2 million	Vehicular
Chippendale/Marr	$2.8 million	Vehicular
Rodgers Creek	$2.4 million	Vehicular
Pipe Creek	$1.4 million	Vehicular
Almondel	$3.1 million	Vehicular

The Lawson Creek Bridge at the 2000 Block Esquimalt has not been included in this analysis as it is a pedestrian bridge associated with the District's trail system, and as such is owned and operated by the Parks Department.

Based on the unit costs shown in **Table 3.1** as well as the estimated bridge replacement costs in **Table 3.2**, the total replacement value for the District's Transportation related infrastructure is estimated at $222 million. A breakdown of this estimate is shown in **Figure 3.1** and **Table 3.3**. In **Figure 3.1** "Other" refers to gardens, ditches, the dock, special crosswalks and concrete barriers.

As can be seen in **Figure 3.1**, more than half (64%) of the District's transportation infrastructure (by value) is within the pavement of its roadways. If the value of the curbs is included, then approximately 71% of the District's transportation infrastructure (by value) is within its roads. Fifteen percent (15%) of the District's transportation infrastructure (by value) is within its bridges, and 4% within its street lights, while the remaining 10% includes other types of infrastructure such as signals, retaining walls, lanes and sidewalks.

Figure 3.1 Total Replacement Value by Asset Type in $millions (2012)



* ***Other refers to gardens, ditches, the dock, special crosswalks and barriers***

Table 3.3 Total Replacement Value by Asset Type

Asset Type	Quantity		Value
Roads	2,018,804	m^2	$141,316,280
Lanes	78,307	m^2	$5,012,740
Sidewalks	29,945	m^2	$1,939,435
Curbs	278,432	m^2	$16,416,060
Traffic signals	11	units	$2,540,000
Pedestrian signals	10	units	$1,500,000
Street lights	1,096	units	$8,768,000
Gardens	2,687	m^2	$403,050
Signs	7,588	units	$493,220
Sign posts	4,582	units	$490,274
Ditch culverts	5,122	m	$2,561,000
Retaining wall	9,306	m^2	$2,201,750
Dock	1	units	$500,000
Special Cross Walks	2	units	$100,000
Barriers	1,450	m	$159,500
Bridges	16	units	$33,352,819
Roundabout	3	m	$1,500,000
Traffic Circle	5	units	$1,250,000
Total			**$220,504,128**

As can be seen in **Figure 3.2**, the majority (60%) of West Vancouver's roads by replacement value (as well as length) are local residential roads.

Figure 3.2 Replacement Value for Roads- by Road Type

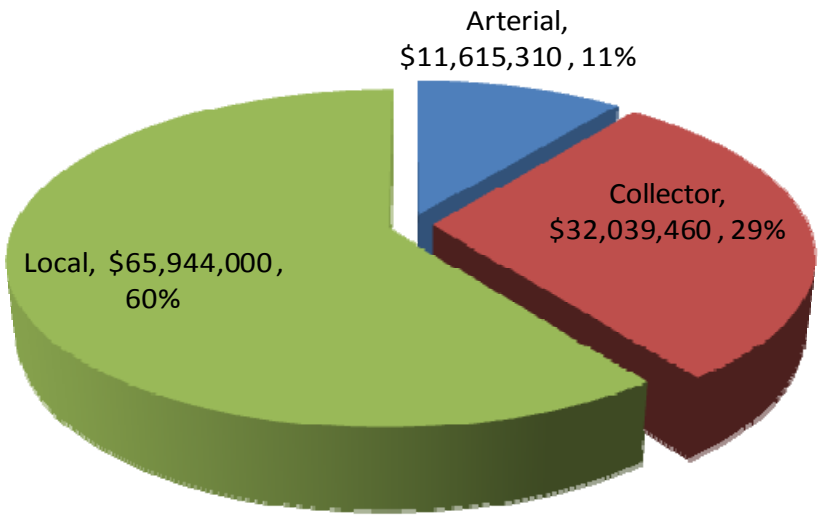
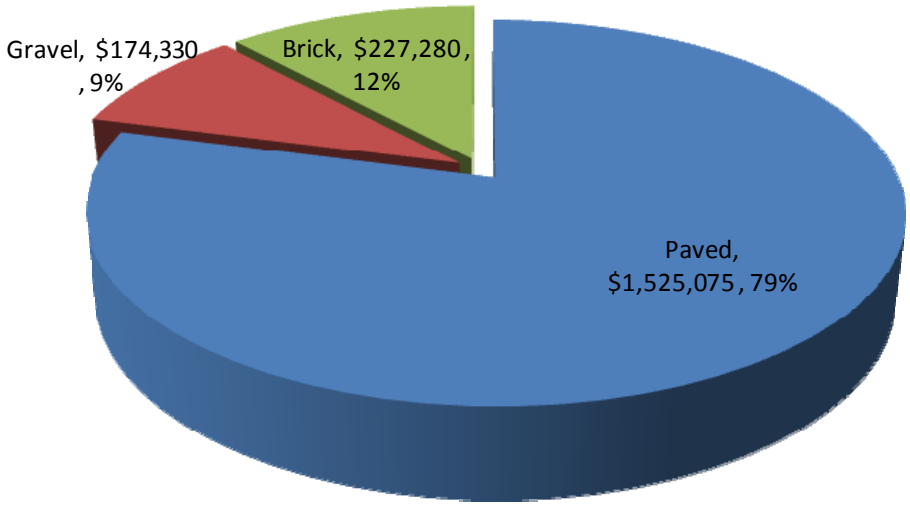


Figure 3.3 Replacement Value for Lanes by Lane Type



As can be seen in **Figure 3.3**, the majority (79%) of West Vancouver's lanes by replacement value (and length) are paved.

4. What is its Condition?

Condition assessments were not conducted as part of this study. We did however draw on condition information that was already available, which is described below.

Table 4.1 summarises which type of transportation asset receives condition assessments on a regular basis and which ones are inspected only as issues arise. Bridges, roads, ditches, signals, special crosswalks and the dock are on a regular inspection schedule. The entire inventory of signs and sign posts was inspected in 2005. The condition of the roads and bridges are tracked within the District's pavement and bridge management systems respectively.

Table 4.1 Condition Assessment Program for Transportation Assets

Asset Type	Schedule	Last Inspection	Comment
Roads	All roads every 5 years	2010	Tracked within Road Matrix system
Lanes	As issues arise		
Sidewalks	As issues arise		
Curbs	As issues arise		
Traffic signals	Annually		Inspected/maintained by "Cobra" and a report submitted annually
Pedestrian signals	Annually		Inspected/maintained by "Cobra" and a report submitted annually
Street lights (Ornamental Lamps)	As issues arise		
Gardens	As issues arise		
Signs	No set schedule	2005	Entire inventory was inspected in 2005
Sign posts	No set schedule	2005	Entire inventory was inspected in 2005
Ditches	Annual inspection		Condition not tracked
Retaining wall	As issues arise		
Dock	Annual inspection	2008	Condition and replacement plan in 2008 Balanced Environmental report.
Special Cross Walks	Annually		Inspected/maintained by "Cobra" and a report submitted annually
Barriers	As issues arise		
Bridge	Annually		Alternating between major and minor inspections. Tracked in Bridge Management System
Roundabout	As issues arise		
Traffic Circle	As issues arise		

More details about the condition of the transportation assets are provided in **Sections 4.1** to **4.3**.

4.1 Roads

Historically the District inspects the pavement on its roadways every 5 years. The results of these assessments are compiled within the District's pavement management system called Road Matrix. This system identifies rehabilitation work that should be completed as the road infrastructure deteriorates. At the time that this study was initiated the Road Matrix program contained data from its 2006 inspection. It is this 2006 data which has been used for the analysis associated with this plan.

The condition of a pavement is often determined and described used the Pavement Quality Index (PQI) which is a composite index reflecting both pavement smoothness and cracking. **Table 4.2** shows the average PQI for each road type in West Vancouver. A PQI of 98 represents a road in like new condition. The lower the PQI the worse the condition of the road is. On average the arterial roads are in better condition than the residential roads. As can be seen in **Table 4.2** the roads are, on average, halfway through their estimated service life.

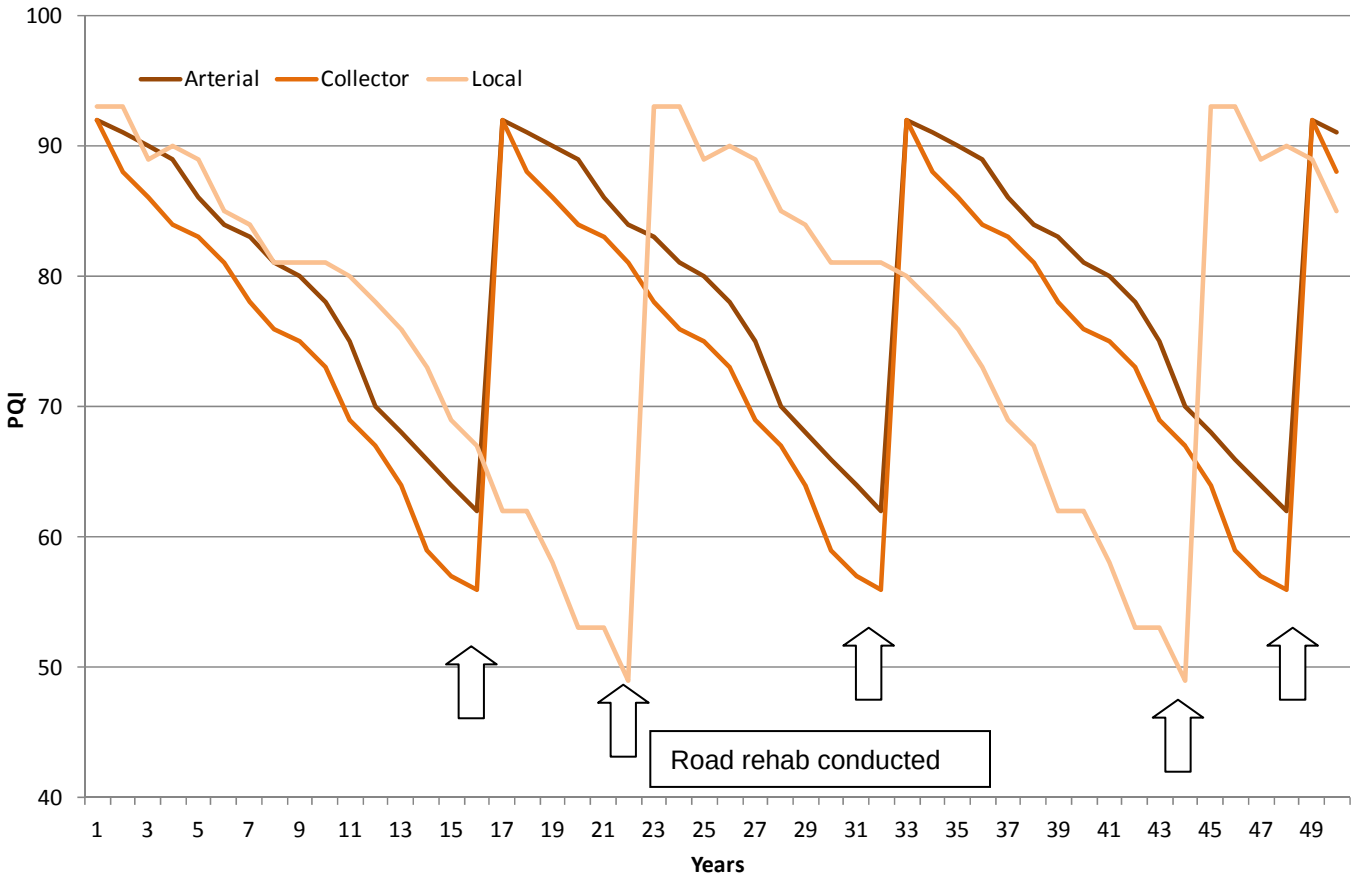
It is generally accepted that roads deteriorate non-linearly, with deterioration accelerating over time. However, as a first approximation using linear deterioration we can estimate that on average, District roads are approximately halfway through their estimated service lives (see Table 4.2).

Table 4.2 Average Condition of West Vancouver Roadways

ROADS	Area (m2)	Average PQI	Typical PQI when rehab is required	Avg % of service life used
Arterial	181,307	79.9	62	50%
Collector Residential	543,714	75.5	56	54%
Local Residential	1,325,543	69.5	49	58%
TOTAL	2,050,564	71.4		

The condition of a specific roadway will depend on a number of factors such as quality of road base, traffic volume, maintenance practices, disturbances such as utility cuts, weather and age. However, the typical deterioration of roadway asphalt based on data from West Vancouver's Road Matrix system can be estimated as shown in **Figure 4.1**.

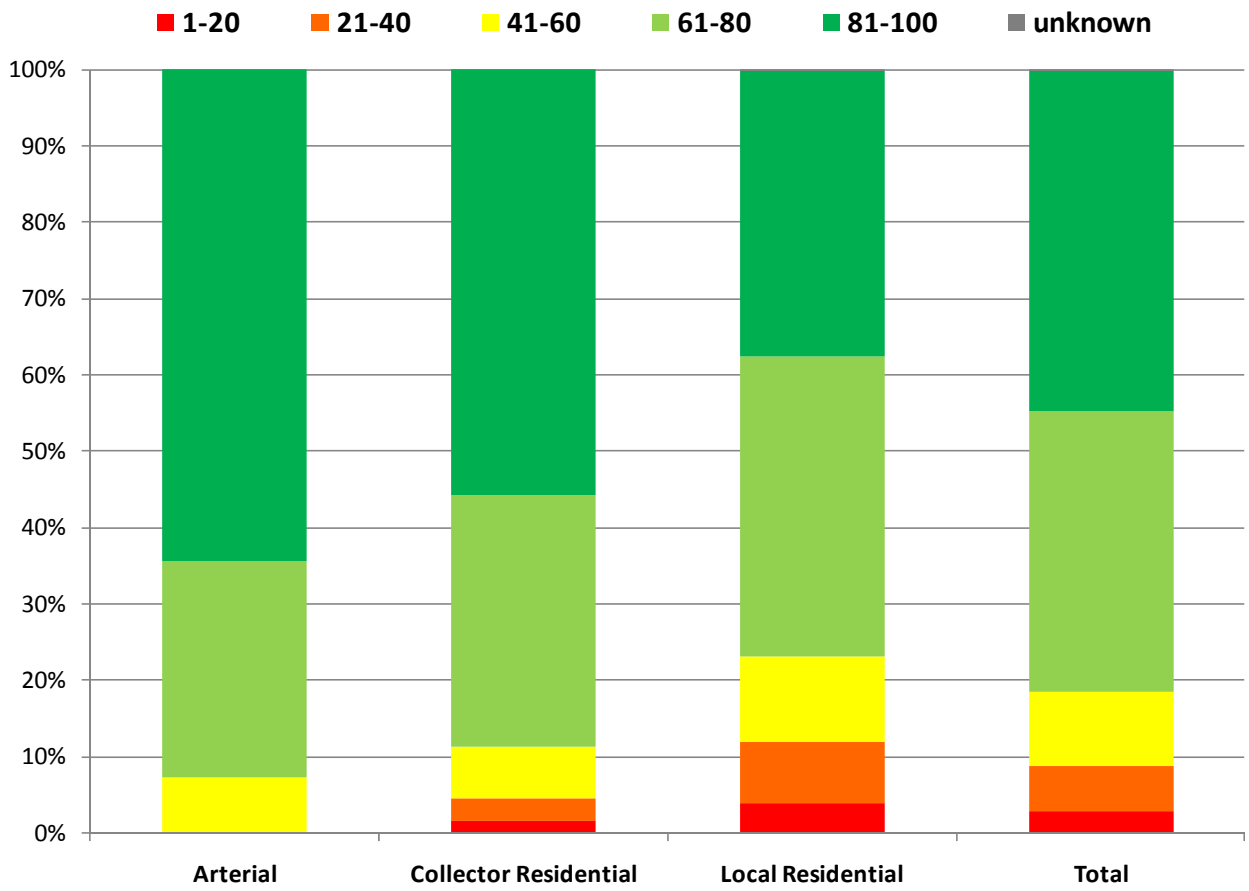
Figure 4.1 Typical Asphalt Deterioration for Different Road Types



The PQI for the roads in West Vancouver are summarised in **Figures 4.2** and **4.3**. According to the PQI reported in the Road Matrix program, the majority (81%) of West Vancouver's roads are showing some signs of deterioration but are still in good or fair condition. **Figures 4.2** and **4.3** do not include the District's 6 km of cul-de-sacs as they are not assessed as part of the District's road condition assessment program and are therefore not within the District's Road Matrix program. Although we do not know the condition of these cul-de-sacs, we have made appropriate assumptions later on to include them within this Transportation Asset Management Plan.

