Municipality of Jasper

Strategic Asset Management Study

- Final

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Executive Summary

The purpose of the Municipality of Jasper Asset Management study is to provide a high level strategic assessment of the Municipality's infrastructure assets and develop a long-range funding plan needed to attain infrastructure sustainability. The process for providing this analysis is in line with the Canadian Infraguide, "Seven Questions to Effective Asset Management".

Table ES-1 illustrates the current state of the infrastructure for each of the eight asset groups. The current backlog of infrastructure that has exceeded its theoretical service life (TSL) is in the Machinery and Vehicles Asset Groups. However, the major infrastructure groups (i.e. Roadways, Water, Sanitary, Storm, and Buildings) are currently in reasonable shape with a relatively small proportion of its infrastructure network that has exceeded its TSL.

Table ES-1 – Current State of the Infrastructure

Asset Group	Inventory	Replacement Cost	Currently Exceeded TSL
Roadways	• Roadways – 22.9 km • Alleys – 7.4 km • Sidewalks (incl. C&G) – 24.1 km • RR Pedestrian Underpass • Signals and Street Lights	$57.1 Million	7%
Water	• Pipes – 32.2 km • Wells and Pumping Facility – 3 wells • Treatment and Reservoir Facility	$45.7 Million	14%
Wastewater – Sanitary	• Pipes (Gravity) – 23.6 km • Pipes (Force Main) – 1.0 km • Lift Stations – 2 • Treatment Facility	$41.6 Million	3%
Wastewater – Storm	• Pipes (Gravity) – 13.4 km	$31.0 Million	0%
Land Improvements	• Engineering (i.e. parking lots) – 17 records • Recreation (i.e. courts, fields) – 6 records	$4.2 Million	23%
Buildings	• Facility Envelopes (excluding water and wastewater facilities) – 20 Structures • Interior Components (i.e. renewal items) – 188 records	$61.7 Million $13.7 Million $75.4 Million	11%
Machinery	• Various non-mobile, including building components – 103 Records	$5.0 Million	32%
Vehicles	• Mobile equipment for all Departments – 75 Records	$8.9 Million	38%
TOTAL		**$268.9 Million**	

Based on each of the asset group's Infrastructure Renewal Investment Plan, Table ES-2 illustrates the results of a Long Range Funding Plan showing the Capital Renewal Needs required to attain infrastructure sustainability. The table shows two scenarios. The first is based on conventional renewal, which would typically involve infrastructure replacement at the end of its service life. The second involves some preservation enhancement measures applied mid-life. Preservation maintenance is starting to become common practice to a few of the Engineering Services

asset groups (i.e. Roadways, Sanitary, and Storm Water). This is a key component to the National Infraguide and measures to minimize costs over the infrastructure life-cycle.

Table ES-2 – Long Range Funding Plan - 2016

			Conventional		Preservation Enhanced	
Asset Group	Replacement Cost ($M)	Current Budget Allocation ($M/yr)	Backlog ($M)	Capital Renewal Needs ($M/yr)	Backlog ($M)	Capital Renewal Needs ($M/yr)
Roadways	57.10	0.71	4.07	1.41	4.52	1.22
Water	45.70	0.31	6.25	0.94	6.25	0.94
Sanitary	41.60	0.11	1.29	0.89	3.90	0.52
Storm Water	31.00	0.02	-	0.82	0.01	0.21
Land improvements	4.20	0.11	0.97	0.20	0.97	0.20
Buildings	75.40	1.05	8.59	1.73	8.59	1.73
Machinery	5.00	0.18	1.61	0.38	1.61	0.38
Vehicles	8.90	0.05	3.35	0.65	3.35	0.65
TOTAL	**268.90**	**2.54**	**26.13**	**7.02**	**29.20**	**5.85**

Note * Shaded cells indicate preservation enhancements not currently explored in these asset groups

Comparing the two scenarios (i.e. Conventional vs. Preservation Enhanced), the Preservation Enhanced solution requires $1.17 Million/year (i.e. 7.02 - 5.85) less capital investment than the Conventional approach. However, a Preservation Enhanced solution still requires $3.31 Million/yr ($5.85-2.54) additional funding needs (i.e. 130%).

Looking into the budget category for each of the asset groups, Table ES-3 presents an illustration of the proportion of tax increases, utility rate increases, and user fees would be required to meet these new capital renewal funding needs. This is based on the Preservation Enhanced scenario.

Table ES-3 – Capital Renewal Funding Needs to Current Budget Revenue Comparisons

Asset Groups	Additional Funding Need ($ Million)	Budget Category	2015 Budget Revenues ($ Million)	Increase (%)
Roadways Machinery Vehicles	1.22-0.71 = 0.51 0.38-0.18 = 0.20 0.65-0.05 = 0.60 1.31	Municipal Taxes	6.84	16
Water Sanitary Wastewater Storm Wastewater	0.94-0.31 = 0.63 0.52-0.11 = 0.41 0.21-0.02 = 0.19 1.23	Utilities	3.17	28
Buildings Land Improvements	1.73-1.05 = 1.68 0.20-0.11 = 0.09 1.77	Culture and Recreation (i.e. user fees)	1.14	61

Recognizing a challenging funding issue, a Moving Forward Strategy was developed to address some additional processes that may further reduce the funding needs and help to close the financial gap. This strategy developed an implementation plan which is summarized in Table ES-4.

Table ES-4 – Implementation Plan

Item	Time	Estimated Cost	Comments
2016 Budget Plan	November, 2015	$0	Based on preliminary capital renewal needs revenue increases ranging between: • Municipal Taxes (4% – 16%) • Utility Rates (4% - 28%) • Culture and Recreation User Fees (4% - 61%)
Water Main Break History Condition Rating Assessment and Performance Measures	March, 2016	$8,000	Desktop analysis
Sanitary and Storm Flush, Sewer Photography, and Performance Measures	May – June, 2016	$126,000	Based on pipes with a TSL < 30 years. This would include 9600 m of sanitary sewer and 1000 m of storm sewer. Price estimated at $10/m for flush, CCTV photography and post data processing plus $16,000 for condition rating interpolation and forecasting.
Utility Rate Review * Key component to 2017 budget preparation	July, 2016	$15,000	To make certain utility rates meet not only operating needs but contain provision for capital renewal.
Roadway and Sidewalks Condition Rating	August-September, 2016	$20,000	Assumes manual condition rating for both roadways and sidewalks. Add $8000 to upgrade to automated pavement condition rating.
Engineering Assets (Roadways, sidewalks, water distribution, and wastewater (sanitary and storm) collection) Life-Cycle Optimization Analysis * Key component to 2017 budget preparation	February - October, 2016	$24,000	Based on minimizing costs of the infrastructures life-cycle, providing infrastructure sustainability, realistic budget allocations, and detailed treatment scheduling of all listed infrastructure assets within these groups. A key component is expected to include new preservation enhancing treatments (i.e. sewer liners, etc) designed to minimize capital renewal costs over the life cycle.
Facilities Risk Management Enhancement to Restricted Funds Workbooks * Key component to 2018 budget preparation	January, 2017	$5,000	Enhancement to existing Culture and Recreation capital renewal facilities programming
Water and Wastewater Treatment Plants and Pumping Facilities Internal Components Assessment and Capital	March, 2017	$8,000	Inspection and deficiency/preventative maintenance listing with internal Operations staff

Renewal Programming * Key component to 2018 budget preparation			
Fleet Management System (Vehicles and Machinery Asset Groups) * Key component to 2018 budget preparation	April 2017	$10,000	Based on conventional fleet management principles within a relatively simple spreadsheet environment.
Project Management (15%)	January 2016 to December 2017	$32,400	This may be internal management salary costs attributed to this initiative or an outsourced Owner's Engineer to manage the delivery of works listed above.
2017 Budget Plan	November, 2016	$0	Based on results attained in the above implementation planning components.
2018 Budget Plan	November, 2017	$0	
TOTAL		**$248,400**	

With respect to the findings of this study, the following presents the overall conclusions and recommendations.