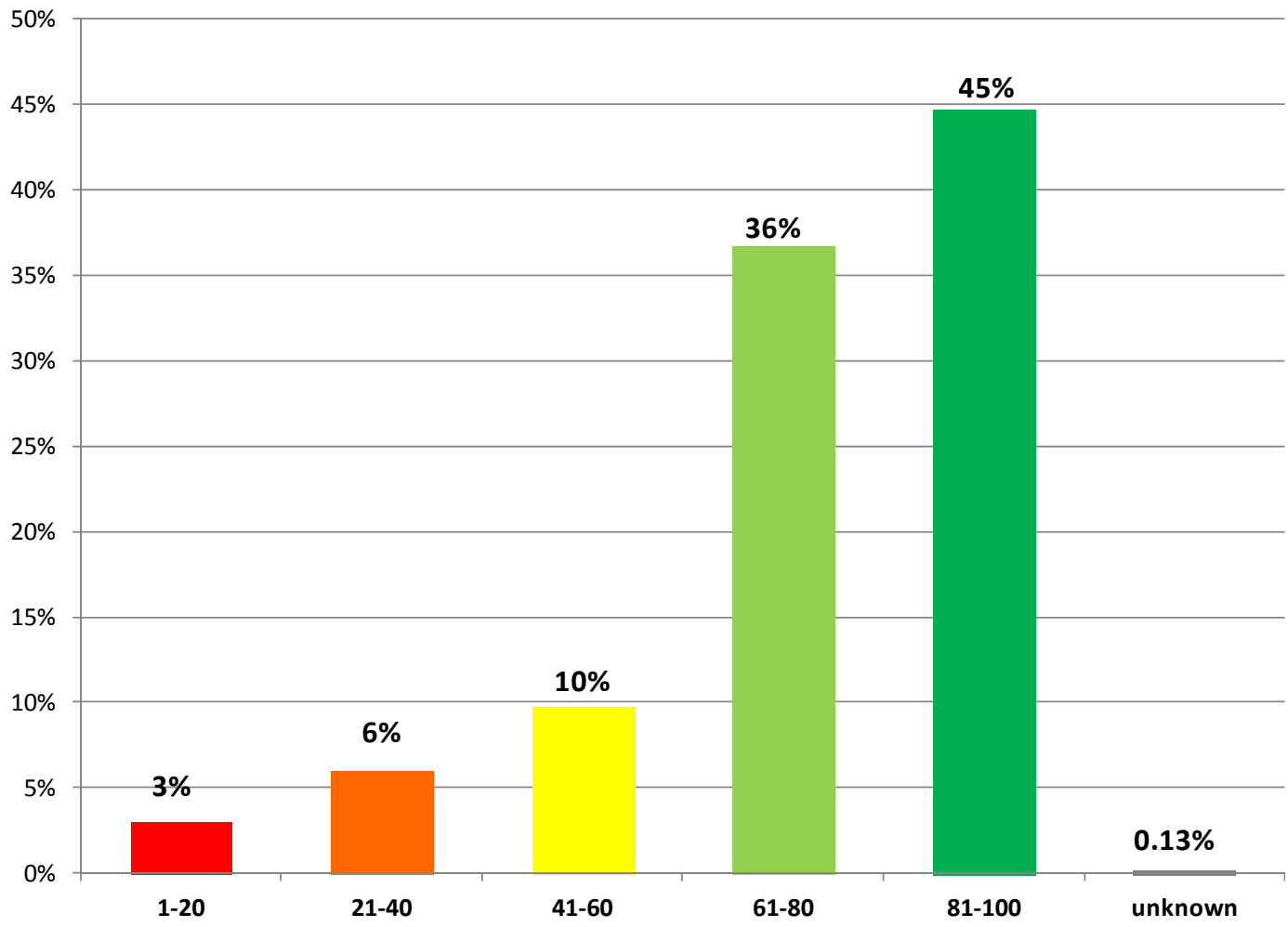
Appendix C shows pictures of various roadways In West Vancouver with different PQI.

Figure 4.2 PQI Range for Each Road Type



Source data: Pavement Quality Index values extracted from the District of West Vancouver's Pavement Management System in April 2010

Figure 4.3 PQI Range for All Road Types



Source data: Pavement Quality Index values extracted from the District of West Vancouver's Pavement Management System in April 2010

4.2 Bridges

The District of West Vancouver regularly inspects and performs maintenance and rehabilitation work on its bridges. The results of these inspections, the condition of specific bridge components and recommended maintenance and repair work can be found within West Vancouver's Bridge Management System called Planet GIS.

In 2008, all of the District's bridges were inspected. **Table 4.3** shows the age of each bridge and the results from the District's 2008 Bridge Inspection Report. The District of West Vancouver has been responsive in dealing with issues resulting from the inspection. For instance, as a result of the 2008 inspection, the District replaced the deck of the Keith Place bridge over Brothers Creek.

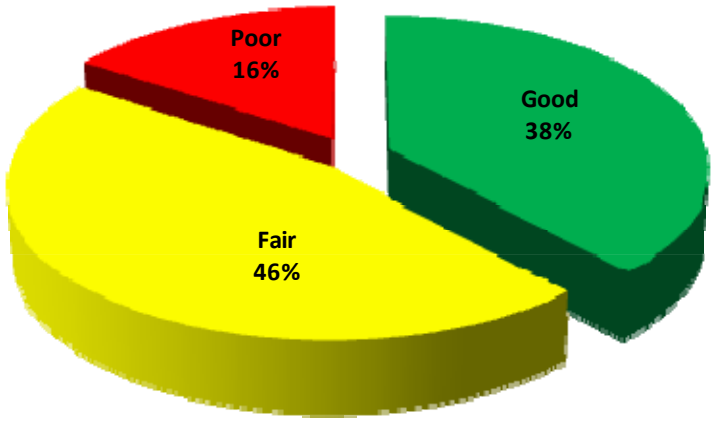
Table 4.3 Age and Condition of West Vancouver's Bridges from 2008 Bridge Inspection Report

Bridge	Age	Inspection Summary
400 Block Keith Road - Brothers Creek (1)	58	Strengthening of the bridge was carried out in 2007. Although the bridge is showing signs of deterioration due to age and usage, it is in good condition overall.
500 Block Inglewood - Brothers Creek (2)	24	Need to relieve pressure of pipes on abutments & reinstate pipe so they rest on pipe hangers.
3900 Block Marine Drive - Sandy Cove (3)	71	Bridge has been seismically upgraded. Some important rehab work needed (install guardrail; relocate bus stop; repair staircase; repair expansion joint seals.)
4300 Block Marine Drive - Cypress Creek (5)	70	Overall the bridge is considered to be in fair to good condition. Abutment remediation needed and vegetation needs to be trimmed.
Nelson Canyon - Nelson Creek (6)	54	This pedestrian bridge is part of the TransCanada Trail network. It also serves to support the watermain suspended beneath.
300 Block Keith Place - Brothers Creek (8)	19	Some immediate rehab work required on this bridge.
1100 Block Millstream Rd. - Brothers Creek (9)	46	Some minor rehab work required on this bridge.
McCrady - Eagle Lake - Cypress Creek (10)	26	Some rehab work required on this bridge.
1800 Block Sinclair Court - Lawson Creek (11)	15	Biggest concerns are peeling paint, reduced sightlines from overgrown vegetation, trip hazards and downstream erosion.
Whitby - Vinson Creek (12)	8	Despite this bridge's young age it is experiencing cracking and the waterproof membrane needs to be repaired.
Chippendale/MacDonald (14)	3	In as-new condition.
Chippendale/Marr (13)	3	In as-new condition.
Rodgers Creek	0	Not inspected.
Pipe Creek	0	Not inspected.
Almondel (4)	1	Bridge under construction at time of inspection.

4.3 Signs and Sign Posts

The District's street signs were inspected in 2005 and given a rating of good, fair or poor. As can be seen in **Figure 4.4** approximately half (46%) of the signs are in fair condition, 38% are in good condition and 16% are in poor condition. An inventory of the signposts has been developed to determine exact location and post type, but a condition rating was not determined.

Figure 4.4 Street Sign Condition



4.4 Other Assets

Specific information on the condition of the traffic signals, pedestrian signals and specialized crosswalks can be found within an annual inspection report produced by the contractor "Cobra". For the purposes of this study the condition of the traffic signals has been estimated based on their age in comparison to their expected life. The same cannot be done for the street lights as their installation dates are unknown.

The District does not have an inspection program for its retaining walls and barriers. As a result, their condition is unknown. For this study, age in comparison to expected life has been used as a proxy for the condition of the retaining walls. The same cannot be done for the concrete barriers as their installation date is unknown.

The District's Road and Transportation staff maintains the dock annually and as issues arise. In 2008 Balanced Environmental prepared a report for the District in which it indicated the condition of the dock and options for its replacement.

The ditches in West Vancouver are inspected once per year and maintained as required. Their condition is not recorded or tracked. The gardens are also regularly maintained as required.

5. What Needs to be Done?

To sustain the functionality of West Vancouver's Transportation infrastructure, numerous preventative and corrective maintenance activities must occur, and assets must be renewed. In general, maintenance practices impact renewal requirements as effective preventative maintenance programs will help to extend the life of a given asset. For instance, District staff has reported that their street lights last longer when they are regularly maintained. The District's Engineering and Transportation Department currently undertakes substantive inspection, maintenance, and rehabilitation activities for most of its assets and will continue to do so as well as investigate how these activities might be further enhanced.

As outlined in **Table 4.1**, the District regularly inspects most of its transportation assets; namely roads, bridges, ditches, signals and the Eagle Harbour dock. In 2005 the District determined the condition of all its signs and sign posts, but future inspections have not been scheduled at this time.

The District conducts preventative maintenance on its roads, lanes, bridges, dock, street lights, traffic signals and problem ditches. Other assets such as street signs, sidewalks, retaining walls and the majority of ditches are maintained in a reactive manner. More details about the maintenance of individual asset types are provided below.

Based on regular condition assessments, the District's pavement management system called Road Matrix identifies rehabilitation work that should be completed to maintain the roads, sidewalks and curbs in good operating condition. Historically, the majority of roads (i.e. approximately 75%) in West Vancouver have been rehabilitated by pulverizing and repaving. Only a small number of roads (i.e. approximately 5%) have required full reconstruction. The remaining 20% (approximately) have been rehabilitated through mill and overlay. This is in addition to regular maintenance activities such as crack sealing and line painting.

The District conducts maintenance on its gravel, brick and asphalt lanes (filling potholes, replacing bricks, patching asphalt etc.). Gravel lanes will not be paved unless residents initiate the LIP/LAS (local area service lane paving) process. Asphalt and brick lanes will need to be renewed at the end of their service life.

Traffic signals, pedestrian signals and special crosswalks are inspected and maintained by the contractor "Cobra" and a report submitted annually. We have assumed that a traffic signal or street light will get replaced by a similar type of asset. In reality, the District may wish to install a new type of traffic signal or street light or even install one where there previously wasn't one. As these additional costs are likely minor with respect to the District's total infrastructure costs, and unknown at this point in time, they have not been considered in this plan.

The District of West Vancouver should continue to inspect and maintain its bridges in a proactive manner. Maintenance, rehabilitation and replacement needs for the District's bridge network over the next 100 years were identified as part of the "Bridge Infrastructure Long Term Plan" developed by MMM Group in February 2012. The Nelson Creek bridge was formerly a vehicular bridge but is now used only for pedestrians and cyclists as part of West Vancouver's trail system. The District of West Vancouver now needs to decide whether to rehabilitate this bridge or replace it with a pedestrian bridge. It is likely that the bridge will be taken over by the Parks department as it no longer part of the road network.

Currently the District has a variety of retaining walls: concrete retaining walls, dry stacked walls, and Allan Block walls. It was assumed that an existing wall would be replaced by the same type of wall; whereas in reality an existing dry stacked wall that needs to be replaced may be replaced by an Allan Block wall. The retaining walls at the Chippendale and Almondel bridges have been considered as a part of the bridges and have not been considered separately here. The retaining wall inventory that was provided for this study should be considered preliminary. The District is in the process of developing a comprehensive retaining wall inventory to further its transportation asset management practices.

Based on conversations with District staff, gardens and open sections of ditches will only be maintained and not replaced as part of the District's capital renewal program. Therefore there is no renewal cost associated with gardens or open ditches in this asset management plan. Ditch culverts, such as those associated with driveway crossings will need to be renewed at the end of their service life.

As this study provides a high level view of asset renewal requirements, the cost of maintenance and rehabilitation activities – such as the replacement of bridge bearings or replacement of lights – has not been identified. In addition, the benefits of rehabilitation activities to extend an asset beyond its normal service life, have not been considered. Instead, all assets are assumed to require total replacement at the end of their predicted service life, which provides a more conservative approach to budgeting than if rehabilitation strategies were also considered. In **Section 9**, the potential for extending the life of assets through a targeted rehabilitation program is discussed.

6. When Do We Need To Do It?

As outlined in **Section 5**, assets will need to be regularly inspected and maintained, and then replaced at the end of their service life. The graphs in **Section 7** show when assets will need to be renewed and the associated estimated costs. A summary of the service lives by asset type used in this analysis, are presented in **Table 6.1** below. Further discussion on each asset type is provided in **Sections 6.1-6.4**.

Table 6.1 Expected Service Lives for Different Asset Types

Asset Type	Average Estimated Service Life (years)	Source of Estimated Service Life
Road – arterial	15	Based on Road matrix & DWV/AECOM experience
Road – collector	20	
Road – local	25-50	Based on DWV/AECOM experience
Lane – paved	50	Based on DWV experience and industry norms
Lane – gravel	Just requires maintenance	Based on West Van staff experience
Lane – brick	40	Based on AECOM experience
Sidewalk – asphalt	50	Based on Road Matrix data and AECOM experience
Sidewalk – concrete	50	Based on Road Matrix data and AECOM experience
Curb – asphalt	50	Based on Road Matrix data and AECOM experience
Curb – concrete	50	Based on Road Matrix data and AECOM experience
Traffic signal – flashing beacon	30	Based on West Van staff experience
Traffic signal – full	30	Based on West Van staff experience
Pedestrian signal	30	Based on West Van staff experience
Street light	35	Based on West Van staff experience
Gardens	Just requires maintenance	
Signs	10	Based on West Van staff experience
Sign post	40	Based on West Van staff experience
Ditch culverts	50	Based on AECOM experience
Open ditches	Just requires maintenance	
Retaining wall – concrete	75	Based on AECOM experience
Retaining wall – dry stacked rock	150	Based on AECOM experience
Retaining wall – Allan block	100	Based on AECOM experience
Retaining wall – New	100	Based on AECOM experience
Dock	25	Based on West Van staff experience
Special crosswalks	30	Based on West Van staff experience
Barriers	50	Based on AECOM experience
Roundabout	50	Based on AECOM experience
Traffic circle	50	Based on AECOM experience
Bridges	Approx 50-100; varies by bridge	DWV-#334767-v1-ASSET_PROJECT_-_ROAD_INVENTORY.XLS; MMM Group – “Bridge Infrastructure Long Term Plan”; Life span of new bridges estimated by AECOM bridge staff.

6.1 Roads

The District selects roads for repaving based on the road's condition (i.e. PQI), the road classification, coordination with utilities' work, and available budgets. This means that some roadways may need to be repaved after only 15 years of service whereas other roadways may last for 50 years before they need to be repaved. From 2006-2009, West Vancouver rehabilitated (milled and overlaid or partially reconstructed) approximately 2% of its roadways each year.

The District is reviewing its pavement management system to ensure that its road rehabilitation decisions are based on local road data collected. In the absence of a true needs based assessment from the District's pavement management system, AECOM and the District have agreed to use age as an indicator of road condition for this study and the following typical service lives for each road type:

- Arterial – 15 years;
- Collector residential – 20 years; and
- Local residential –25-50 years.

Based on the agreed upon service lives above, the CAP model states that there is approximately 2.1 km of arterial road and 4.4 km of collector residential road that is already due for replacement. In **Section 7** this "backlog" (at an estimated cost of $3 million) has been spread out over the first five years (i.e.2010-2014).

6.2 Bridges

The timing of rehabilitation work over the next 100 years on the District's bridges such as bridge replacement, deck replacement/overlay, wearing surface and waterproofing membrane replacement and crack sealing of wearing surface was outlined in the Bridge Infrastructure Long Term Plan prepared by the MMM Group for the District dated February 1, 2012. A copy of this plan is provided in **Appendix D**. The resulting costs were entered into the CAP model.

6.3 Assets to Be Maintained Only

The District of West Vancouver does not "replace" its gardens, gravel lanes and open ditches but rather maintains them regularly. As this work is completed through maintenance budgets, no capital renewal work associated with gardens, gravel lanes and open ditches has been considered within this study. It should be noted that ditch culverts (i.e. where a ditch goes under a driveway crossing) will need to be replaced at the end of its service life. Based on past experience and industry standards, the District and AECOM have agreed to assume that ditch culverts will be replaced on average every 50 years.

7. How Much Will It Cost?

The cost of future renewals has been determined using the unit replacement costs outlined in **Table 3.1,** except with respect to roads and lanes. Based on historical patterns, it is projected that as roads are renewed in West Vancouver 75% of the time they will be pulverized and paved, 20% of the time they will be milled and overlaid, and 5% of the time they will be fully reconstructed. It is assumed that asphalt lanes will be pulverized and paved every 50 years. The unit costs for each of these types of interventions are outlined in **Table 7.1** below.

Table 7.1 Road Renewal Costs

Road Type	Renewal Methodology	Unit Cost
Arterial/Collector	Full reconstruct	$70
	Pulverize and pave	$55
	Mill and overlay	$25
Local/Lane	Full reconstruct	$70
	Pulverize and pave	$45
	Mill and overlay	$25

The costs associated with bridge renewal were derived from the Bridge Infrastructure Long Term Plan prepared by the MMM Group dated February 1, 2012. A copy of this plan can be found in **Appendix D**.

This financial forecast only considers the cost to renew assets and not to perform regular maintenance such as crack sealing, painting or cleaning. Since the District of West Vancouver does not plan to renew their ditches, gravel lanes or gardens but only maintain them there are no costs for these assets considered within this financial forecast.

Not only will West Vancouver have to renew its existing asset inventory but it will have to renew assets that are added to its inventory in the future. Examples of future assets that the District is anticipating are:

- Transportation infrastructure associated with future development such as Rodgers Creek; and
- New sidewalks that are added to facilitate pedestrian mobility.

The land north of the Upper Levels Highway West between Cypress Mountain and Horseshoe Bay will continue to develop over the coming years. In September 2008 the District of West Vancouver approved a development plan for the Rodgers Creek area, which encompasses approximately 215 acres between Marr Creek and Cave Creek West above the Upper Levels Highway and below the 1200 foot contour. Although the District of West Vancouver will not need to pay for the initial construction of the infrastructure within the Rodgers Creek development, it will take ownership of these assets and be responsible for their renewal. Therefore the cost of the renewal of the major infrastructure items associated with this development; namely roads and bridges, have been included in our financial forecast.

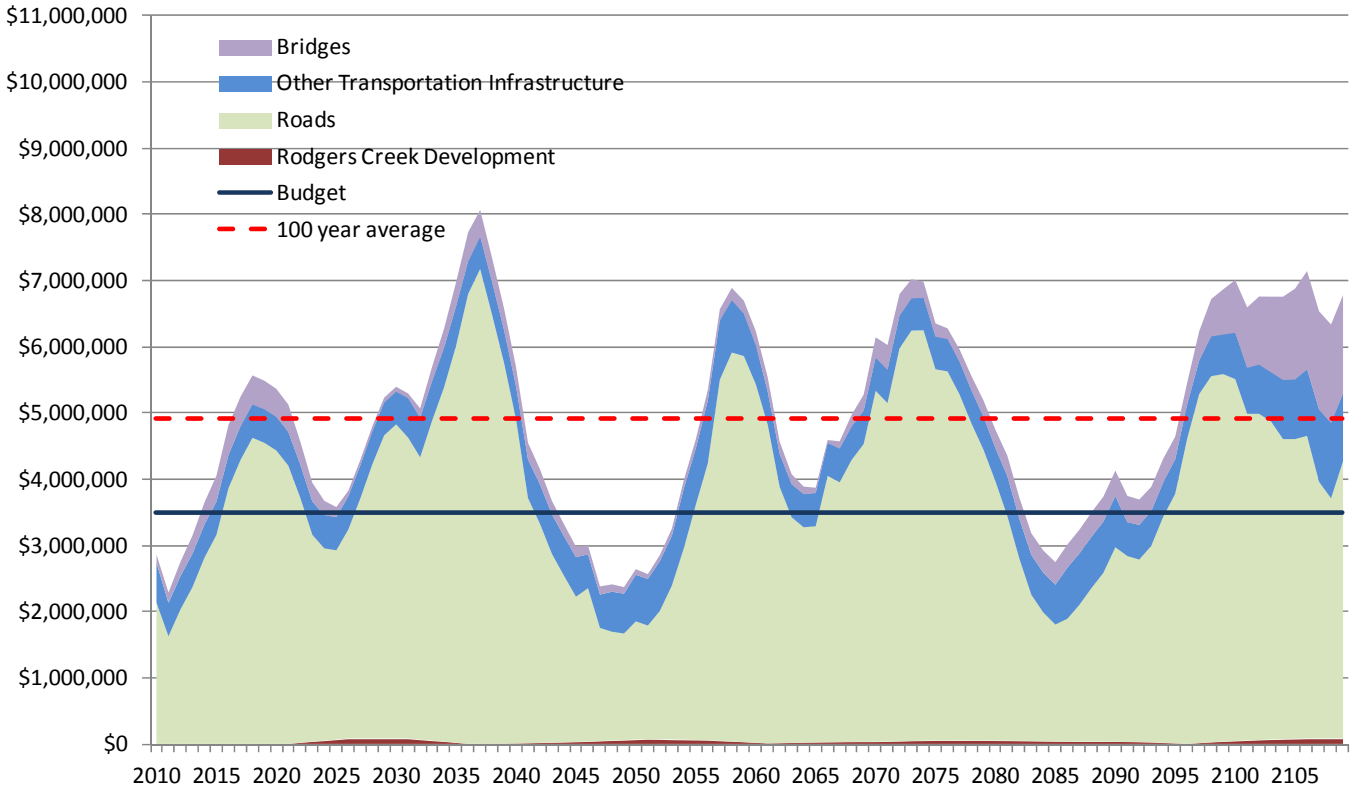
Based on the Rodgers Creek Area Development Plan, the following assumptions about the Rodgers Creek development were made for this financial forecast:

- Development would be completed by 2020;
- A total of 215 acres would be developed;
- 55% of the area would be parkland;
- 20% of the area would be roadway;
- The average street width would be 8 metres; and
- Major bridges such as the Rodgers Creek Bridge have already been included in the asset inventory.

Each year West Vancouver constructs new sidewalks to improve accessibility within West Vancouver. The Safe Routes to School Program calls for sidewalks in proximity to schools, and West Vancouver's Strategic Transportation Plan calls for sidewalks on both sides of arterial roads and on one side of collector and local roads. As part of this financial forecast it has been assumed that the inventory of sidewalks increases by 2 km (or 3000 m^2) each year until all arterial roads have sidewalks on both sides and all collector/local roads have sidewalks on one side.

The renewal costs for all transportation related infrastructure included in this study are shown in **Figure 7.1**. The average renewal costs for all of West Vancouver's Transportation Infrastructure over 100 years is $4.9 million per year. Currently West Vancouver spends approximately $3.5 million per year on the renewal of its entire transportation infrastructure (i.e. roads, bridges and other transportation infrastructure). In **Figures 7.1** and **7.3** "roads" includes the roadway pavement, curbs and sidewalks.

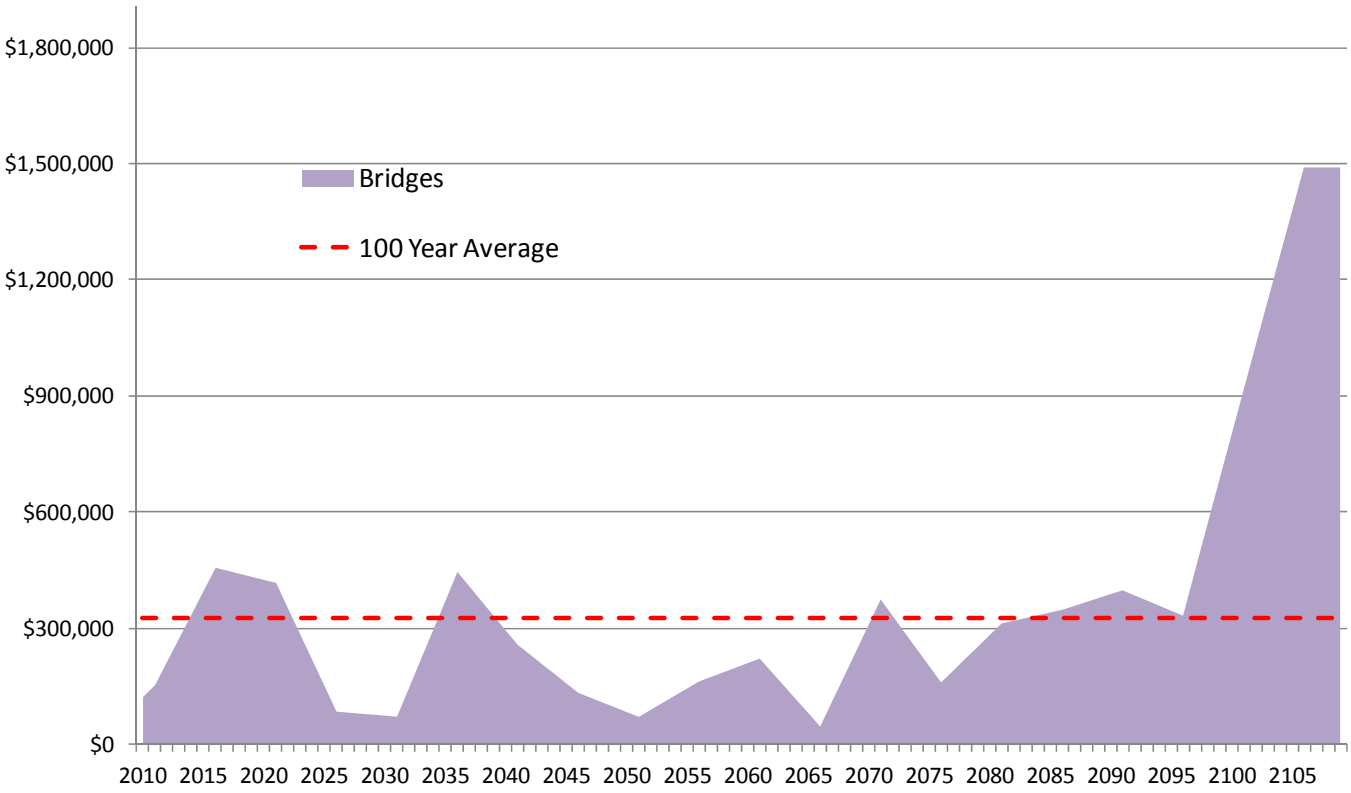
Figure 7.1 Capital Renewal Forecast for All of West Vancouver's Transportation Infrastructure



Note: Other Transportation Infrastructure includes Traffic signals, Pedestrian signals, Street lights (Ornamental Lamps), Signs, Sign posts, Retaining walls, Dock, Special Cross Walks, Barriers, Roundabouts and Traffic Circles

The renewal costs for West Vancouver's bridges that are owned and maintained by the Engineering and Transportation Department are shown in **Figure 7.2**. The costs will vary greatly from year to year, based on the timing of bridge replacements but the average annual renewal cost is estimated at $330,000.

Figure 7.2 Capital Renewal Forecast for West Vancouver's Bridges



The first bridge that requires replacement in the next five years is the Nelson Canyon Bridge. As the Nelson Canyon bridge is no longer part of the road network and is only used for pedestrians and cyclists as part of West Vancouver's trail system, this bridge may be transferred to the District's Park Department. The second bridge that will likely need replacement (in approximately ten years time) is the Keith Road Bridge over Brothers Creek due to its age and seismic risk.

Figure 7.3 shows the capital renewal costs for West Vancouver's roads (including curbs and sidewalks). The estimated capital renewal requirements for these assets are on average $3.9 million per year over 100 years.