Conclusions

- The computed replacement cost value of its infrastructure assets is $268.9 Million. This is significantly greater than the $84.5 Million compiled acquisition costs stated in the Municipality's 2014 Tangible Capital Assets Financial Statements.
- The Municipality of Jasper appears to be running an infrastructure deficit in all eight of its asset groups. Additional funding needs to bridge the financial gap is approximately $3.31 Million/year to $4.48 Million/year depending on the Municipality's decision to implement a proactive preservation enhanced approach or conventional replacement approach within the infrastructure renewal program.
- To address the Long Range Funding Plan needs will require approximately the following increase to existing revenue streams:
    - Municipal Taxes – 16%
    - Utility Rates – 28%
    - Culture and Recreation User Fees – 61%
- It is recognized that sharp tax/rate/fee increases would not be appropriate and that a gradual progressive approach be considered.
- It is recognized that post report asset management measures including condition assessments, life-cycle optimization modeling, risk management, and fleet management will contribute to further reduction in capital renewal funding needs and associated tax/rate/fee increases.
- A moving forward implementation plan beginning January 2016 and concluding December 2017 provides a period of the required assessment and analysis to derive budget programs and detailed work plans that will minimize costs while ensuring sustainability over the infrastructure life-cycle.

- Delivery of this plan should be carefully scoped as not all asset management systems and delivery thereof are created equal. Request for Proposal (RFP) development should reference Best Practices in the field of Asset Management and those practices that will maximize the Return on Infrastructure Investment (ROII) to the Municipality.
- The implementation plan may be managed internal to the Municipality of Jasper outsourcing each component; or managed and delivered in its entirety through the services of an Owner's Engineer.

Recommendations

i. That for budget year 2016, the Municipality of Jasper discusses and implements reasonable tax, utility rate, and user fees increases as a preliminary step to addressing the capital renewal funding needed to attain infrastructure sustainability.

ii. That for the period of January 2016 to December 2017, the Municipality of Jasper use the Implementation Plan to complete the needed analysis to develop a detailed Long Range Capital Plan that will maximize the ROII; and that the Municipality allocate $248,400 to complete those engineering works.

iii. That the Municipality of Jasper incorporates the detailed assessment results applied within the Long-Range Infrastructure Capital Plan for application in the 2017 and 2018 Budgets and beyond; and that this plan is used as a guide in addressing further tax, utility rate, and user fees increases.

Table of Contents

1. Introduction

The purpose of this study is to provide a high level strategic assessment of the Municipality's infrastructure assets and develop a long-range funding plan needed to attain infrastructure sustainability. The projected started with a kick-off meeting on May 1, 2015.

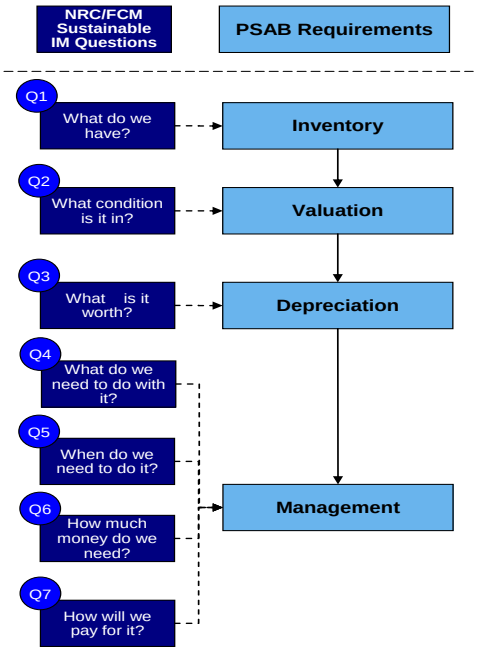
The study is completed in line with Municipality's infrastructure grouping which includes the following. Further discussion on each grouping, including sub-classifications will be addressed later in this report.

- Roadways
- Water Systems
- Sanitary Wastewater Systems
- Storm Water Systems
- Land Improvements
- Buildings
- Machinery
- Vehicles

The study accesses numerous main data sources to conduct the infrastructure analysis. The following lists the various sources and asset group is serves:

- Geographic Information System (GIS) extracted data (Roadways, Water, Sanitary, Storm Water)
- The 2009 Public Sector Accounting Board (PSAB) Tangible Capital Assets (TCA) data (All asset groups)
- Fleet and Equipment Management records (Vehicles)
- Restricted Funds Workbook (Buildings, Machinery, and Land Improvements
- Financial Statements (All asset groups)

The process for providing this analysis is in line with the Canadian Infraguide, "Seven Questions to Effective Asset Management".



The first three steps (Q1-Q3) were to some extent completed in 2009 under the TCA initiative. This should list every asset segment and component. It does not include condition data. However, we compare asset age to the theoretical service life to provide an indication of condition. The historic cost and age since last renewal should also be contained in the TCA data. This can be used to project to current day replacement cost value. However, we do check replacement cost using current day unit prices, as the historic record information may be misleading.

The next three steps (Q4-Q6) include a strategic level assessment that will derive an infrastructure renewal investment plan for each of the infrastructure asset groups. This is based on charting expenditure needs over time and deriving an annualized funding plan to close the financial gap. This is based on two fundamental asset management components. One is capital renewal at the end of the infrastructure service life. The other is capacity upgrade (i.e. size) to meet community infill/density growth needs. This analysis will ultimately determine how much money is needed.

The final step (Q7) will address the reality of budget constraints and a strategy to pay for the infrastructure funding needs. This may in part *involve a moving forward strategy to implement life-cycle optimization analysis proven to reduce funding needs based on "Doing the Right thing to the Right infrastructure at the Right time".*

2. Current State of the Infrastructure

On June 17th the Asset Management Steering Committee met to verify the summary of infrastructure inventory information and overall state of the infrastructure. This information is viewed in terms of quantity, size, material type, and current day replacement cost.

In order to compile the current state of the infrastructure and perform the subsequent asset management analysis, specific information is required to Jasper's infrastructure assets in relation to theoretical service life (TSL) and unit costs to replace/renew the infrastructure assets at the end of projected service life.

Table 1 presents the theoretical service life for each of the asset groups. The Alberta Toolkit was the first source in estimating TSL values for the infrastructure groups. Based on experience in the industry, we made some adjustments. As an example, the Alberta Toolkit uses a TSL of 75 years for all pipe materials. Our experience managing operations for municipal government show significant diversity on material type. Cast Iron (CI) and Vitrified Clay Tile (VCT) have demonstrated relative poor service life in comparison to poly-vinyl chloride (PVC) which is not known to corrode and deteriorate as per some of the older material types. Upon conducting a field assessment of the roadway network and comparing to the known age of some of the pavements and sidewalks, we increased the TSL of PVC pipe assets to nearly double that of other materials.

The above average performance its roadway network is experiencing in comparison to most other Alberta municipalities may be attributed to a few identified factors. One may be related to its granular subgrade, which carries very high strength characteristics. Another may be practice of locating water and wastewater services in the alleys instead of the streets, which may further reduce the risk of subsurface disruptions.

For the Buildings asset group, the Alberta Toolkit references 50 year TSL. Our facilities specialist recommended 75 years for many of the structures. This was in part based on review of the 2011 Appraisals Report, which provided very good indication on serviceability and condition.

The Vehicles and Machinery asset groups, along with the internal Buildings components, the TSL was based primarily on Jasper operations personnel estimation. This was well documented in related Equipment reports and Restricted Funds reports.

Table 1 – Asset Theoretical Service Life Grouping

Asset Group	Sub Class	Materials Class	TSL (Yrs)	Comments
Roadways	Streets	Pavement	40	Adjusted from 20 years based on field assessment
		Gravel	20	Adjusted from 10
	Alleys	Pavement	20	
		Gravel	20	
	Sidewalks	Concrete	50	Adjusted from 30 years based on relative condition to roadways
	Underpass		60	
	Signals		30	
Sanitary	Pipes	PVC	150	
		Concrete	75	
		AC	125	
		VCT	60	
	Force Main	Cast Iron	60	

	Lift Stations		45	
	Treatment		45	
Storm	Pipes	PVC	150	
		VCT	60	
		AC	125	
		Concrete	75	
	Lift Stations		45	
Water	Pipes	PVC	150	
		Cast Iron	60	
		AC	125	
	Wells & Pumping		45	
	Storage and Treatment		45	
Land Improvements	Landscaping	Hard and soft	25	Includes Streetscaping
	Parking lots	Pavement	25	
		Gravel	20	Adjusted from 15
	Trails	Pavement	20	
		Gravel	20	Adjusted from 15
	Sprinkler Systems	Std	25	
	Recycling Station	Outdoor	25	
	Play Grounds	Grounds and Equipment	20	Includes skateboard park; adjusted from 15
	Tennis Courts		20	
	Soccer Pitch	Outdoor	20	
Buildings	Permanent	Wood, Metal, Concrete	50	Or as adjusted by Facilities Specialist. 75 years was commonly used.
	Portable	Wood or Metal	25	Or as adjusted by Facilities Specialist
Machinery				As per Jasper Restricted Funding Report and/or Equipment Replacement Program
Vehicles				As per Jasper Restricted Funding Report and/or Equipment Replacement Program

Table 2 presents the unit prices used to determine and/or provide a check to historic financial and TCA information in determining the current day infrastructure replacement cost. These values are based on the experiences of municipal engineering practitioners and some recent supplier references. These would be the costs to renew or replace the infrastructure. The listed groupings are specific to the Jasper's infrastructure inventory.