Figure 7.3 Capital Renewal Forecast for Roads (Bridges and other infrastructure removed)

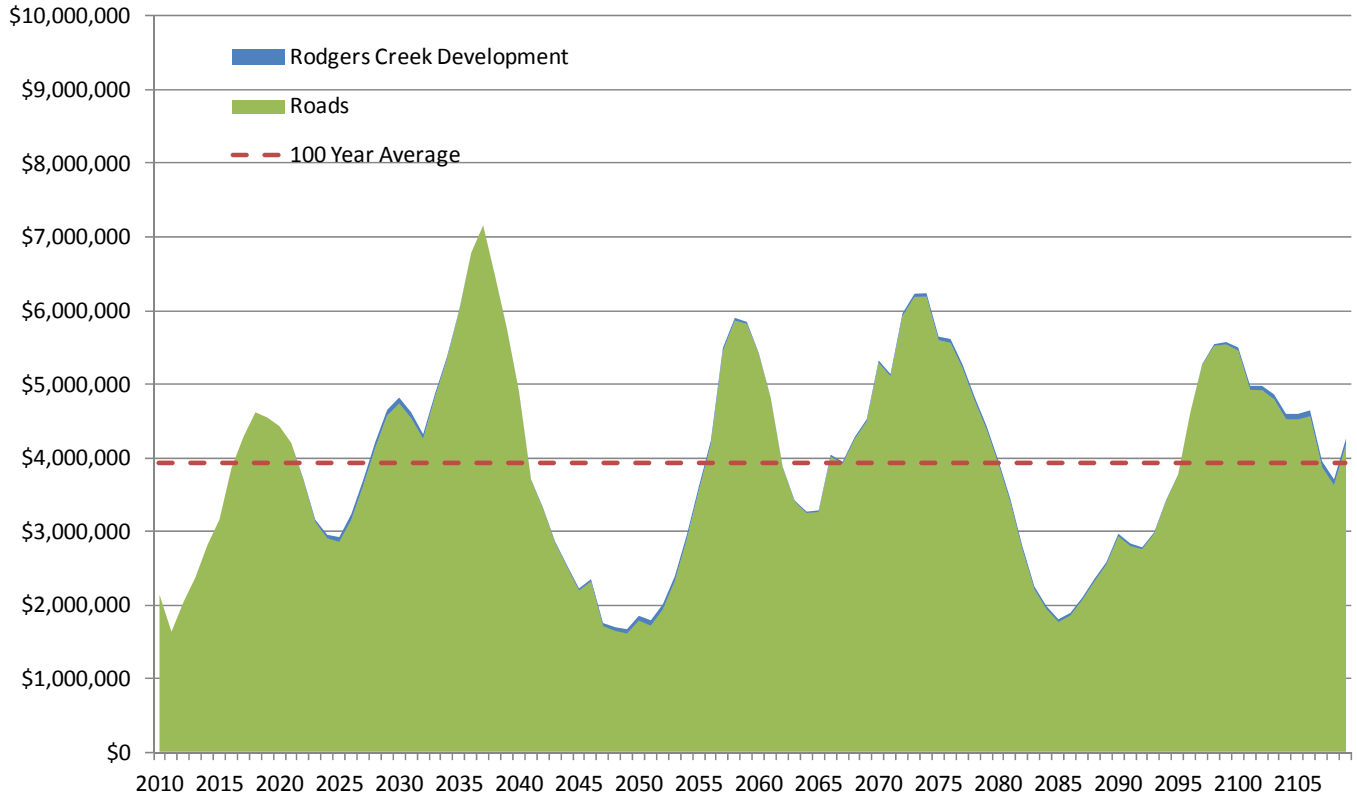
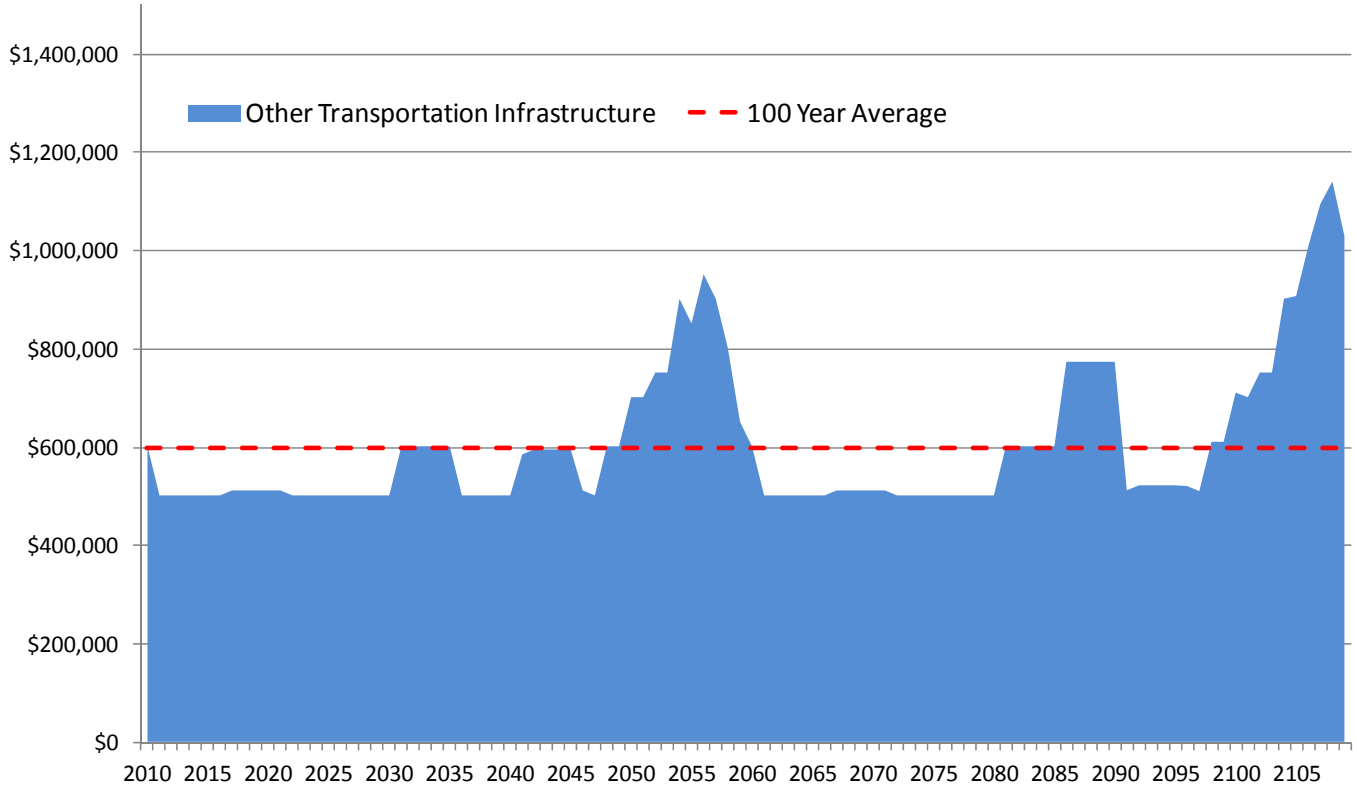


Figure 7.4 shows the capital renewal requirements for West Vancouver's road related infrastructure such as traffic signals, pedestrian signals, street lights (Ornamental Lamps), signs, sign posts, retaining walls, dock, special cross-walks, barriers, ditch culverts, roundabouts and traffic circles The estimated capital renewal requirements for these assets are on average $600,000 per year over 100 years.

Figure 7.4 Capital Renewal Forecast for Road Related Infrastructure (bridges and roads removed)



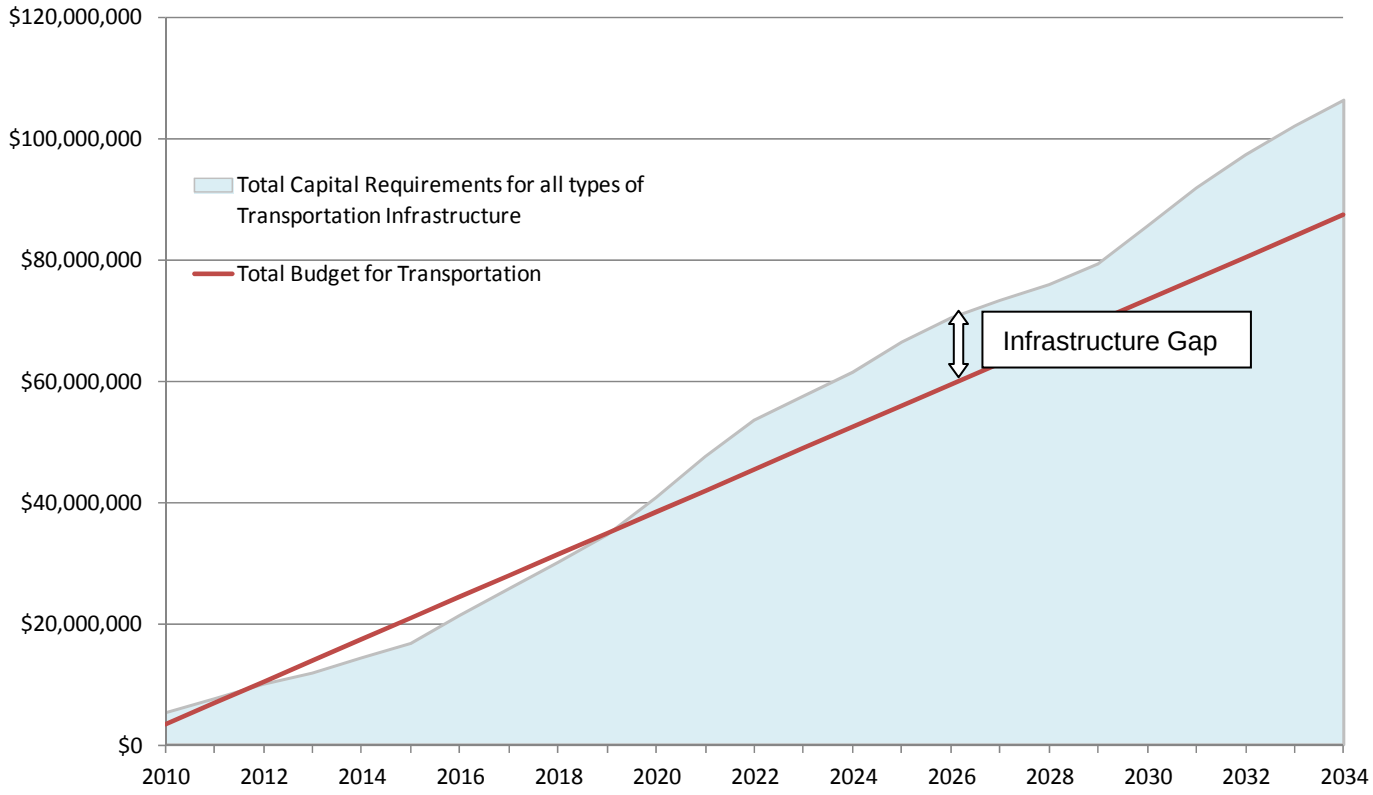
8. Funding Strategies: "How will we pay for it?"

This study has estimated the total reinvestment requirements for West Vancouver's transportation related infrastructure over the next 100 years. It shows when the District can expect waves of high capital expenditures, thereby helping West Vancouver to better determine revenue needs and to optimise O&M practices to extend the life of existing assets.

8.1 Current Funding Levels

West Vancouver spends on average approximately $3.5 million each year on the renewal of its existing transportation infrastructure as well as the construction of new curbs, sidewalks and traffic calming measures. **Figure 8.1** shows how the anticipated renewal requirements compare with the existing renewal budget levels over the next 25 years. The infrastructure gap measures the difference between the required capital renewal budget and the available capital renewal budget. Assuming that the transportation capital renewal budget is only raised to keep up with inflation, the District will not realise an infrastructure gap until 2020. By 2035 (i.e. in 25 years) the infrastructure gap is projected to be $18 million.

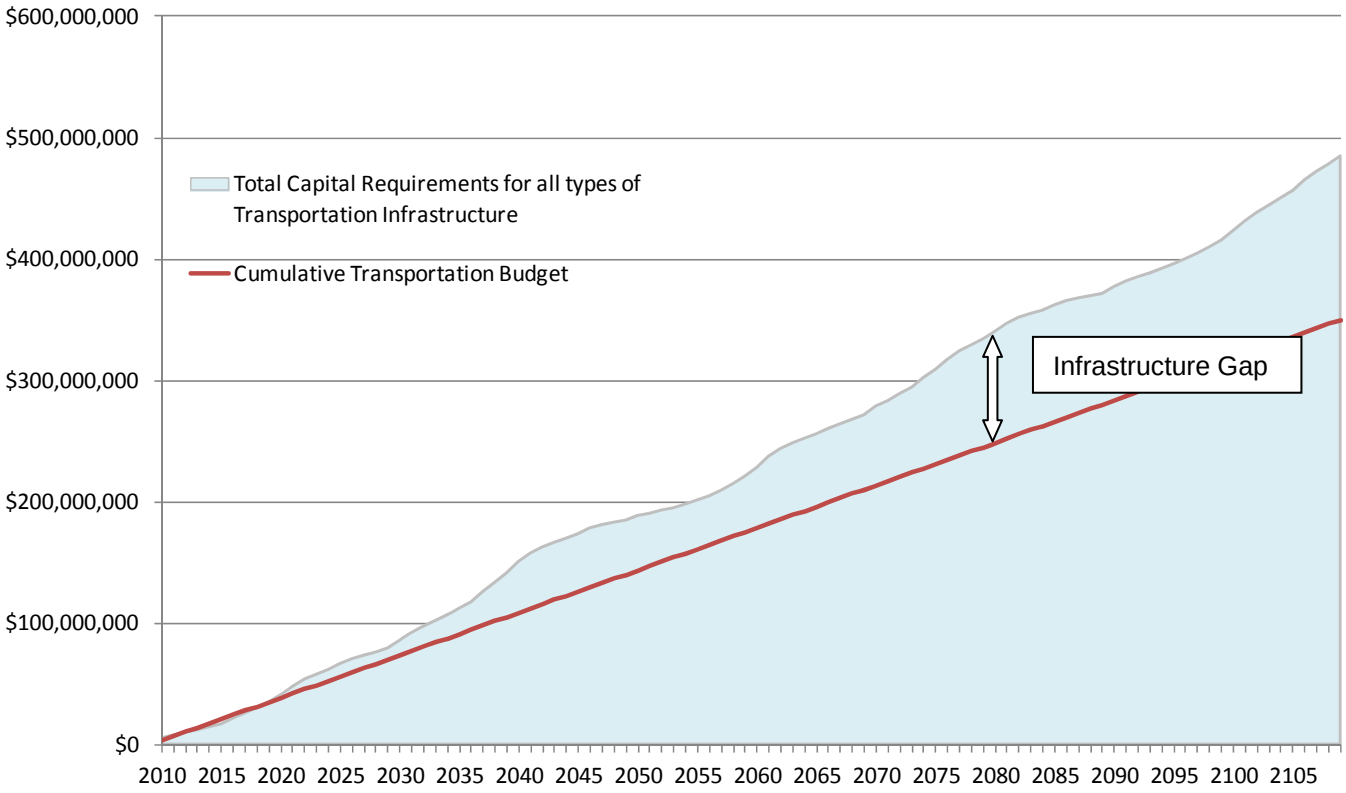
Figure 8.1 Renewal Requirements vs. Existing Budget Levels – 25 Year View



Note: This chart includes all renewal costs related to Bridges, Roads, Lanes, Cul-de-sacs, Sidewalks, Curbs, Traffic signals, Pedestrian signals, Street lights (Ornamental Lamps), Signs, Sign posts, Retaining walls, Dock, Special Cross Walks, Barriers, Ditch Culverts, Roundabouts and Traffic Circles.

Figure 8.2 shows the cumulative infrastructure gap over the next 100 years if the transportation capital renewal budget is only raised to keep up with inflation. By 2109 (i.e. in 100 years) the infrastructure gap is projected to be $135 million.

Figure 8.2 Renewal Requirements vs. Existing Budget Levels – 100 Year View



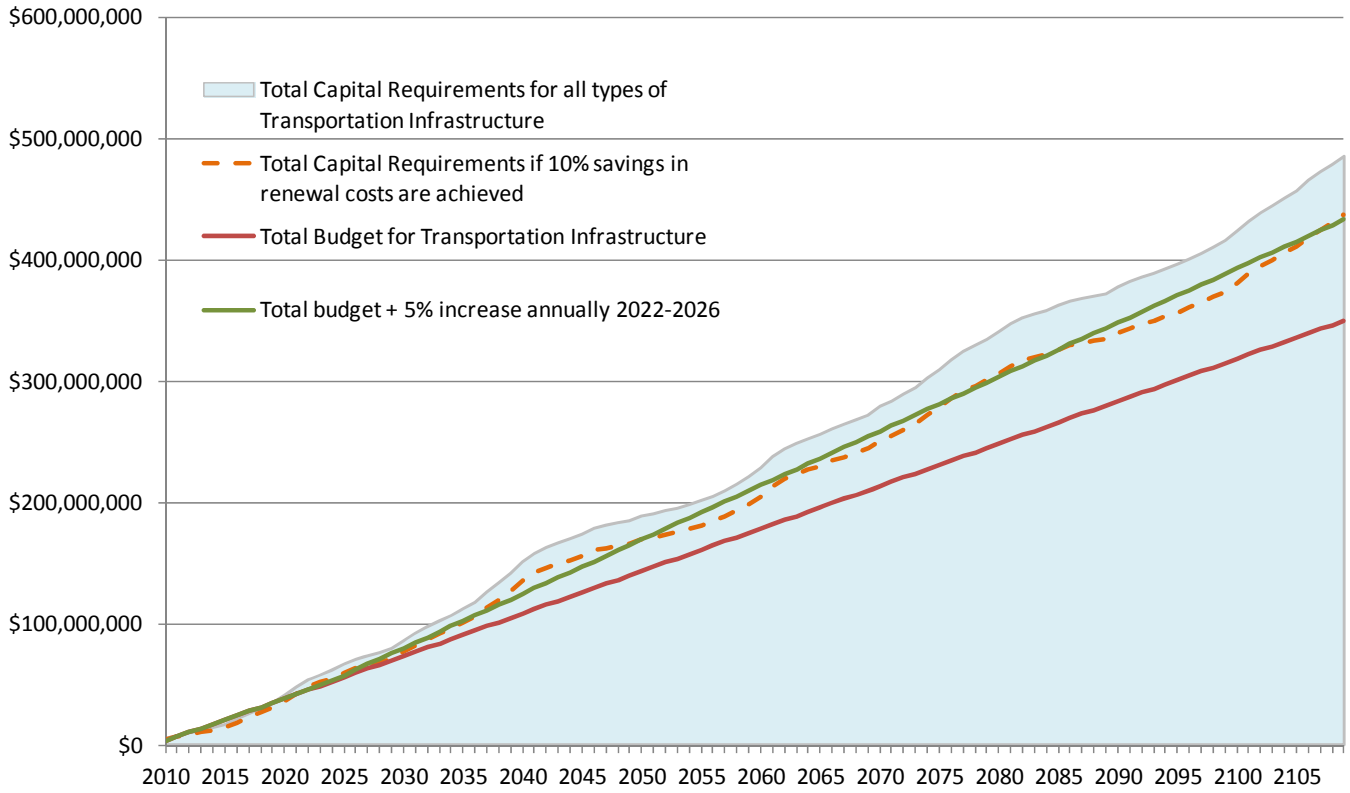
Note: This chart includes all renewal costs related to Bridges, Roads, Lanes, Cul-de-sacs, Sidewalks, Curbs, Traffic signals, Pedestrian signals, Street lights (Ornamental Lamps), Signs, Sign posts, Retaining walls, Dock, Special Cross Walks, Barriers, Ditch Culverts, Roundabouts and Traffic Circles.

8.2 Future Strategies

It is estimated that the District will have sufficient funding until 2020, however, the District can take measures now to reduce the infrastructure gap that is projected beyond 2020. For example, the District can continue to extend the life of its assets through a proactive inspection, maintenance and rehabilitation program and reduce capital renewal costs by coordinating capital works wherever possible. The District may also choose to work with the electorate to determine an acceptable level of service for pavement condition and other transportation related assets.

If West Vancouver was able to reduce its asset renewal costs by 10% (through preventive maintenance and by coordinating capital works) then it would cut its projected infrastructure gap in half. The District could then address the remaining infrastructure gap, as shown in **Figure 8.3**, by increasing its Transportation Renewal budget by 5% each year for five years between 2022 and 2026.

Figure 8.3 Eliminating the Infrastructure Gap through Reduced Costs and Increased Budget



Note: This chart includes all renewal costs related to Bridges, Roads, Lanes, Cul-de-sac, Sidewalks, Curbs, Traffic signals, Pedestrian signals, Street lights (Ornamental Lamps), Signs, Sign posts, Retaining walls, Dock, Special Cross Walks, Barriers, Ditch Culverts, Roundabouts and Traffic Circles.

The scenario shown in **Figure 8.3** illustrates the benefit of reducing lifecycle costs and provides a potential funding strategy that satisfies theoretical asset replacement requirements. The replacement scenarios in this study are theoretical; many factors will impact the actual rate of infrastructure renewal. Examples of some of these factors include assessments of risk or criticality, resource levelling, opportunistic cost sharing, short term affordability, and future reserve policies. These factors will be as important in the development of future capital financial planning as the physical replacement requirements identified by this theoretical replacement scenario.

Effective communication is critical to educate and engage stakeholders to assist in meeting the upcoming challenges associated with the management of the District's infrastructure. West Vancouver's Engineering and Transportation Department recently informed Council and the public on the cost of maintaining the District's Water, Sanitary and Stormwater infrastructure. The information from this report will help the District continue that education process with respect to its transportation infrastructure.

The District should take steps now to improve its database with respect to the inventory and condition of its transportation infrastructure. Areas with the greatest level of uncertainty are the inventory and condition of the District's retaining walls, transit shelters, bus pads, signs and signposts.

8.3 Infrastructure Funding Mechanisms

Effective infrastructure renewal funding:

- Allocates costs to those benefiting from the service thus increasing equity in provision of services;
- Supports accountability by clear allocation of funds;
- Incorporates life cycle costs of infrastructure (i.e. depreciation, O&M and renewal);
- Provides reliable, predictable, dedicated funding to support multi-year infrastructure investment strategies; and
- Supports demand management efforts.

The funding of bridge replacements is particularly challenging as the costs are large but infrequent. If the District developed a designated infrastructure reserve fund (similar to a capital reserve fund) that collected renewal funding each year then today's bridge users would contribute to the future renewal of that bridge, rather than encumbering future generations with the entire cost of renewing that asset. A designated infrastructure reserve fund would also provide reliable, predictable and dedicated funding. However, managing a long-term fund over several Council terms can be challenging, as different Councils may make changes to the fund and there may not be the political will to contribute to a project that is 10 to 20 years in the future. In addition, funds may get "lost" in the general municipal funds and not be used for their intended use. It is therefore recommended that the District begin discussions with Engineering staff, financial staff and Council to develop policy with respect to how it wishes to finance large but infrequent infrastructure projects such as the replacement of a bridge. Developing policy around infrastructure financing is a useful tool for institutionalizing asset management within a municipality.

Should West Vancouver want to investigate new funding mechanisms we recommend that the District refer to the *National Guide to Sustainable Municipal Infrastructure's* best practice titled *"Alternative Funding Mechanisms"*. The *National Guide to Sustainable Municipal Infrastructure: Innovations and Best Practices* is a compendium of technical best practices for addressing infrastructure issues. The best practice on alternative funding mechanisms describes eight methods for developing innovative funding sources to meet infrastructure needs, or to align costs with benefits to users. The eight alternative funding mechanisms described are Special Levies, Development Fees, Utility Models, Sponsorships, Innovative Transportation Revenues and Incentives, Government Service Partnerships, Funding Partnerships, and Strategic Funding Allocations.

8.4 Next Steps

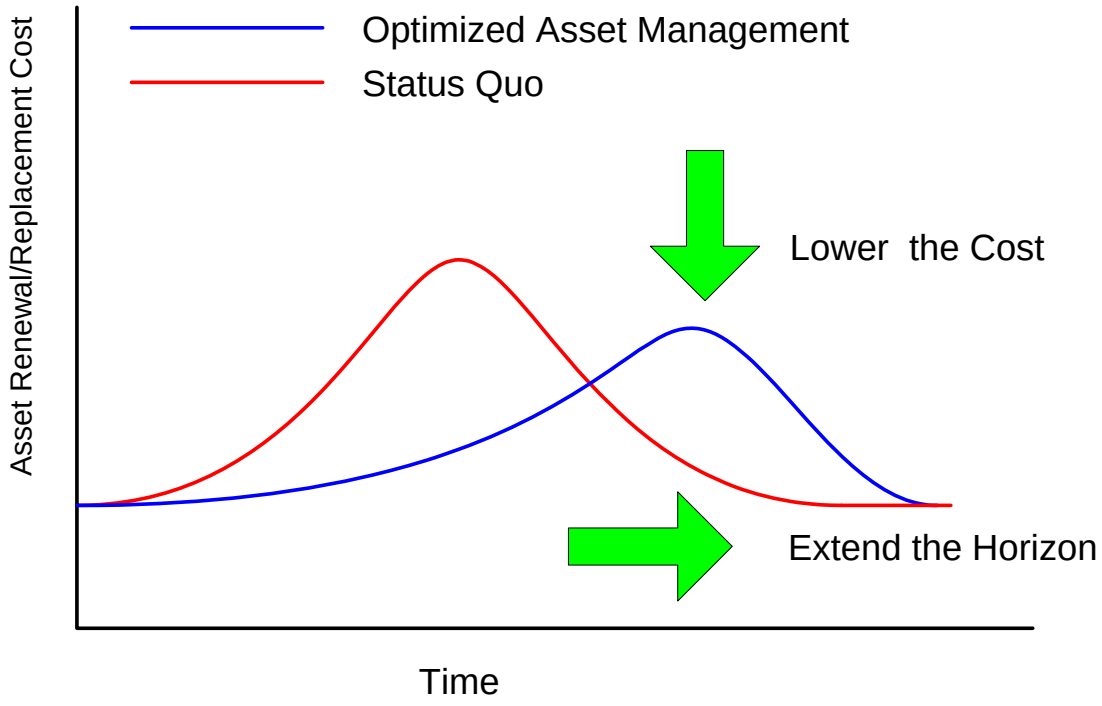
Given that West Vancouver's current budget levels are only sustainable until 2020, we recommend that the District begin now to take the following actions:

- Review its pavement management system to help identify a true localized needs-based assessment which will be based on the measured/observed results from the road data collection;
- Consult with its Council and residents to determine acceptable level of service associated with its transportation infrastructure;
- Fill in data gaps with respect to the inventory and condition of its transportation infrastructure;
- Develop policy with respect to financing large but infrequent infrastructure projects such as the replacement of a bridge;
- Review its asset maintenance practices to ensure that its assets are inspected and maintained in order to reduce their life-cycle costs while providing the necessary levels of service; and
- Maintain asset information so that it is readily available and facilitates the optimization of West Vancouver's assets.

9. Adopting Asset Management Practices

Good asset management planning seeks to capitalize on two means of cost savings: preventative maintenance and effective asset renewal planning. This will result in the optimization of lifecycle costs for individual assets as depicted in **Figure 9.1**.

Figure 9.1 Means of Achieving Savings through Asset Management



By continuing with its preventative maintenance program, West Vancouver can attain, and hopefully extend, the expected service life of its infrastructure, and will benefit accordingly. For instance, crack sealing will slow down the deterioration of road pavement and extend its service life. We recommend that West Vancouver periodically review its preventative maintenance program to ensure that it is gaining maximum benefit from it.

A risk based approach will allow West Vancouver to determine the most cost-effective strategy for maintaining an asset based on the consequences of failure. By identifying the most cost effective renewal and/or replacement strategy for each asset and by integrating capital works of different utilities (water, sewer, road etc.) whenever possible, the District will optimise its capital renewal budgets. Together this will have the benefit of lowering the actual cost of the renewal program.

The efficient integration of capital works of different utilities requires coordinating the capital renewal programs for the water, sanitary, storm and road systems. Accomplishing this requires developing procedures and communication channels, which can be facilitated but not replaced by information management systems. Effectively managing and communicating asset information as outlined in the District of West Vancouver's Asset Management Information Management Strategy will help West Vancouver optimize transportation asset maintenance and rehabilitation needs.

This study has adhered to present day best practices for performing strategic level asset management. A “needs-based” approach has been taken that gives consideration to our current knowledge of asset life spans, and current replacement costs. Consideration has not been given to factors that might either accelerate renewal efforts (e.g. additional financing, resource levelling), or decelerate renewal efforts (e.g. short term affordability). These additional factors will remain for continued public debate, and provide input into the annual rate setting process. Ultimately, a “budget-based” approach to asset management will govern the extent to which West Vancouver will manage assets in a sustainable fashion over the short and long term.

10. Recommendations

This section outlines the six (6) key recommendations that are a result of this study. The recommendations fall under two main categories:

- Sustainable funding; and
- Improving asset information and optimizing renewal budgets.

10.1 Sustainable Funding

Without sustainable funding an organisation cannot maintain a given level of service from its assets. Effective communication of this study's results to Council and the general public is critical to obtaining sustainable infrastructure funding.

Recommendation #1
The District is recommended to develop policy with respect to financing large but infrequent infrastructure projects such as the replacement of a bridge.

Recommendation #2
The District of West Vancouver should develop a plan to communicate transportation infrastructure renewal needs to the public, and to determine acceptable levels of service and resulting funding requirements.

Recommendation #3
West Vancouver should maintain and update the CAP model (or similar tool) to periodically check that its renewal funding is sufficient to meet its capital renewal needs.

10.2 Improving Asset Information and Optimizing Renewal Budgets

By identifying the most cost effective renewal and/or replacement strategy for each asset and by integrating capital works of different utilities (water, sanitary, stormwater, road etc.) whenever possible, the District will optimise its capital renewal budgets. Together this will have the benefit of lowering the actual cost of the renewal program, but can only be accomplished with sufficient information about the assets.

Recommendation #4
The District should coordinate its road capital renewal program with other utilities (water, stormwater and sanitary) to ensure that total costs are minimized.

Recommendation #5
The District should ensure that asset inventory and condition information is up-to-date, accurate and readily available. In particular the District needs to update its inventory with respect to its retaining walls, transit shelters, bus pads, signs and signposts.

Recommendation #6
The District should regularly inspect and track the condition of its assets. This is the best way to ensure that assets can continue to function as intended and to extend the life of these assets. Specifically the District should review its pavement management system to identify a true localized needs based assessment which will be based on the measured and observed results from the road data collected.