Table 2 – Asset Unit Price Grouping

Asset Group	Sub Class	Materials Class	Unit Price	Comments
Roadways	Streets	Pavement	$900/m	$75/m2 x 12 m width
		Gravel	$200/m	$20/m2 x 10 m width
	Alleys	Pavement	$300/m	$60/m2 x 5 m wide
		Gravel	$100/m	$20/m2 x 5 m wide
	Sidewalks	Concrete	$1080/m	$600/m2 x 1.8 m (incl. curb & gutter)
	Underpass			As per PSAB
	Signals	Std	$250,000	
Sanitary	Pipes	200 mm	$1000/m	Inc. manholes and service connections @ $200/m
		250	$1200/m	Inc. manholes and service connections
		300	$1400/m	Inc. manholes and service connections
		375	$1700/m	Inc. manholes and service connections
		450	$2000/m	Inc. manholes and service connections
		600	$2600/m	Inc. manholes and service connections
	Pipes - Force	100 mm	$500/m	Inc. valves @ $100/m
		150	$700/m	
	Lift Stations			As per PSAB and Town Admin.
	WWTP			As per PSAB and Appraisals Report.
Storm	Pipes – Gravity	200 mm	$1000/m	Incl. manholes and catch basins @ $200/m
		250	$1200/m	Incl. manholes and catch basins
		300	$1400/m	Incl. manholes and catch basins
		375	$1700/m	Incl. manholes and catch basins
		450	$2000/m	Incl. manholes and catch basins
		600	$2600/m	Incl. manholes and catch basins
		675	$2800/m	Incl. manholes and catch basins
		750	$3200/m	Incl. manholes and catch basins
		900	$3800/m	Incl. manholes and catch basins
		1075	$4400/m	Incl. manholes and catch basins
		1200	$5000/m	Incl. manholes and catch basins
	Lift Stations			None in inventory
Water	Pipes	50 mm	$200/m	
			$700/m	Inc. valves hydrants and service connections @ $400/m
			$800/m	Inc. valves hydrants and service connection
		150	$1000/m	Inc. valves hydrants and service connection
		200	$1200/m	Inc. valves hydrants and service connection
		250	$1400/m	Inc. valves hydrants and service connection
		300	$1600/m	Inc. valves hydrants and service connection
		350	$1800/m	Inc. valves hydrants and service connection
		400	$2000/m	Inc. valves hydrants and service connection
		450	$2200/m	Inc. valves hydrants and service connection

	Wells and Pumping	3 wells and Bldg		As per PSAB and Appraisals Report.
	Storage and Treatment	WTP and Reservoir		As per PSAB and Appraisals Report.
Buildings				As per Facilities Specialist, PSAB Historic Cost, Restricted Funds Report, and Appraisals Report
Land Improvements				As per PSAB Historic Cost
Machinery				As per Jasper Restricted Funds Report and/or Equipment Replacement Program
Vehicles				As per Jasper Restricted Funds Report and/or Equipment Replacement Program

In compiling the thousands of infrastructure records for each of the eight infrastructure groups, Table 3 summarizes the current day state of the infrastructure. This includes a summary of the inventory quantity, current day replacement cost, and estimation of proportion of inventory that has currently exceeded its theoretical service life.

Table 3 – Current State of the Infrastructure

Asset Group	Inventory	Replacement Cost	Currently Exceeded TSL
Roadways	• Roadways – 22.9 km • Alleys – 7.4 km • Sidewalks (incl. C&G) – 24.1 km • RR Pedestrian Underpass • Signals and Street Lights	$57.1 Million	7%
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Machinery	• Various non-mobile, including building components – 103 Records	$5.0 Million	32%
Vehicles	• Mobile equipment for all Departments – 75 Records	$8.9 Million	38%
TOTAL		**$268.9 Million**	

In comparison, the Municipality of Jasper TCA report dated December 31, 2014 illustrates a compiled acquisition cost of $84.5 Million. Therefore the financial reporting is not reflecting the true value of the Municipality's assets replacement cost today. This in part may be due limited historic cost information in record for many engineering assets. Our replacement cost value of $268.9 Million is based on comparing both the historic costs on record projected to today's value to a unit cost analysis for each asset on record. This provides a reality check against the financial records and involves reviewing other reports (i.e. assessments) along with engineering and operations judgement in the valuation analysis.

The roadways asset group are in relatively good condition with only 7% exceeding its theoretical service life (TSL). As discussed above, this is largely in part to adopting a TSL that is approximately twice normal values. The field review supports this finding. This provides opportunity to plan for preservation maintenance activities that may be able to further sustain the roadway network in a cost effective manner.

The water distribution system is just beginning to approach the end of its service life. This is largely in part due to the vast amount of cast iron pipes. This is supported by the Director of Operations, who states they are starting to see problems with the water distribution system.

The wastewater (storm and sanitary) collection system is currently in good shape. As per the roadway network, this provides the opportunity to plan for preservation maintenance activities that may be able to further sustain the wastewater collection network in a cost effective manner.

Land improvements including parking lots are beginning to exceed their TSL. Addressing this may be an activity focus in the not-too-distant future.

The Buildings asset group has only one building structure that has exceeded its service life. This is a River Runner maintenance building. The backlog is predominately related to miscellaneous building components due for replacement or repair. The Municipality's restricted funds report provides a comprehensive listing of these.

The Machinery's and Vehicles Asset Groups have the greatest proportion of assets that have exceeded their TSL. This group has the shortest asset life span, and therefore require more frequent renewal investments. This is indication that Jasper is running an aging fleet. However, this will be discussed later in this report in discussing concepts around fleet management practices that can proactively address and optimize fleet replacement cycles and other items.

The following sections will build off the State of the Infrastructure current day findings in relation to expenditure needs over time.

3. Strategic Asset Management

3.1 Budget Allocations

Part of the strategic asset management assessment involves comparing funding needs against current levels of investment. To get an indication of funding level allocations to each of the asset groups, we referenced Capital Budgets and Projects reports as well as Trial Balance reports. Within these reports we reviewed each expenditure line item and allocated the expenditure to one of our eight asset groups. In further discussion around the Trial Balance reports, we realized there may be additional Municipal investment in capital renewal through operating budgets that cannot be discretely identified. To compensate, we made an estimation of the operating budget allocation to capital renewal as a proportion of the Trial Balance expenditures. Table 4 presents a summary of these findings.

Table 4 – Historic Budget Allocations

		BUDGET ALLOCATIONS ($ Millions)								
Source	Year	Roads	Water	Sanitary	Storm	Land Improvements	Buildings	Machinery	Vehicles & Heavy Equipment	Total
Capital Budgets and Projects	2013	0.35	0.00	0.11	0.00	0.10	1.81	0.22	0.00	2.59
	2014	1.04	0.13	0.14	0.00	0.29	0.36	0.26	0.00	2.22
	2015	1.00	0.95	0.05	0.05	0.20	0.93	0.18	0.20	3.56
Average		0.80	0.36	0.10	0.02	0.20	1.03	0.22	0.07	2.79
Source	Year	Roads	Water	Sanitary	Storm	Land Improvements	Buildings	Machinery	Vehicles & Heavy Equipment	Total
	Estimated percentage of increased renewal by way of the respective operating budgets	10%	20%	5%	2%	10%	10%	10%	10%	
Trail Balance Reports	2013	0.11	0.19	0.07	0.00	0.07	1.60	0.12	0.00	2.16
	2014	1.16	0.32	0.15	0.04	0.00	0.53	0.17	0.06	2.41
Average		0.63	0.26	0.11	0.02	0.03	1.06	0.14	0.03	2.29
Net Average		**0.71**	**0.31**	**0.11**	**0.02**	**0.11**	**1.05**	**0.18**	**0.05**	**2.54**

As per the above table, the indication is the Municipality is allocating approximately $2.54 Million/year towards capital renewal. The associated expenditure levels within each asset group will be used in the following Infrastructure renewal investment plan in determining financial gap (i.e. difference between capital renewal expenditure needs and funding levels).

3.2 Infrastructure Renewal Investment Plan

The following tables and graphs summarize the Infrastructure Renewal Investment Plans for each of the eight asset groups. The information from each table is compiled from large data sets containing physical attributes, TSL, and replacement cost information for each infrastructure asset. The following tables aggregate the information and compile expenditure needs over time.

This analysis is based on the combined remaining service life (RSL) (i.e. deterioration) and capacity analysis. As we do not have master planning studies to estimate the capacity needs, we estimate these based on a proportion of

replacement cost, which varies between asset groups. This is based on similar proportions from other studies that included capacity needs from master planning studies.

The analysis computes the financial gap, which is the difference between current level funding to the actual expenditure needs. This determines the additional funding needs annualized to balance at the end of the analysis period. We include the element of a "Reserve Balance", which allows relative uniform annual expenditures and thereby smoothing the expenditure spikes.

Roadways

Table 5 presents the Roadways Infrastructure Renewal Investment Plan. It is highlighted that the current day funding level is approximately $0.71 Million/year. In order to match forecast expenditure needs of the infrastructure life-cycle, an additional $0.70 Million/year is required to sustain the infrastructure assets in accordance with conventional pavement and concrete rehabilitation practices. The analysis assumes a 2 percent discount rate (i.e. interest – inflation), which is used for all financial forecasts. This is consistent for all asset groups.

Table 5 – Roadways Infrastructure Renewal Investment Plan

Roadways - Conventional								
		Total Replacement Cost:			$ 57,087,468			
		Proportion RC for Capacity Needs:			0.05%			
Year	RSL Renewal Needs ($)	Capacity Renewal Needs ($)	Total Capital Renewal Needs ($)	Capital Renewal Budget Allocations ($)	Financial Gap ($)	Additional Funding to Balance ($)	Surplus/Deficit ($)	Reserve Balance ($)
2016	4,069,731	28,544	4,098,275	710,000	(3,388,275)	700,000	(2,688,275)	(2,688,275)
2017	1,626,245	29,115	1,655,360	724,200	(931,160)	714,000	(217,160)	(2,905,434)
2018		29,697	29,697	738,684	708,987	728,280	1,437,267	(1,468,167)
2019	193,265	30,291	223,555	753,458	529,902	742,846	1,272,748	(195,420)
2020	2,911,832	30,897	2,942,729	768,527	(2,174,202)	757,703	(1,416,499)	(1,611,919)
2021	5,738,551	31,515	5,770,065	783,897	(4,986,168)	772,857	(4,213,312)	(5,825,230)
2022		32,145	32,145	799,575	767,430	788,314	1,555,744	(4,269,486)
2023	95,288	32,788	128,076	815,567	687,491	804,080	1,491,571	(2,777,915)
2024	3,743,561	33,444	3,777,005	831,878	(2,945,127)	820,162	(2,124,965)	(4,902,880)
2025	2,595,793	34,112	2,629,905	848,516	(1,781,389)	836,565	(944,825)	(5,847,705)
2026		34,795	34,795	865,486	830,691	853,296	1,683,987	(4,163,717)
2027	6,296,570	35,491	6,332,060	882,796	(5,449,265)	870,362	(4,578,903)	(8,742,620)
2028		36,200	36,200	900,452	864,251	887,769	1,752,021	(6,990,599)
2029	584,363	36,924	621,287	918,461	297,173	905,525	1,202,698	(5,787,901)
2030	3,086,133	37,663	3,123,796	936,830	(2,186,966)	923,635	(1,263,331)	(7,051,232)
2031	4,572,140	38,416	4,610,556	955,567	(3,654,989)	942,108	(2,712,881)	(9,764,113)
2032		39,184	39,184	974,678	935,493	960,950	1,896,443	(7,867,670)
2033	18,460	39,968	58,428	994,171	935,743	980,169	1,915,912	(5,951,757)
2034	6,263,017	40,767	6,303,785	1,014,055	(5,289,730)	999,772	(4,289,958)	(10,241,715)
2035	1,254,293	41,583	1,295,876	1,034,336	(261,540)	1,019,768	758,228	(9,483,487)
2036	2,728,273	42,414	2,770,687	1,055,023	(1,715,665)	1,040,163	(675,501)	(10,158,988)
2037	910,401	43,263	953,663	1,076,123	122,460	1,060,966	1,183,426	(8,975,562)
2038	5,701,642	44,128	5,745,770	1,097,646	(4,648,125)	1,082,186	(3,565,939)	(12,541,501)
2039	426,510	45,011	471,520	1,119,598	648,078	1,103,829	1,751,908	(10,789,593)
2040	1,854,082	45,911	1,899,993	1,141,990	(758,003)	1,125,906	367,904	(10,421,690)
2041	6,382,656	46,829	6,429,485	1,164,830	(5,264,655)	1,148,424	(4,116,231)	(14,537,921)
2042	657,216	47,766	704,982	1,188,127	483,145	1,171,393	1,654,538	(12,883,383)
2043	606,348	48,721	655,069	1,211,889	556,820	1,194,821	1,751,641	(11,131,742)
2044	11,789,743	49,695	11,839,439	1,236,127	(10,603,312)	1,218,717	(9,384,595)	(20,516,337)
2045	1,041,162	50,689	1,091,851	1,260,850	168,999	1,243,091	1,412,090	(19,104,247)
2046	963,858	51,703	1,015,561	1,286,067	270,506	1,267,953	1,538,459	(17,565,788)
2047	1,818,309	52,737	1,871,046	1,311,788	(559,258)	1,293,312	734,054	(16,831,734)
2048		53,792	53,792	1,338,024	1,284,232	1,319,178	2,603,410	(14,228,323)
2049		54,868	54,868	1,364,784	1,309,917	1,345,562	2,655,479	(11,572,845)
2050	1,249,610	55,965	1,305,575	1,392,080	86,505	1,372,473	1,458,978	(10,113,867)
2051	745,328	57,084	802,412	1,419,922	617,509	1,399,923	2,017,432	(8,096,435)
2052	362,388	58,226	420,614	1,448,320	1,027,706	1,427,921	2,455,627	(5,640,807)
2053		59,391	59,391	1,477,286	1,417,896	1,456,480	2,874,375	(2,766,432)
2054		60,578	60,578	1,506,832	1,446,254	1,485,609	2,931,863	165,431
2055		61,790	61,790	1,536,969	1,475,179	1,515,321	2,990,500	3,155,931
2056	6,145,110	63,026	6,208,136	1,567,708	(4,640,428)	1,545,628	(3,094,800)	61,131

Figure 1 illustrates the Roadways Infrastructure Renewal Investment Plan for the above table. However, the roadways asset group is one area which preservation maintenance technology has evolved quite strong over recent years. The actual application of the appropriate preservation maintenance program is typically based on

optimization modeling through pavement management system technologies. However, given the visual inspection of the roadways, it is assumed a mid-life micro-surfacing treatment may be applied for part of the network that has not already exceeded its TSL. On such an application, there is strong indication the additional expenditure needs may be reduced from $0.70 Million per year to $0.51 Million/year, a savings of $0.19 Million/'year. This corresponding expenditure needs over time is illustrated in Figure 2, which provides a comparison between conventional renewal practices and potential preservation enhanced methods.