APPENDIX A – Transportation Asset Inventory

DISTRICT OF WEST VANCOUVER ASSET EVALUATION STUDY - ASSET INVENTORY

Asset Group	Category	Asset Type	Asset Name	Location	Quantity (What do we own?)	Unit Type	2010 Unit Replacement value of current asset	2010 Replacement value of current asset (What is it worth?)	2010 Unit replacement value of future asset	Expected Replacement year	Date in Service	Expected Service Life (yrs)	2010 Replacement Value (How much will it cost?)
Roads	Roads	Arterial		Various	165,933	m2	$ 70	$ 11,615,310					$ 11,615,310
Roads	Roads	Collector		Various	533,991	m2	$ 70	$ 37,379,370					$ 37,379,370
Roads	Roads	Local		Various	1,318,880	m2	$ 70	$ 92,321,600					$ 92,321,600
Lanes	Lanes	Paved		Various	61,003	m2	$ 70	$ 4,270,210				50	$ 4,270,210
Lanes	Lanes	Gravel		Various	11,622	m2	$ 25	$ 290,550	$ -				$ -
Lanes	Lanes	Brick		Various	5,682	m2	$ 100	$ 568,200				40	$ 568,200
Sidewalks	Sidewalks	Asphalt			233	m2	$ 35	$ 8,155				50	$ 8,155
Sidewalks	Sidewalks	Concrete			29712	m2	$ 65	$ 1,931,280				50	$ 1,931,280
Curbs	Curbs	Asphalt			9662	m	$ 30	$ 289,860				50	$ 289,860
Curbs	Curbs	Concrete			268770	m	$ 60	$ 16,126,200				50	$ 16,126,200
Traffic signals	Traffic and Ped Signals	Flashing Beacons			1	unit	$ 40,000	$ 40,000					$ 40,000
Traffic signals	Traffic and Ped Signals	Full			10	unit	$ 250,000	$ 2,500,000					$ 2,500,000
Pedestrian signals	Traffic and Ped Signals				10	unit	$ 150,000	$ 1,500,000					$ 1,500,000
Street lights	Street lights				1096	unit	$ 8,000	$ 8,768,000				35	$ 8,768,000
Gardens	Other				2687	m2	$ 150	$ 403,050	$ -				$ -
Signs	Signs and posts				7588	unit	$ 65	$ 493,220				10	$ 493,220
Sign posts	Signs and posts				4582	unit	$ 107	$ 490,274				40	$ 490,274
Ditches (open)	Other	ditches open			57417	m	$ 25	$ 1,435,425					
Ditch culverts	Other	culverts			5122	m	$ 500	$ 2,561,000	$ -			50	$ 2,561,000
Retaining wall	Retaining wall	Concrete	Keith Rd 800-900 bl.		695	m2	$ 600	$ 417,000	$ 1,200	2045	1970	75	$ 834,000
Retaining wall	Retaining wall	Dry Stacked Rock	Marine Dr - various		6796	m2	$ 200	$ 1,359,200		2090	1940	150	$ 1,359,200
Retaining wall	Retaining wall	Dry Stacked Rock	6200 blk Marine Dr.		99	m2	$ 200	$ 19,800		2100	1950	150	$ 19,800
Retaining wall	Retaining wall	Dry Stacked Rock	Eagle Harbour Rd @ Eagle Harbour Beach		123	m2	$ 200	$ 24,600		2100	1950	150	$ 24,600
Retaining wall	Retaining wall	Dry Stacked Rock	6200 blk. Wellington		258	m2	$ 200	$ 51,600		2110	1960	150	$ 51,600
Retaining wall	Retaining wall	Allan Block	Marine Dr 11th-13th		427	m2	$ 650	$ 277,550		2109	2009	100	$ 277,550
Retaining wall	Retaining wall	Allan Block	Sinclair Ct. (east side)		80	m2	$ 650	$ 52,000		2095	1995	100	$ 52,000
Retaining wall	Retaining wall	Allan Block	Chippendale Bridge over Marr Creek		360	m2	$ -	$ -		2104	2004	100	$ -
Retaining wall	Retaining wall	Reco	Almondel Bridge over Cypress Creek		468	m2	$ -	$ -		2109	2009	100	$ -
Dock	Other		Eagle IslandDock		1	unit	$ 500,000	$ 500,000		2010	1985	25	$ 500,000
Special Cross Walks	Other				2	unit	$ 50,000	$ 100,000				25	$ 100,000
Barriers	Other				1450	unit	$ 110	$ 159,500				50	$ 159,500
Bridges	Bridges		400 Block Keith Road - Brothers Creek		1	unit	$ 2,571,979	$ 2,571,979	$ 2,571,979	2024	1952	72	$ 2,571,979
Bridges	Bridges		500 Block Inglewood - Brothers Creek		1	unit	$ 1,294,339	$ 1,294,339	$ 1,294,339	2094	1986	108	$ 1,294,339
Bridges	Bridges		3900 Block Marine Drive - Sandy Cove		1	unit	$ 2,141,520	$ 2,141,520	$ 2,141,520	2034	1939	95	$ 2,141,520
Bridges	Bridges		4300 Block Marine Drive - Cypress Creek		1	unit	$ 2,908,908	$ 2,908,908	$ 1,107,000	2039	1940	99	$ 1,107,000
Bridges	Bridges		Nelson Canyon - Nelson Creek		1	unit	$ 3,863,428	$ 3,863,428	$ 2,000,000	2014	1956	58	$ 2,000,000

Bridges	Bridges		2000 Block Esquimalt Ave. - Lawson Creek	1	unit	$ 368,299		$ -	2079	1991	88	$ -
Bridges	Bridges		300 Block Keith Place - Brothers Creek	1	unit	$ 1,652,917	$ 1,652,917	$ 1,652,917	2089	1991	98	$ 1,652,917
Bridges	Bridges		1100 Block Millstream Rd. - Brothers Creek	1	unit	$ 489,321	$ 489,321	$ 489,321	2069	1964	105	$ 489,321
Bridges	Bridges		McCrady - Eagle Lake - Cypress Creek	1	unit	$ 533,889	$ 533,889	$ 533,889	2054	1984	70	$ 533,889
Bridges	Bridges		1800 Block Sinclair Court - Lawson Creek	1	unit	$ 680,568	$ 680,568	$ 680,568	2094	1995	99	$ 680,568
Bridges	Bridges		Whitby - Vinson Creek	1	unit	$ 4,974,851	$ 4,974,851	$ 4,974,851	2104	2002	102	$ 4,974,851
Bridges	Bridges		Chippendale/MacDonald	1	unit	$ 2,175,600	$ 2,175,600	$ 2,175,600	2082	2007	75	$ 2,175,600
Bridges	Bridges		Chippendale/Marr	1	unit	$ 2,797,200	$ 2,797,200	$ 2,100,000	2082	2007	75	$ 2,100,000
Bridges	Bridges		Rodgers	1	unit	$ 2,400,000	$ 2,400,000	$ 2,400,000	2085	2010	75	$ 2,400,000
Bridges	Bridges		Pipe	1	unit	$ 1,400,000	$ 1,400,000	$ 1,400,000	2112	2012	100	$ 1,400,000
Bridges	Bridges		Almondel	1	unit	$ 3,100,000	$ 3,100,000	$ 3,100,000	2084	2009	75	$ 3,100,000
Roundabout	Roundabouts and Circles		Marine Drive/Nelson/Rosebery	1	unit	$ 500,000	$ 500,000		2052	2002	50	$ 500,000
Roundabout	Roundabouts and Circles		Fulton/21st	1	unit	$ 500,000	$ 500,000		2058	2008	50	$ 500,000
Roundabout	Roundabouts and Circles		Taylor Way/Southborough/Stevens	1	unit	$ 500,000	$ 500,000		2054	2004	50	$ 500,000
Traffic Circle	Roundabouts and Circles		Chelsea Court/Chairlift Road	1	unit	$ 250,000	$ 250,000		2057	2007	50	$ 250,000
Traffic Circle	Roundabouts and Circles		Chairlift Road/Skilift Place/Skilift Road	1	unit	$ 250,000	$ 250,000		2058	2008	50	$ 250,000
Traffic Circle	Roundabouts and Circles		Keith Road/Birchfield lace/Caulfield Drive	1	unit	$ 250,000	$ 250,000		2057	2007	50	$ 250,000
Traffic Circle	Roundabouts and Circles		Westmount Road/Rockview Place	1	unit	$ 250,000	$ 250,000		2059	2009	50	$ 250,000
Traffic Circle	Roundabouts and Circles		Mathers Ave/30th Street	1	unit	$ 250,000	$ 250,000		2056	2006	50	$ 250,000
												$ -

APPENDIX B - Project Methodology and Sources of Data

	Roads	Lanes	Sidewalks/ Curbs	Traffic Signals/ St. Lights/ Gardens/	Signs	Sign posts	Bridges	Ditches	Roundabouts/ Traffic Circles/ Crosswalks	Dock/Retaining Walls/Barriers
What do we own? (Sect. 2)	Taken from DWV-#334767-v1-ASSET_PROJECT_-_ROAD_INVENTORY.XLS and add newly constructed roads	Taken from DWV-#334767-v1-ASSET_PROJECT_-_ROAD_INVENTORY.XLS	Taken from DWV-#334767-v1-ASSET_PROJECT_-_ROAD_INVENTORY.XLS	Taken from DWV-#334767-v1-ASSET_PROJECT_-_ROAD_INVENTORY.XLS	Taken from DWV-#334767-v1-ASSET_PROJECT_-_ROAD_INVENTORY.XLS	Taken from DWV-#334767-v1-ASSET_PROJECT_-_ROAD_INVENTORY.XLS	Can be found within DWV's BMS (Planet GIS)	Taken from GIS inventory	From Emails from DWV staff	DWV-#192274-v1-MARINE_DRIVE_BARRIER_DATA_SHEET.XLS and DWV-#389312-v1-Asset_Project_-_Retaining_walls.DOC
What is it worth? (Sect. 3)	Based on standard unit costs to be agreed upon with DWV.	Based on standard unit costs to be agreed upon with DWV.	Based on standard unit costs to be agreed upon with DWV.	Based on standard unit costs to be agreed upon with DWV.	Based on standard unit costs to be agreed upon with DWV.	Based on standard unit costs to be agreed upon with DWV.	Take from DWV-#334767-v1-ASSET_PROJECT_-_ROAD_INVENTORY.XLS (add inflation to 2008 estimate)	Apply unit construction cost ($50/m – open channel $500/m for culvert)	From Emails from DWV staff	Dock – DWV estimate. AECOM unit cost for walls and barriers
What is its condition? (Sect. 4)	Based on PQI from pavement management system (PMS)	Unknown	Based on PQI from pavement management system (PMS)	Age based	Based on staff inspection poor/medium/good	Unknown – use age as proxy	Can be found within DWV's BMS (Planet GIS)	Operable working condition	Unknown – use age as proxy	Unknown – use age as proxy
What needs to be done? (Sect. 5)	Crack sealing, mill & overlay pulverize and pave, regular inspections and total reconstruction	Maintenance, inspections + replacement at the end of its service life.	Inspections + replacement at the end of its service life.	Regular maintenance + replacement at the end of its service life.	Regular maintenance + replacement at the end of its service life.	Regular maintenance + replacement at the end of its service life.	Bridge Infrastructure Long Term Plan by MMM Group dated February 1, 2012.	Maintenance only for open ditch + replacement of culvert	Regular maintenance + replacement at the end of its service life.	Regular maintenance + replacement at the end of its service life.
When do we need to do it? (Sect. 6)	Service Lives: Arterial – 15 years Collector – 20 years Local – 25-50 years	Brick renewed every 40 years. Asphalt renewed every 50 years. Gravel lanes to be maintained as needed.	Expected service life = 50 years	Traffic signals replaced after 15 years and street lights replaced after 35 years. Gardens to be maintained as needed.	Assume average 10 year lifespan so that 10% replaced each year	Assume a 40 year lifespan so that 2.5% of the posts are replaced each year.	Bridge Infrastructure Long Term Plan by MMM Group dated February 1, 2012.	Culvert replaced every 50 years.	At end of service life (see Section 6)	At end of service life (see Section 6)
How much will it cost? (Sect. 7)	CAP model output						Bridge Infrastructure Long Term Plan	CAP model output		

APPENDIX C - Illustrative Examples of West Vancouver Roadways with Different PQI

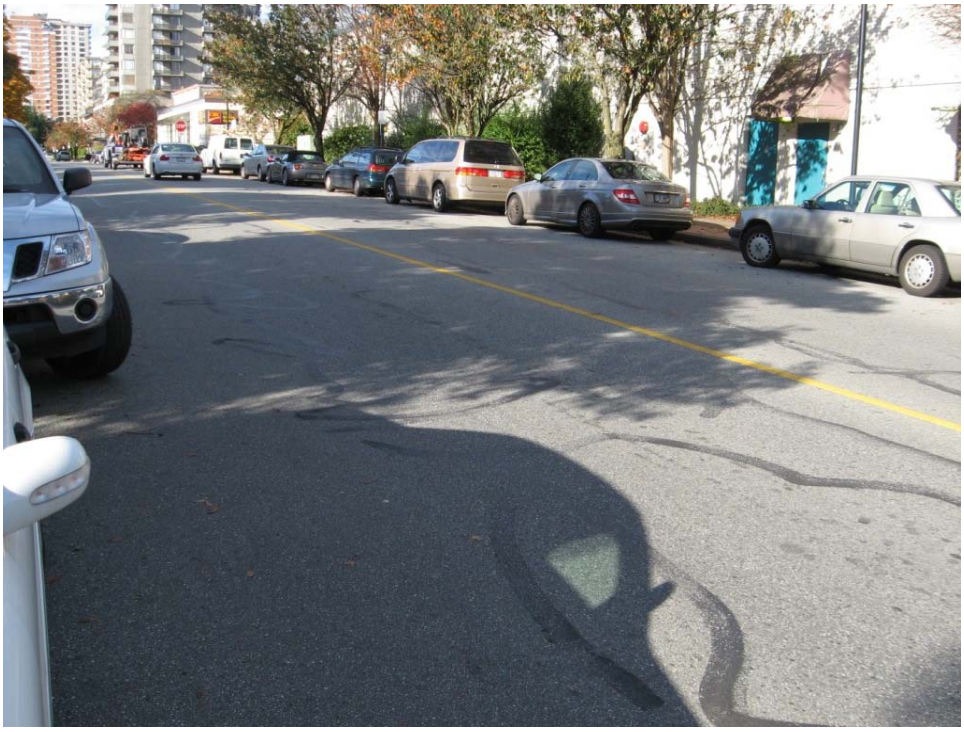
2100 Block Bellevue **CRACK SEALANT**

828 17th Street **RUTTING**
CRACKING

825 17th Street **RUTTING**
CRACKING

1300 Bellevue Ave **LONGITUDINAL CRACKING**

2100 Block Marine Drive **PATCHING MANHOLE**



1600 Block Bellevue **CRACK SEALANT**

433 Eastcot Rd **LONGITUDINAL CRACKING**

433 Eastcot Rd **PATCHING**
RAVELING

480 Eastcot Rd **LONGITUDINAL CRACKING**

483 Eastcot Rd **ALLIGATOR CRACKING**
POTHOLE

1500 Marine Drive **CORRUGATIONS**

1505 Marine Drive **PATCHES, CRACKING RUTTING**

1500 Block Marine Drive **MANHOLE**

15th Street @ Marine Drive **MANHOLE**

1400 Block Marine Drive **CORRUGATIONS**

1400 Block Marine Drive **PITTING IN PARKING LANES**

1425 Marine Drive (Bus Stop) **CORRUGATIONS**

510 Eastcot Rd

ALLIGATOR CRACKING
RUTTING

549 Eastcot Rd

ALLIGATOR CRACKING
RUTTING

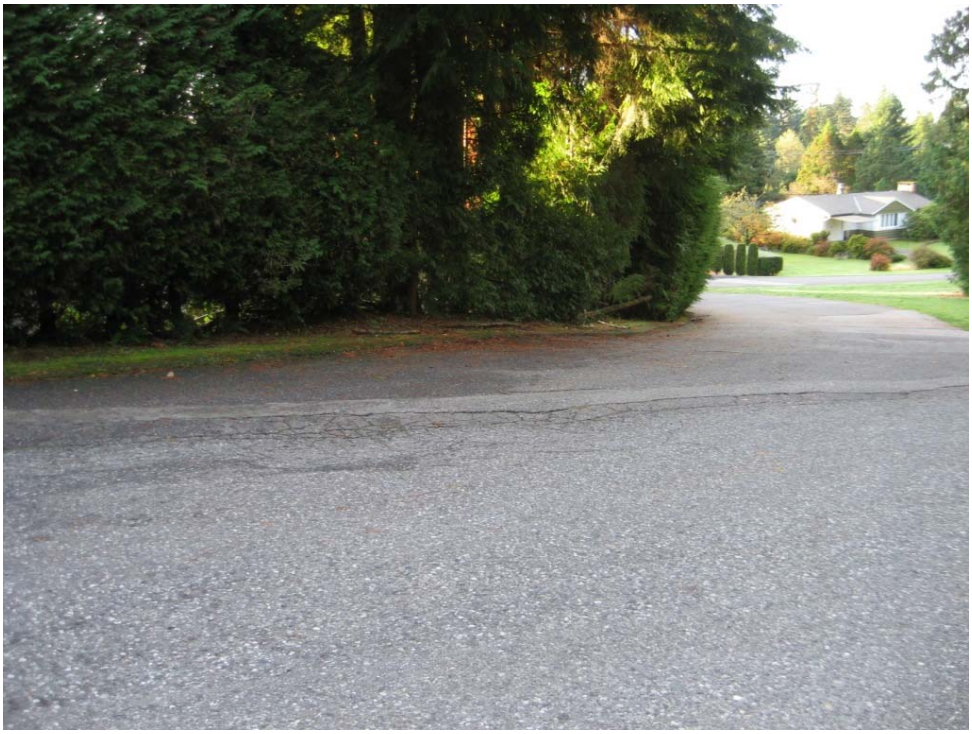
2588 Bellevue (South of Railway) **PATCHING, RAVELLING SPALLING**

2604 Bellevue (South of Railway) **CRACKING**

2636 Bellevue (South of Railway) **SPALLING**

2678 Bellevue (South of Railway) **CRACKING**
PATCHING

2690 Bellevue (South of Railway) **CRACKING**



537 Eastcot Rd

ALLIGATOR CRACKING
RUTTING

550 Eastcot Rd

ALLIGATOR CRACKING
RUTTING

1366 Kings Ave **PATCHES, CRACKING RAVELLING**

1366 Kings Ave **CRACKING RUTTING**

566 Eastcot Rd

ALLIGATOR CRACKING
PATCHING

563 Eastcot Rd

GENERAL ROAD CONDITION
BURHILL RD – MATHERS AVE

2170 Queens Ave **PATCHES, RUTTING ALLIGATOR CRACKING**

2100 Block Queens Ave **PATCHES, SPALLING ALLIGATOR CRACKING**

2100 Block Queens Ave

GENERAL CONDITION

APPENDIX D – Bridge Infrastructure Long Term Plan

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February 1st, 2012

File: 50-11015

Mr. John McMahon
Manager, Roads and Transportation
District of West Vancouver
3755 Cypress Bowl Road
West Vancouver, BC V7S 3E7

Subject: Bridge Infrastructure Long Term Plan - FINAL

General:

MMM has been retained by the District of West Vancouver to prepare a long term maintenance plan for the District's bridge network. Please find included with this report a table outlining the expected costs for maintenance, rehabilitation and replacement of the District's bridges for the upcoming 100 year forecasted maintenance period. It is understood that this information will be used to assist with estimation of future and long-term budgeting requirements for management of the District's bridge infrastructure.

The intent of the plan is to provide a high level estimate of the long term expenditures that can be expected in order to maintain the District's bridge network. The plan has been prepared based on recently acquired visual inspection data, typical accepted rates for deterioration of common materials and typical life expectancies of bridge elements. Without detailed material testing and assessment, estimating the remaining life of structural components is to be considered an approximation only.

Long Term Maintenance Plan:

The attached forecast should be considered as representative of estimated costs within the 5 year period following the most recent bridge inspections completed in 2011. The validity of the plan for future years requires that the results therein are verified and updated in accordance with recommendations provided in future bridge inspection assignments. It should be noted that the predictions of bridge condition and deterioration beyond approximately 30 years can only be based on broad assumptions of typical expected component life under regular observed current traffic and cannot be based on any sound engineering or scientific principles.

There are numerous factors affecting the service life of a bridge structure and the expected longevity of a particular component of the bridge. Some of these variables include:

- Environmental variables such as climate, relative humidity and water levels,
- Construction practices, quality of construction and use of inferior or defective materials,
- Service variables including level of service, traffic volumes, and truck traffic usage,
- Maintenance issues such as regular upkeep and attention to mitigation of defects affecting bridge service life,
- Change in network, such as the addition of new bridges.

Maintenance Plan Development:

The remaining service life of each bridge has been reviewed based on the date of construction, the anticipated design life and its present condition.

Capital Maintenance Items:

Unit rates and costs for complete structure replacement as well as component replacement have been estimated for each structure based on present day construction cost estimates. These items have been separated from the routine annual costs for each structure for clarity.

Wearing Surface:

The most heavily used component of a bridge is normally the wearing surface as it experiences abrasion and wear from each vehicle that passes. The majority of the District's bridges are asphalt surfaced. Due to the fact that asphalt surfacing is less durable than concrete, asphalt wearing surfaces generally have a shorter replacement return period. As part of the maintenance plan it has been estimated that replacement of asphalted bridge wearing surfaces will be carried out at 20 to 25 year intervals. Resurfacing with asphalt also includes installation of a waterproofing membrane to the underlying concrete deck surface. This practice assists to prolong the service life and serviceable condition of the bridge deck. Waterproofing membranes are typically not applied to timber decks.

***Bridge Deck*:**

In the absence of a wearing surface, the bridge deck itself receives the traffic wear. It is possible to replace the deck of a bridge in its entirety or in part as part of a capital maintenance item. Concrete bridge decks are assumed to require replacement at 75 year intervals for asphalt-surfaced decks and 50 years for unsurfaced concrete decks. For unsurfaced concrete bridge decks, allowance in costing has been made for performance of partial depth concrete overlay repairs rather than complete deck replacement.

The replacement period for a timber deck is more dependent on the traffic usage and environmental conditions at the bridge than that of concrete decks. For the only bridge in the

District's inventory with a timber deck (McCrady Road at Cypress Creek), it is estimated that the bridge deck members, including floor beams, will require replacement at 25 year intervals.

Crack Sealing:

Crack sealing has been specified for select bridges in order to prolong the service life of the aging unsurfaced bridge decks. The bridges where crack sealing is prescribed are currently in a condition where this type of repair is warranted before the forecasted replacement date of the deck or bridge.

Bridge Design Life:

The design life for a bridge is 75 years as specified in the Canadian Highway Bridge Design Code. The recommended service life of each bridge has been evaluated and adjusted depending on the current condition of the main structural elements of the structure. Generally, it is not uncommon for newer bridges to exceed 100 years of service with proper maintenance, as such this lifespan has been considered for new structures and bridge replacement cycles in this forecast. The design life for culverts has been estimated to be 50 years.

Routine Maintenance Items:

We have applied a unit rate per square meter of bridge deck area for estimation of routine maintenance funding requirements. Routine maintenance includes bridge maintenance items such as cleaning of bearing seats, sidewalk clearing, power-washing, graffiti removal, expansion joint maintenance, coating touch-up and other annual costs to ensure the bridges remain in serviceable condition. The BC Ministry of Transportation and Infrastructure's annual budgeting allocation for structures included in their maintenance regimen is $\$7.78/m^2$ of bridge deck area. We have included this maintenance unit rate in this assignment.

Nelson Canyon Bridge:

The future of the Nelson Canyon Bridge is currently undetermined. The bridge has reached the end of its service life as a vehicle bridge and is now restricted to pedestrian use only. The bridge is part of the Trans-Canada Trail system. A large component of the replacement of this bridge will be involved with dismantling and demolition of the existing structure given the height of the pier towers and the fact that the bridge spans a deep gorge. We have assumed that a replacement structure will most likely be limited to pedestrian service. Under these assumptions the forecasted estimated replacement cost for this bridge is $2 Million.

British Properties Development:

The British Properties ongoing development will result in further bridges being added to the network. For example, Pipe Creek Bridge currently being designed by MMM for the British Properties is scheduled for construction in 2012, with hand over to the District expected sometime after. Because the general details of this structure are known it has been included in the plan. The

District should however be cognisant that further structures will be built in the coming years (which at this time are not clearly defined) which will need to be maintained by the District.

Summary:

Forecasted costs have been presented in the attached charts. The figures illustrate the total combined routine and capital costs on both 5 and 10 year bases. The third chart indicates the general trend of capital funding requirements over the next 100 years.

The routine maintenance costs for the District's bridge network are approximately $175,000 for each five year period. This is approximately $35,000 per year for the five year period. This estimate is for the carrying out of maintenance activities, and does not include costs associated with annual condition inspections. The District may choose to amend this rate as they see suitable. As bridges age and others are replaced, the District may apportion this routine maintenance budget accordingly depending on the condition and maintenance needs of each individual bridge.

There is a notable period with significant increased funding needs near the end of the forecasting period when the numerous recently constructed bridges in the British Properties see the end their respective service lives. Realistically these replacements would likely be staggered based on the deterioration progression of each structure over time.

We trust that this report meets your budget estimating and funding forecasting requirements at this time. This report is for long range budget estimation purposes only and contains forward looking information that may change over time. Please do not hesitate to contact us should you have any questions or comments concerning this report or any of the information contained herein.

Yours very truly,

MMM Group Limited

Brian Counihan, P.Eng.
Project Engineer, Bridges
MMM Group Ltd.

DISTRICT OF WEST VANCOUVER BRIDGE INFRASTRUCTURE LONG TERM PLAN

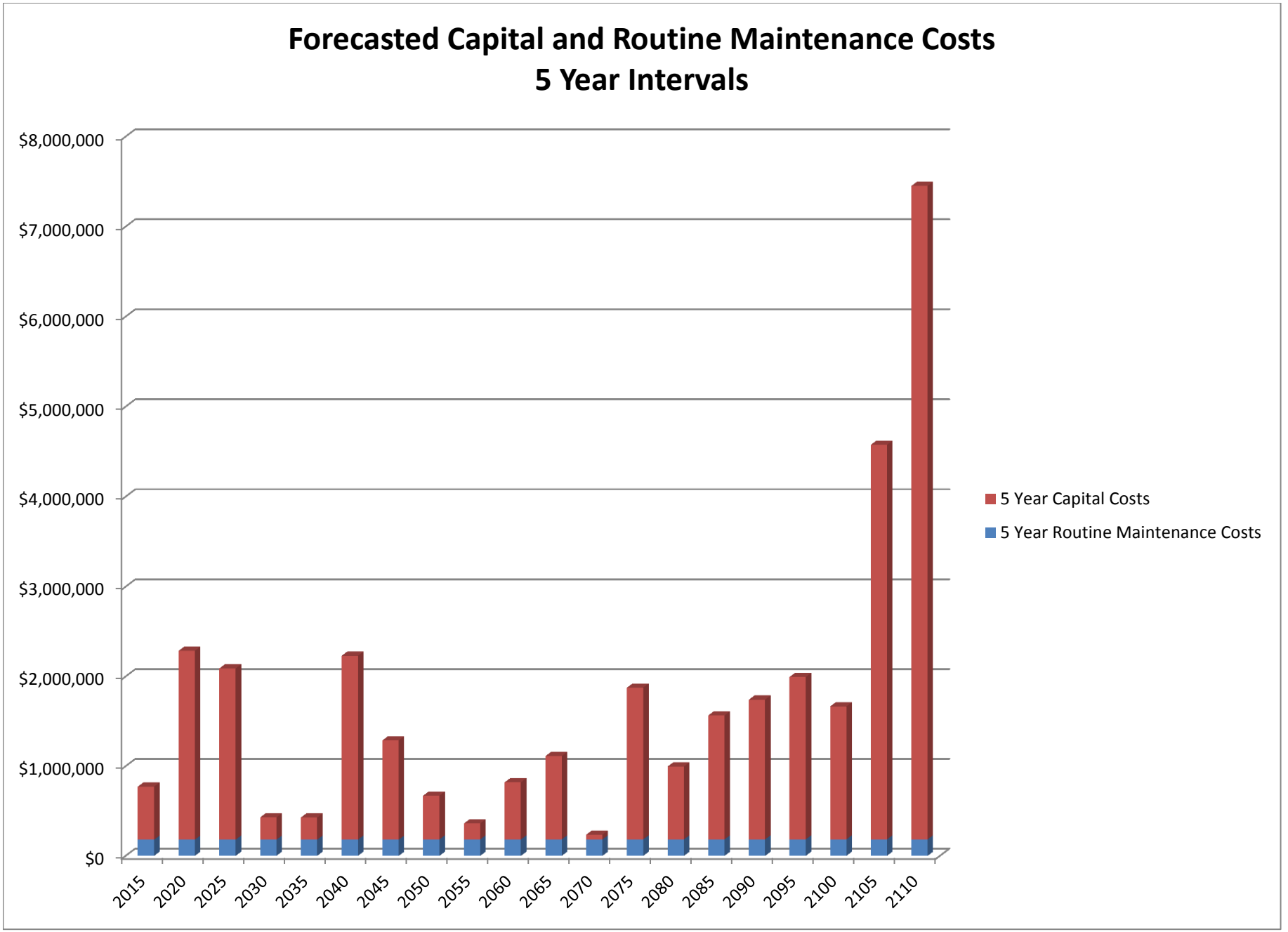
General:		Life (years)	Replacement Cost $/m^2
Crack sealing of concrete decks:		25	$100
Deck resurfacing (including waterproofing membrane):		20-25	$150
Deck replacement (including demolition):	1.) Concrete (unsurfaced)	40	$1,500
	2.) Concrete (surfaced)	75	$1,500
	3.) Timber (unsurfaced)	25	$500
Bridge Design Life (including demolition):	Steel and Concrete	100	$3,000 - $6,500
Routine Maintenance Unit Costs:	$7.78/sq. m		

Notes:

1.) Clause 1.4.2.3 of CSA S6-06 defines the design life of new structures to be 75 years. The actual service life of a structure is usually much longer. For the purposes of budgeting, the service life of new structures has been assumed to be 100 years from the date of construction.
2.) The expected life of asphalt surfacing on concrete decks is 20 years.
3.) Rates and expected service life estimates used in this analysis are approximate and only serve to obtain orders of magnitude of future maintenance, rehabilitation and replacement costs.
4.) Items included in "Capital" maintenance budgets are major items such as bridge deck replacement, major rehabilitation works and other items listed under Urgency Ratings 1-4. "Routine" maintenance budget items are minor items that can be undertaken by the Municipality.
5.) Forecasted routine maintenance costs are annual costs for the entire 5 year period and are based on a unit rate amount of $7.78 per square meter of deck area.

Bridge Replacement
Deck Replacement / Overlay
Wearing Surface and Waterproofing Membrane Replacement
Crack Sealing of Wearing Surface