Figure 1 – Roadways Infrastructure Renewal Investment Plan – Conventional Renewal Practice

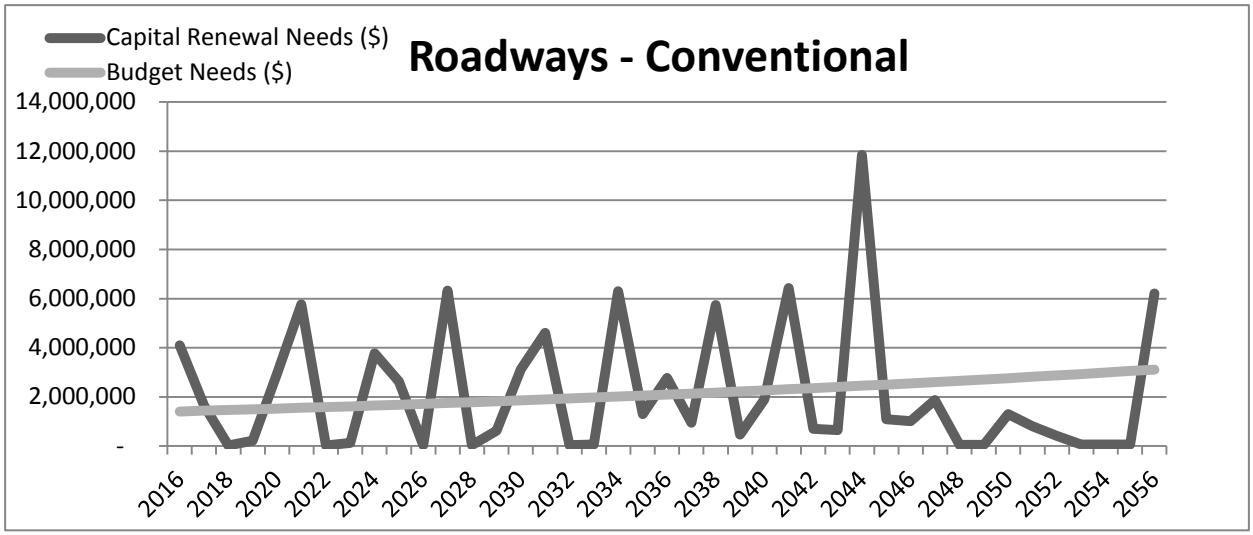
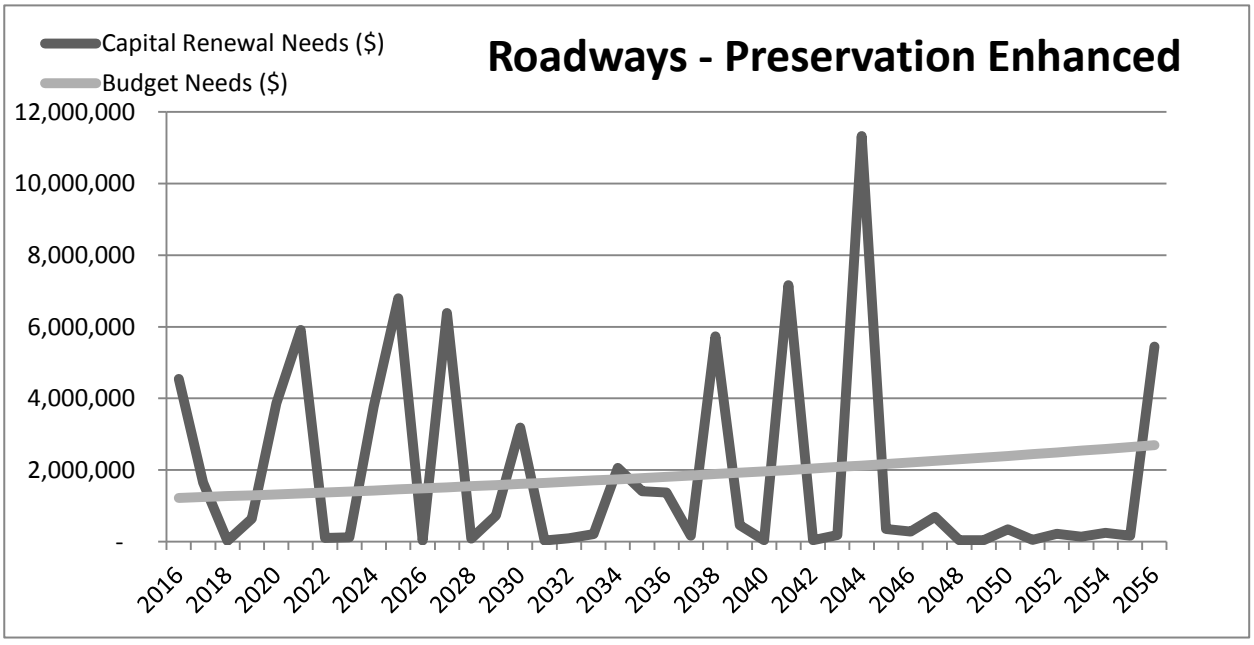


Figure 2 – Roadways Infrastructure Renewal Investment Plan – Preservation Enhanced Renewal Practice



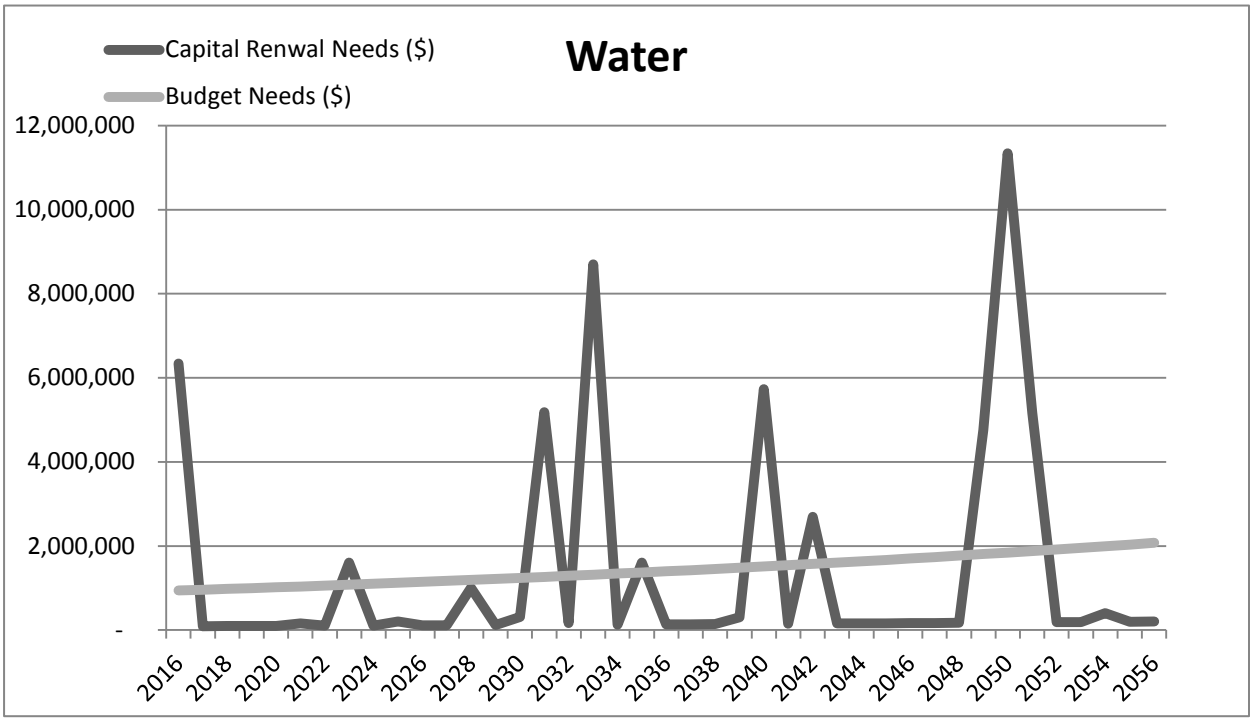
Water Systems

Table 6 and Figure 3 present the Water Systems Infrastructure Renewal Investment Plan. It is highlighted that the current day funding level is approximately $0.31 Million/year. In order to match forecast expenditure needs of the infrastructure life-cycle, an additional $0.63 Million/year is required to sustain the infrastructure assets in accordance with conventional replacement practices. For the piping system, open trench replacement or pipe-bursting running approximately the same price. Domestic water pressure systems do not typically permit mid-life preservation practices, such as the pipe-lining. The backlog of $6.2 Million shows there is some pipe replacement that may be required in the immediate future. However, much of the piping may require replacement in approximately 20 years from now. In order to address that, it may be necessary to begin building the reserve fund today to prepare for today's needs and the significant funding requirements in the not-too-distant horizon.