	Structure	Seismic Risk	Route Importance	Deck Area (m^2)	New Deck Area (m^2)	Posted Load Limit?	Built	Replacement Costs: Bridge ($/$m^2$)	Replacement Costs: Deck ($/$m^2$)	Budget	Forecasted Annual Maintenance Costs, Capital Rehabilitation Costs and Replacement Costs: 2011	2016	2021	2026	2031	2036	2041	2046	2051	2056	2061	2066	2071	2076	2081	2086	2091	2096	2101	2106
											2015	2020	2025	2030	2035	2040	2045	2050	2055	2060	2065	2070	2075	2080	2085	2090	2095	2100	2105	2110
1	Keith Road over Brothers Creek	Very High	Medium	354	354	YES	1952	$5,000	$2,500	Capital	$105,500		$1,770,000					$53,100				$53,100						$885,000		
										Routine	$2,754	$2,754	$2,754	$2,754	$2,754	$2,754	$2,754	$2,754	$2,754	$2,754	$2,754	$2,754	$2,754	$2,754	$2,754	$2,754	$2,754	$2,754	$2,754	$2,754
2	Inglewood Road over Brothers Creek	Moderate	Medium	198	198	NO	1986	$4,500	$1,100	Capital	$20,900	$29,700				$29,700						$217,800					$891,000				$29,700
										Routine	$1,540	$1,540	$1,540	$1,540	$1,540	$1,540	$1,540	$1,540	$1,540	$1,540	$1,540	$1,540	$1,540	$1,540	$1,540	$1,540	$1,540	$1,540	$1,540	$1,540
3	3900 Block Marine Drive at Sandy Cove	Low	High	375	375	NO	1939	$5,000	$1,800	Capital	$242,000	$56,250				$1,875,000					$56,250				$56,250				$56,250		
										Routine	$2,918	$2,918	$2,918	$2,918	$2,918	$2,918	$2,918	$2,918	$2,918	$2,918	$2,918	$2,918	$2,918	$2,918	$2,918	$2,918	$2,918	$2,918	$2,918	$2,918
4	Almondel Bridge	Low	Low	448	448	NO	2008	$5,000	$1,800	Capital	$1,951					$67,200						$67,200				$806,400					$2,240,000
										Routine	$3,485	$3,485	$3,485	$3,485	$3,485	$3,485	$3,485	$3,485	$3,485	$3,485	$3,485	$3,485	$3,485	$3,485	$3,485	$3,485	$3,485	$3,485	$3,485	$3,485
5	4300 Block Marine Drive at Cypress Creek	Low	High	164	246	NO	1940	$4,500	$1,100	Capital	$20,350		$24,600				$1,107,000					$36,900				$36,900				$36,900	
										Routine	$1,276	$1,276	$1,276	$1,276	$1,276	$1,276	$1,276	$1,914	$1,914	$1,914	$1,914	$1,914	$1,914	$1,914	$1,914	$1,914	$1,914	$1,914	$1,914	$1,914
6	Nelson Canyon Bridge	High	N/A	656	200	N/A	1956	$10,000	$1,000	Capital		$2,000,000																			
										Routine	$1,556	$1,556	$1,556	$1,556	$1,556	$1,556	$1,556	$1,556	$1,556	$1,556	$1,556	$1,556	$1,556	$1,556	$1,556	$1,556	$1,556	$1,556	$1,556	$1,556
7	Esquimalt Pedestrian Bridge over Lawson Creek	Low	N/A	64	64	N/A	1991	$3,000	$1,000	Capital	$26,740	$6,400			$64,000										$192,000						
										Routine	$498	$498	$498	$498	$498	$498	$498	$498	$498	$498	$498	$498	$498	$498	$498	$498	$498	$498	$498	$498
8	Keith Place over Brothers Creek	Low	Low	320	320	NO	1991	$4,500	$1,800	Capital	$11,000					$48,000						$576,000						$1,440,000		
										Routine	$2,490	$2,490	$2,490	$2,490	$2,490	$2,490	$2,490	$2,490	$2,490	$2,490	$2,490	$2,490	$2,490	$2,490	$2,490	$2,490	$2,490	$2,490	$2,490	$2,490
9	Millstream Road over Brothers Creek	Low	Low	64	64	YES	1964	$5,000	$1,100	Capital	$29,600			$70,400					$320,000					$9,600					$9,600		
										Routine	$498	$498	$498	$498	$498	$498	$498	$498	$498	$498	$498	$498	$498	$498	$498	$498	$498	$498	$498	$498
10	McCrady Road over Cypress Creek	Low	Low	135	135	YES	1984	$4,000	$850	Capital	$34,800		$114,750					$114,750						$114,750		$540,000					
										Routine	$1,050	$1,050	$1,050	$1,050	$1,050	$1,050	$1,050	$1,050	$1,050	$1,050	$1,050	$1,050	$1,050	$1,050	$1,050	$1,050	$1,050	$1,050	$1,050	$1,050
11	Sinclair Court over Lawson Creek	Low	Low	133	133	NO	1995	$4,000	$1,100	Capital	$19,900	$13,300			$146,300														$532,000		
										Routine	$1,035	$1,035	$1,035	$1,035	$1,035	$1,035	$1,035	$1,035	$1,035	$1,035	$1,035	$1,035	$1,035	$1,035	$1,035	$1,035	$1,035	$1,035	$1,035	$1,035
12	Chippendale Road over McDonald Creek	Low	Low	871	871	NO	2002	$5,000	$1,800	Capital	$31,535			$130,650						$130,650				$1,567,800						$4,355,000	
										Routine	$6,776	$6,776	$6,776	$6,776	$6,776	$6,776	$6,776	$6,776	$6,776	$6,776	$6,776	$6,776	$6,776	$6,776	$6,776	$6,776	$6,776	$6,776	$6,776	$6,776
13	Chippendale Road over Marr Creek	Low	Low	314	314	NO	2004	$5,000	$1,800	Capital	$15,200			$47,100						$47,100					$565,200						$1,570,000
										Routine	$2,443	$2,443	$2,443	$2,443	$2,443	$2,443	$2,443	$2,443	$2,443	$2,443	$2,443	$2,443	$2,443	$2,443	$2,443	$2,443	$2,443	$2,443	$2,443	$2,443
14	Chippendale Road over W. McDonald Creek	Low	Low	418	418	NO	2005	$1,300	N/A	Capital	$32,300										$543,400										$543,400
										Routine	$3,252	$3,252	$3,252	$3,252	$3,252	$3,252	$3,252	$3,252	$3,252	$3,252	$3,252	$3,252	$3,252	$3,252	$3,252	$3,252	$3,252	$3,252	$3,252	$3,252
15	Chippendale Road over Rodgers Creek	Low	Low	371	371	NO	2010	$5,000	$1,800	Capital					$37,100						$37,100						$667,800				$1,855,000
										Routine	$2,886	$2,886	$2,886	$2,886	$2,886	$2,886	$2,886	$2,886	$2,886	$2,886	$2,886	$2,886	$2,886	$2,886	$2,886	$2,886	$2,886	$2,886	$2,886	$2,886
16	Pipe Creek Bridge	Low	Low	206	206	NO	2012	$5,000	$1,800	Capital						$30,900						$30,900						$370,800			$1,030,000
										Routine	$1,603	$1,603	$1,603	$1,603	$1,603	$1,603	$1,603	$1,603	$1,603	$1,603	$1,603	$1,603	$1,603	$1,603	$1,603	$1,603	$1,603	$1,603	$1,603	$1,603
	Estimated Annual Routine Maintenance Costs										$36,060	$36,060	$36,060	$36,060	$36,060	$36,060	$36,060	$36,698	$36,698	$36,698	$36,698	$36,698	$36,698	$36,698	$36,698	$36,698	$36,698	$36,698	$36,698	$36,698
	Estimated Routine Maintenance Costs per 5 Year Period										$180,302	$180,302	$180,302	$180,302	$180,302	$180,302	$180,302	$183,491	$183,491	$183,491	$183,491	$183,491	$183,491	$183,491	$183,491	$183,491	$183,491	$183,491	$183,491	$183,491
	Estimated Capital Costs per 5 Year Period										$591,776	$2,105,650	$1,909,350	$248,150	$247,400	$2,050,800	$1,107,000	$487,850	$177,750	$636,750	$928,800	$53,100	$1,692,150	$813,450	$1,383,300	$1,558,800	$1,810,800	$1,482,850	$4,391,900	$7,268,100
	Estimated Routine Maintenance Costs per 10 Year Period											$360,603		$360,603		$360,603		$363,793		$366,983		$366,983		$366,983		$366,983		$366,983		
	Estimated Capital Costs per 10 Year Period											$2,697,426		$2,157,500		$2,298,200		$1,594,850		$814,500		$981,900		$2,505,600		$2,942,100		$3,293,650		$11,660,000


Forecasted Capital and Routine Maintenance Costs
5 Year Intervals
$8,000,000
$7,000,000
$6,000,000
$5,000,000
$4,000,000
$3,000,000
$2,000,000
$1,000,000
$0
2015
2020
2025
2030
2035
2040
2045
2050
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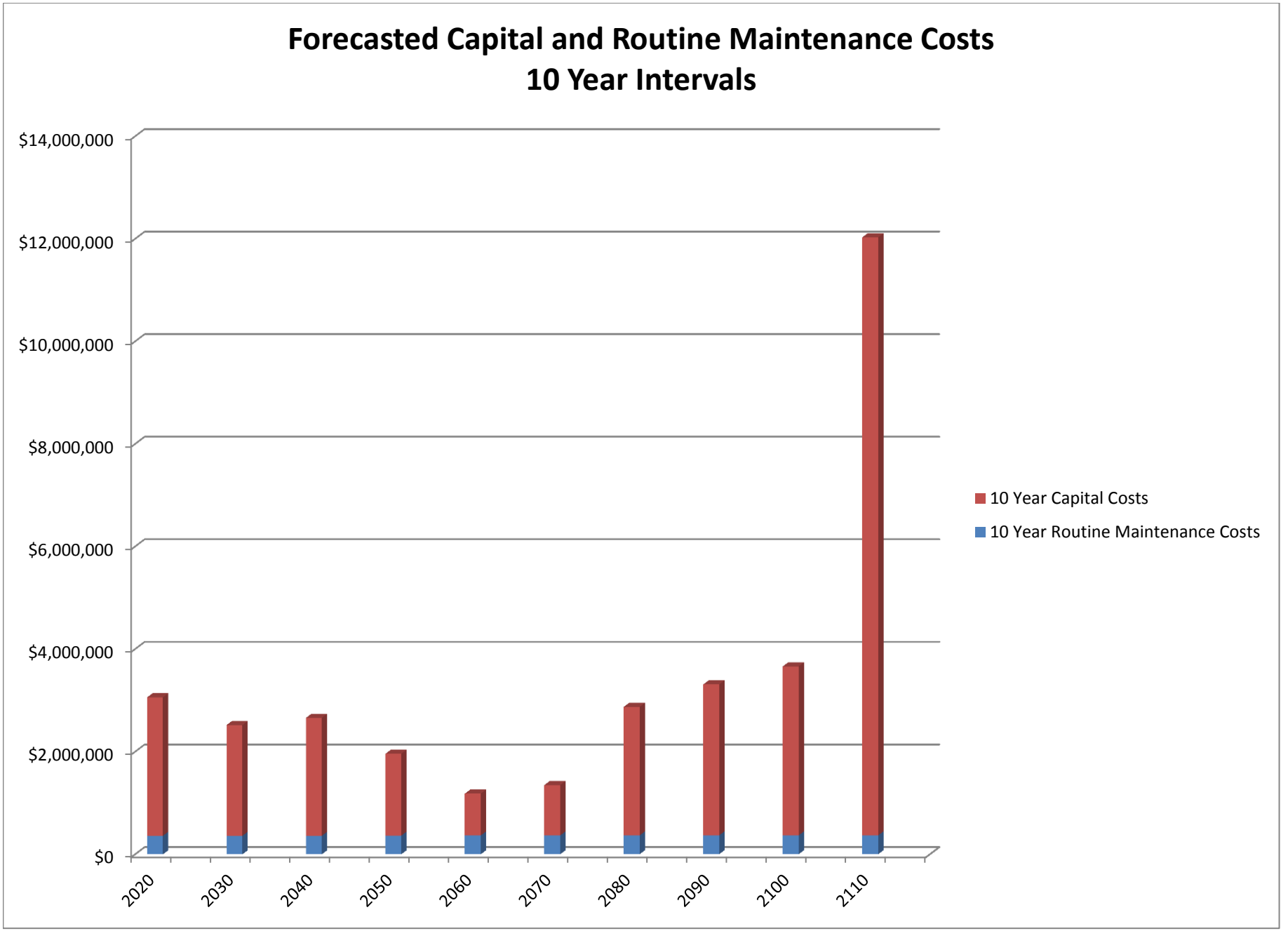
2090
2095
2100
2105
2110
5 Year Capital Costs
5 Year Routine Maintenance Costs


Forecasted Capital and Routine Maintenance Costs
10 Year Intervals
$14,000,000
$12,000,000
$10,000,000
$8,000,000
$6,000,000
$4,000,000
$2,000,000
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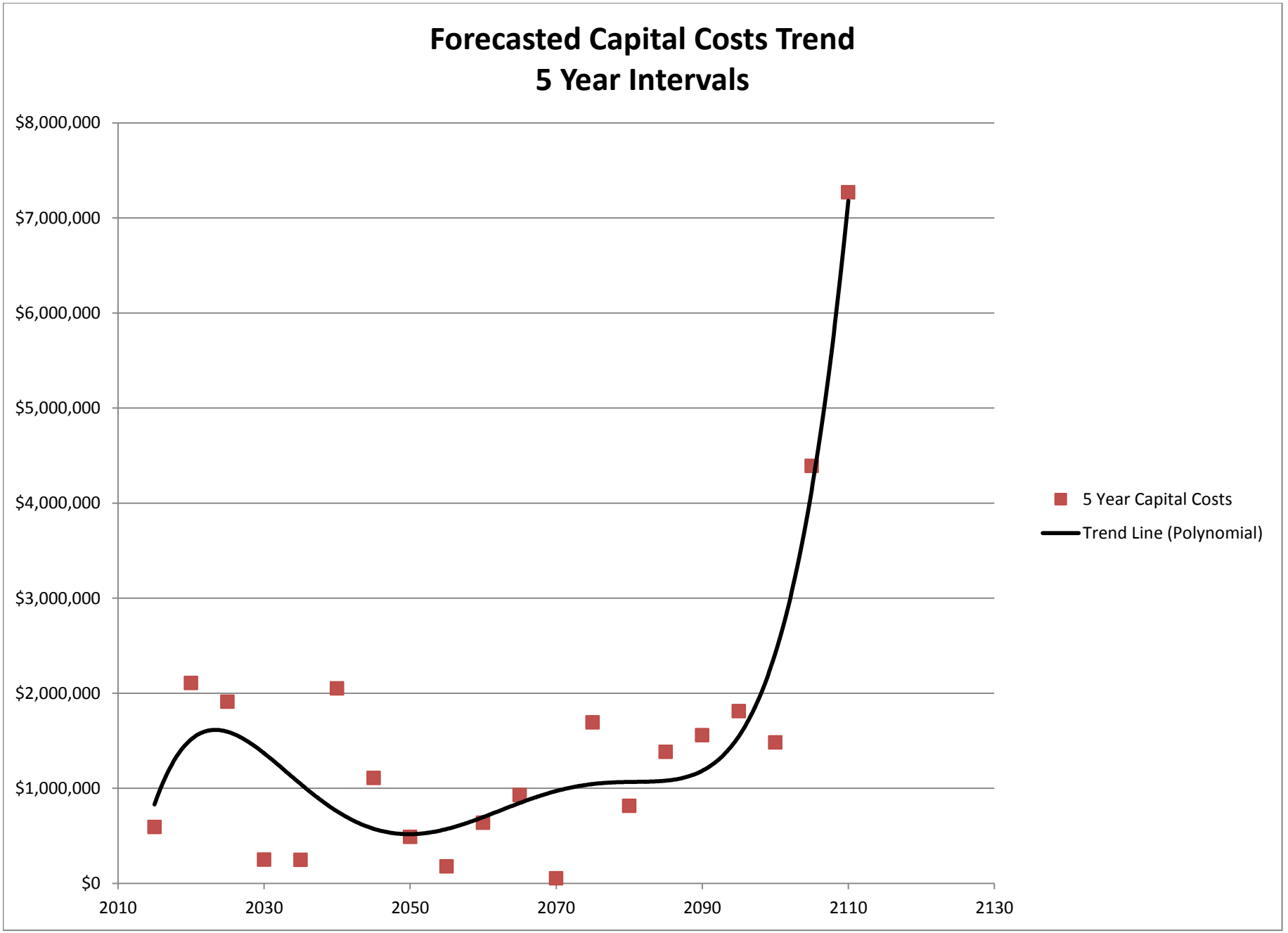
2060
2070
2080
2090
2100
2110
10 Year Capital Costs
10 Year Routine Maintenance Costs


Forecasted Capital Costs Trend
5 Year Intervals
$8,000,000
$7,000,000
$6,000,000
$5,000,000
$4,000,000
$3,000,000
$2,000,000
$1,000,000
$0
2010
2030
2050
2070
2090
2110
2130
5 Year Capital Costs
Trend Line (Polynomial)

Statement of Qualifications and Limitations

The attached Report (the "Report") has been prepared by AECOM Canada Ltd. ("Consultant") for the benefit of the client ("Client") in accordance with the agreement between Consultant and Client, including the scope of work detailed therein (the "Agreement").

The information, data, recommendations and conclusions contained in the Report (collectively, the "Information"):

- is subject to the scope, schedule, and other constraints and limitations in the Agreement and the qualifications contained in the Report (the "Limitations")
- represents Consultant's professional judgement in light of the Limitations and industry standards for the preparation of similar reports
- may be based on information provided to Consultant which has not been independently verified
- has not been updated since the date of issuance of the Report and its accuracy is limited to the time period and circumstances in which it was collected, processed, made or issued
- must be read as a whole and sections thereof should not be read out of such context
- was prepared for the specific purposes described in the Report and the Agreement
- in the case of subsurface, environmental or geotechnical conditions, may be based on limited testing and on the assumption that such conditions are uniform and not variable either geographically or over time

Consultant shall be entitled to rely upon the accuracy and completeness of information that was provided to it and has no obligation to update such information. Consultant accepts no responsibility for any events or circumstances that may have occurred since the date on which the Report was prepared and, in the case of subsurface, environmental or geotechnical conditions, is not responsible for any variability in such conditions, geographically or over time.

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- as agreed in writing by Consultant and Client
- as required by law
- for use by governmental reviewing agencies

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