Table 6 – Water Systems Infrastructure Renewal Investment Plan

Water								
		Total Replacement Cost:			$45,650,683			
		Proportion RC for Capacity Needs:			0.20%			
Year	RSL Renewal Needs ($)	Capacity Renewal Needs ($)	Total Capital Renewal Needs ($)	Capital Renewal Budget Allocations ($)	Financial Gap ($)	Additional Funding to Balance ($)	Surplus/Deficit ($)	Reserve Balance ($)
2016	6,247,647	91,301	6,338,948	310,000	(6,028,948)	630,000	(5,398,948)	(5,398,948)
2017		93,127	93,127	316,200	223,073	642,600	865,673	(4,533,276)
2018		94,990	94,990	322,524	227,534	655,452	882,986	(3,650,289)
2019		96,890	96,890	328,974	232,085	668,561	900,646	(2,749,644)
2020	142	98,828	98,970	335,554	236,584	681,932	918,517	(1,831,127)
2021	61,305	100,804	162,109	342,265	180,156	695,571	875,727	(955,400)
2022		102,820	102,820	349,110	246,290	709,482	955,773	372
2023	1,500,068	104,877	1,604,944	356,093	(1,248,852)	723,672	(525,180)	(524,808)
2024		106,974	106,974	363,214	256,240	738,145	994,386	469,578
2025	95,487	109,114	204,601	370,479	165,878	752,908	918,786	1,388,364
2026		111,296	111,296	377,888	266,592	767,966	1,034,559	2,422,923
2027		113,522	113,522	385,446	271,924	783,326	1,055,250	3,478,173
2028	890,136	115,792	1,005,928	393,155	(612,773)	798,992	186,219	3,664,393
2029		118,108	118,108	401,018	282,910	814,972	1,097,882	4,762,275
2030	187,483	120,470	307,953	409,038	101,086	831,272	932,357	5,694,632
2031	5,057,053	122,880	5,179,933	417,219	(4,762,714)	847,897	(3,914,817)	1,779,815
2032	38,179	125,337	163,516	425,564	262,048	864,855	1,126,903	2,906,718
2033	8,573,182	127,844	8,701,026	434,075	(8,266,952)	882,152	(7,384,799)	(4,478,082)
2034		130,401	130,401	442,756	312,356	899,795	1,212,151	(3,265,931)
2035	1,469,504	133,009	1,602,513	451,611	(1,150,902)	917,791	(233,111)	(3,499,042)
2036		135,669	135,669	460,644	324,975	936,147	1,261,122	(2,237,920)
2037		138,382	138,382	469,857	331,474	954,870	1,286,344	(951,576)
2038		141,150	141,150	479,254	338,104	973,967	1,312,071	360,495
2039	157,939	143,973	301,912	488,839	186,926	993,447	1,180,373	1,540,868
2040	5,582,052	146,853	5,728,905	498,616	(5,230,289)	1,013,315	(4,216,974)	(2,676,106)
2041		149,790	149,790	508,588	358,798	1,033,582	1,392,380	(1,283,726)
2042	2,539,521	152,785	2,692,307	518,760	(2,173,547)	1,054,253	(1,119,294)	(2,403,020)
2043		155,841	155,841	529,135	373,294	1,075,338	1,448,632	(954,387)
2044		158,958	158,958	539,718	380,760	1,096,845	1,477,605	523,217
2045		162,137	162,137	550,512	388,375	1,118,782	1,507,157	2,030,374
2046		165,380	165,380	561,522	396,142	1,141,158	1,537,300	3,567,675
2047		168,687	168,687	572,753	404,065	1,163,981	1,568,046	5,135,721
2048		172,061	172,061	584,208	412,146	1,187,261	1,599,407	6,735,128
2049	4,580,311	175,502	4,755,813	595,892	(4,159,922)	1,211,006	(2,948,916)	3,786,212
2050	11,162,626	179,012	11,341,638	607,810	(10,733,829)	1,235,226	(9,498,603)	(5,712,391)
2051	4,983,580	182,593	5,166,173	619,966	(4,546,207)	1,259,930	(3,286,277)	(8,998,668)
2052		186,244	186,244	632,365	446,121	1,285,129	1,731,250	(7,267,418)
2053		189,969	189,969	645,012	455,043	1,310,832	1,765,875	(5,501,544)
2054	211,275	193,769	405,044	657,913	252,869	1,337,048	1,589,917	(3,911,627)
2055	1,440	197,644	199,084	671,071	471,987	1,363,789	1,835,776	(2,075,850)
2056	1,220	201,597	202,817	684,492	481,675	1,391,065	1,872,740	(203,110)
TOTAL	53,340,151	5,716,381			(39,647,425)			

Figure 3 – Water Systems Infrastructure Renewal Investment Plan



Sanitary Wastewater Systems

Table 7 presents the Sanitary Wastewater Systems Infrastructure Renewal Investment Plan. The Sanitary asset group has a relatively modest renewal backlog at $1.3 Million. This is attributed to the fact that the theoretical service life for the majority of the piping system is expected around year 2031 and then again at year 2046.

It is highlighted that the current day funding level is approximately $0.11 Million/year. In order to match forecast expenditure needs of the infrastructure life-cycle, an additional $0.78 Million/year is required to sustain the infrastructure assets in accordance with conventional replacement practices

Figure 4 illustrates the Sanitary Infrastructure Renewal Investment Plan for the above table. However, the Sanitary asset group is one area which preservation maintenance technology has evolved quite strongly over recent years. The actual application of the appropriate preservation maintenance program is typically based on optimization modeling through sewer photography and infrastructure management system technologies. If the deterioration levels are not severe, this provides opportunity for mid-life lining treatments. A common liner application with the City of Edmonton is Cured-In-Place (CIP) liners. Centrifugally Cast Cured in-Place (CCCP) concrete is also gaining popularity in Western Canada. In Jasper, there is strong indication the additional expenditure needs may be reduced from $0.78 Million per year to $0.41 Million/year, a savings of $0.37 Million/'year. This corresponding expenditure needs over time is illustrated in Figure 5, which provides a comparison between conventional renewal practices and potential preservation enhanced methods.

The savings of the preservation enhanced alternative requires a proactive approach, which would require upfront expenditures if $3.9 Million. The conventional alternative will defer most of the upfront cost, but is significantly more expensive on a life-cycle basis.

Table 7 – Sanitary Wastewater Infrastructure Renewal Investment Plan

Wastewater - Sanitary - Conventional								
		Total Replacement Cost:			$ 41,562,119			
		Proportion RC for Capacity Needs:			0.20%			
Year	RSL Renewal Needs ($)	Capacity Renewal Needs ($)	Total Capital Renewal Needs ($)	Capital Renewal Allocations ($)	Financial Gap ($)	Additional Funding to Balance ($)	Surplus/Deficit ($)	Reserve Balance ($)
2016	1,291,930	83,124	1,375,054	110,000	(1,265,054)	780,000	(485,054)	(485,054)
2017		84,787	84,787	112,200	27,413	795,600	823,013	337,959
2018		86,482	86,482	114,444	27,962	811,512	839,474	1,177,432
2019		88,212	88,212	116,733	28,521	827,742	856,263	2,033,695
2020		89,976	89,976	119,068	29,091	844,297	873,388	2,907,084
2021		91,776	91,776	121,449	29,673	861,183	890,856	3,797,940
2022		93,611	93,611	123,878	30,266	878,407	908,673	4,706,613
2023		95,484	95,484	126,355	30,872	895,975	926,847	5,633,459
2024		97,393	97,393	128,883	31,489	913,894	945,384	6,578,843
2025		99,341	99,341	131,460	32,119	932,172	964,291	7,543,134
2026	437,512	101,328	538,840	134,089	(404,750)	950,816	546,065	8,089,200
2027		103,355	103,355	136,771	33,417	969,832	1,003,249	9,092,448
2028		105,422	105,422	139,507	34,085	989,229	1,023,314	10,115,762
2029		107,530	107,530	142,297	34,767	1,009,013	1,043,780	11,159,542
2030	17,146	109,681	126,827	145,143	18,316	1,029,193	1,047,509	12,207,051
2031	5,295,515	111,874	5,407,389	148,046	(5,259,343)	1,049,777	(4,209,566)	7,997,485
2032	338,117	114,112	452,229	151,006	(301,223)	1,070,773	769,550	8,767,035
2033	6,060,933	116,394	6,177,327	154,027	(6,023,301)	1,092,188	(4,931,112)	3,835,923
2034	121,935	118,722	240,657	157,107	(83,550)	1,114,032	1,030,482	4,866,405
2035	848,897	121,096	969,994	160,249	(809,744)	1,136,313	326,568	5,192,973
2036		123,518	123,518	163,454	39,936	1,159,039	1,198,975	6,391,948
2037		125,989	125,989	166,723	40,735	1,182,220	1,222,954	7,614,902
2038		128,508	128,508	170,058	41,549	1,205,864	1,247,414	8,862,316
2039		131,079	131,079	173,459	42,380	1,229,981	1,272,362	10,134,678
2040	440,586	133,700	574,286	176,928	(397,358)	1,254,581	857,223	10,991,901
2041	-	136,374	136,374	180,467	44,093	1,279,673	1,323,765	12,315,666
2042		139,102	139,102	184,076	44,974	1,305,266	1,350,241	13,665,906
2043		141,884	141,884	187,758	45,874	1,331,371	1,377,245	15,043,152
2044		144,721	144,721	191,513	46,791	1,357,999	1,404,790	16,447,942
2045		147,616	147,616	195,343	47,727	1,385,159	1,432,886	17,880,828
2046	11,857,047	150,568	12,007,615	199,250	(11,808,365)	1,412,862	(10,395,503)	7,485,325
2047	3,224,649	153,579	3,378,228	203,235	(3,174,993)	1,441,119	(1,733,874)	5,751,451
2048	3,201,883	156,651	3,358,534	207,299	(3,151,235)	1,469,942	(1,681,293)	4,070,158
2049	16,387,239	159,784	16,547,023	211,445	(16,335,578)	1,499,340	(14,836,237)	(10,766,080)
2050	352,291	162,980	515,270	215,674	(299,596)	1,529,327	1,229,731	(9,536,348)
2051		166,239	166,239	219,988	53,749	1,559,914	1,613,662	(7,922,686)
2052		169,564	169,564	224,388	54,824	1,591,112	1,645,936	(6,276,750)
2053	229,795	172,955	402,750	228,875	(173,875)	1,622,934	1,449,060	(4,827,691)
2054	467,651	176,414	644,065	233,453	(410,613)	1,655,393	1,244,780	(3,582,910)
2055		179,943	179,943	238,122	58,179	1,688,501	1,746,680	(1,836,230)
2056		183,542	183,542	242,884	59,343	1,722,271	1,781,614	(54,616)
TOTAL	50,573,126	5,204,410			(48,890,434)			

Figure 4 – Sanitary Infrastructure Renewal Investment Plan – Conventional Renewal Practice

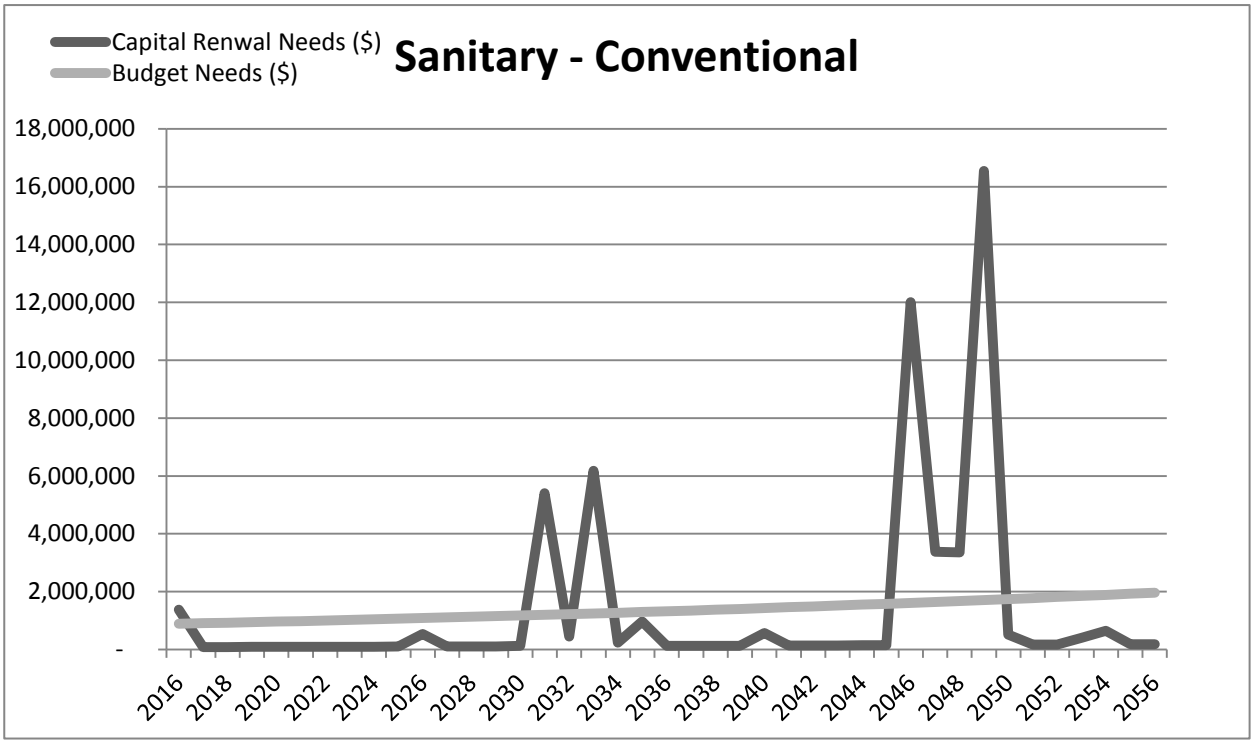
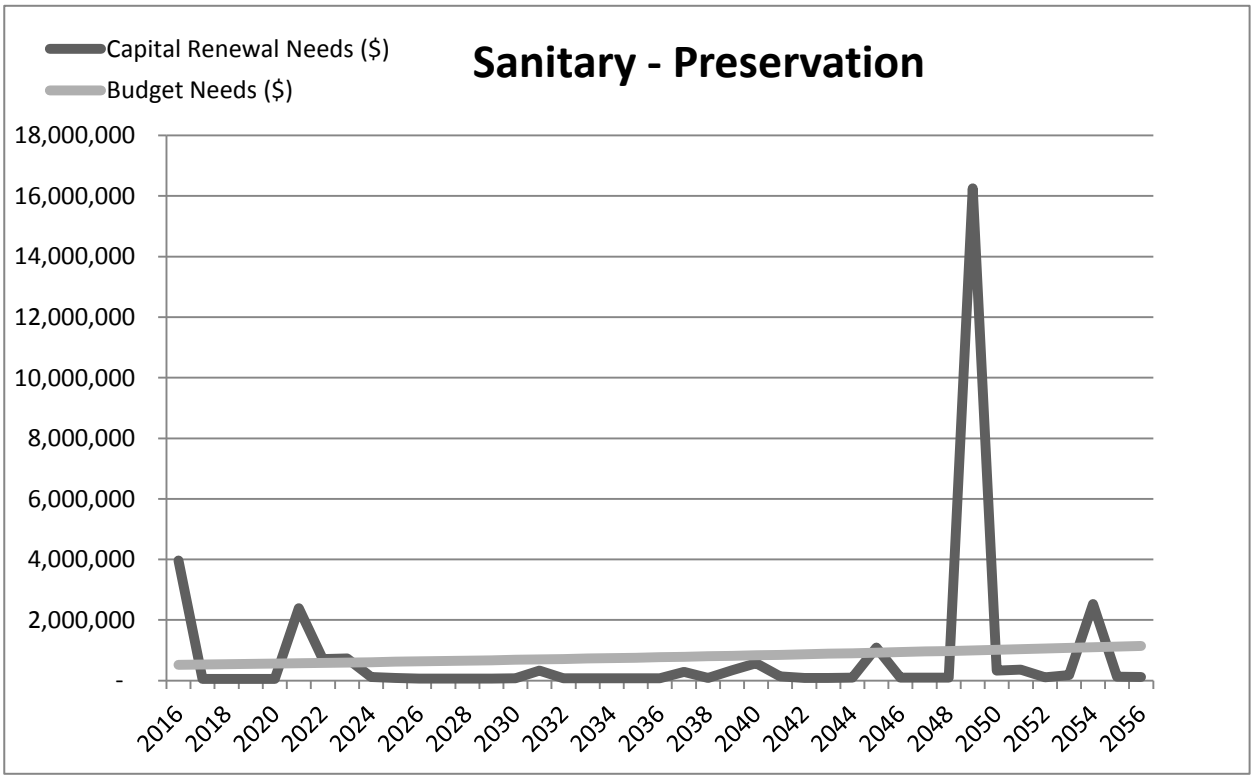


Figure 5 – Sanitary Infrastructure Renewal Investment Plan – Preservation Enhanced Renewal Practice



Storm Wastewater Systems

Table 8 presents the Stormwater Infrastructure Renewal Investment Plan. The Storm Water asset group has no backlog. This is attributed to the fact that the theoretical service life for the majority of the piping system is expected around year 2045 to 2052.

It is highlighted that the current day funding level is approximately $0.02 Million/year. In order to match forecast expenditure needs of the infrastructure life-cycle, an additional $0.80 Million/year is required to sustain the infrastructure assets in accordance with conventional replacement practices

Table 8 – Storm Wastewater Infrastructure Renewal Investment Plan

Wastewater - Storm - Conventional								
		Total Replacement Cost:			$ 30,951,976			
		Proportion RC for Capacity Needs:			0.05%			
Year	RSL Renewal Needs ($)	Capacity Renewal Needs ($)	Total Capital Renewal Needs ($)	Capital Renewal Budget Allocations ($)	Financial Gap ($)	Additional Capital Renewal Funding to Balance ($)	Surplus/Deficit ($)	Reserve Balance ($)
2016		15,476	15,476	20,000	4,524	800,000	804,524	804,524
2017		15,786	15,786	20,400	4,614	816,000	820,614	1,625,139
2018		16,101	16,101	20,808	4,707	832,320	837,027	2,462,165
2019		16,423	16,423	21,224	4,801	848,966	853,767	3,315,933
2020		16,752	16,752	21,649	4,897	865,946	870,843	4,186,775
2021		17,087	17,087	22,082	4,995	883,265	888,260	5,075,035
2022		17,428	17,428	22,523	5,095	900,930	906,025	5,981,059
2023		17,777	17,777	22,974	5,197	918,949	924,145	6,905,205
2024		18,133	18,133	23,433	5,301	937,328	942,628	7,847,833
2025		18,495	18,495	23,902	5,407	956,074	961,481	8,809,313
2026		18,865	18,865	24,380	5,515	975,196	980,710	9,790,024
2027		19,242	19,242	24,867	5,625	994,699	1,000,324	10,790,348
2028		19,627	19,627	25,365	5,738	1,014,593	1,020,331	11,810,679
2029		20,020	20,020	25,872	5,852	1,034,885	1,040,738	12,851,417
2030		20,420	20,420	26,390	5,969	1,055,583	1,061,552	13,912,969
2031		20,829	20,829	26,917	6,089	1,076,695	1,082,783	14,995,753
2032	7,829	21,245	29,074	27,456	(1,618)	1,098,229	1,096,610	16,092,363
2033		21,670	21,670	28,005	6,335	1,120,193	1,126,528	17,218,891
2034		22,104	22,104	28,565	6,461	1,142,597	1,149,058	18,367,949
2035		22,546	22,546	29,136	6,591	1,165,449	1,172,040	19,539,989
2036		22,997	22,997	29,719	6,722	1,188,758	1,195,480	20,735,469
2037		23,456	23,456	30,313	6,857	1,212,533	1,219,390	21,954,859
2038		23,926	23,926	30,920	6,994	1,236,784	1,243,778	23,198,637
2039		24,404	24,404	31,538	7,134	1,261,519	1,268,653	24,467,290
2040		24,892	24,892	32,169	7,277	1,286,750	1,294,026	25,761,316
2041		25,390	25,390	32,812	7,422	1,312,485	1,319,907	27,081,223
2042		25,898	25,898	33,468	7,571	1,338,734	1,346,305	28,427,528
2043		26,416	26,416	34,138	7,722	1,365,509	1,373,231	29,800,759
2044		26,944	26,944	34,820	7,876	1,392,819	1,400,696	31,201,455
2045	5,012,996	27,483	5,040,479	35,517	(5,004,962)	1,420,676	(3,584,286)	27,617,169
2046		28,033	28,033	36,227	8,195	1,449,089	1,457,284	29,074,453
2047		28,593	28,593	36,952	8,359	1,478,071	1,486,430	30,560,882
2048		29,165	29,165	37,691	8,526	1,507,632	1,516,158	32,077,041
2049	5,326,840	29,748	5,356,588	38,445	(5,318,144)	1,537,785	(3,780,359)	28,296,682
2050	24,879,506	30,343	24,909,850	39,214	(24,870,636)	1,568,541	(23,302,095)	4,994,586
2051		30,950	30,950	39,998	9,048	1,599,912	1,608,959	6,603,546
2052	14,398,059	31,569	14,429,628	40,798	(14,388,830)	1,631,910	(12,756,920)	(6,153,375)
2053		32,201	32,201	41,614	9,413	1,664,548	1,673,961	(4,479,414)
2054		32,845	32,845	42,446	9,601	1,697,839	1,707,440	(2,771,973)
2055	263,786	33,502	297,287	43,295	(253,992)	1,731,796	1,477,803	(1,294,170)
2056		34,172	34,172	44,161	9,989	1,766,432	1,776,421	482,251
TOTAL	49,889,016	968,952			(49,605,767)			

Figure 6 illustrates the Storm Water Infrastructure Renewal Investment Plan for the above table. The Storm Water asset group is another area which preservation maintenance technology is becoming cost effective practice, similar to Sanitary asset group.

With the application of preservation enhanced alternative, there is strong indication the additional expenditure needs may be reduced from $0.80 Million per year to $0.19 Million/year, a savings of $0.61 Million/'year. This corresponding expenditure needs over time is illustrated in Figure 7, which provides a comparison between conventional renewal practices and potential preservation enhanced methods.

Even though the application of the preservation enhanced alternative requires a proactive approach, the upfront costs are negligible until the year 2020. Even though the preservation maintenance costs are applied sooner than conventional maintenance, the overall life-cycle costs are significantly less.

Figure 6 – Storm Water Infrastructure Renewal Investment Plan – Conventional Renewal Practice

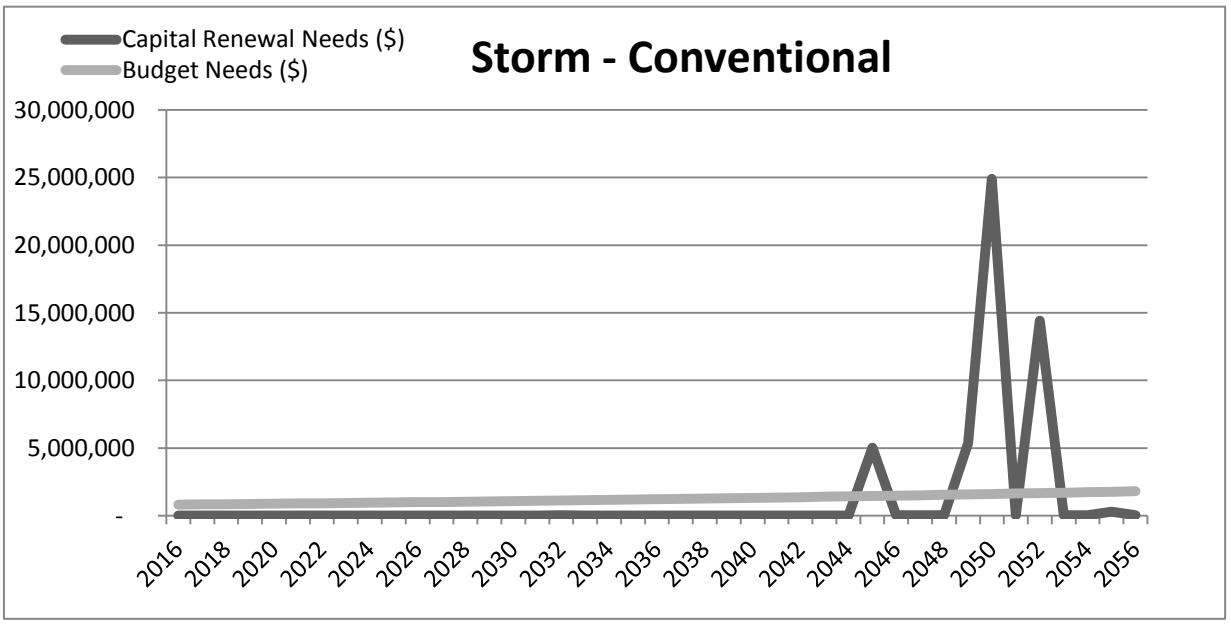
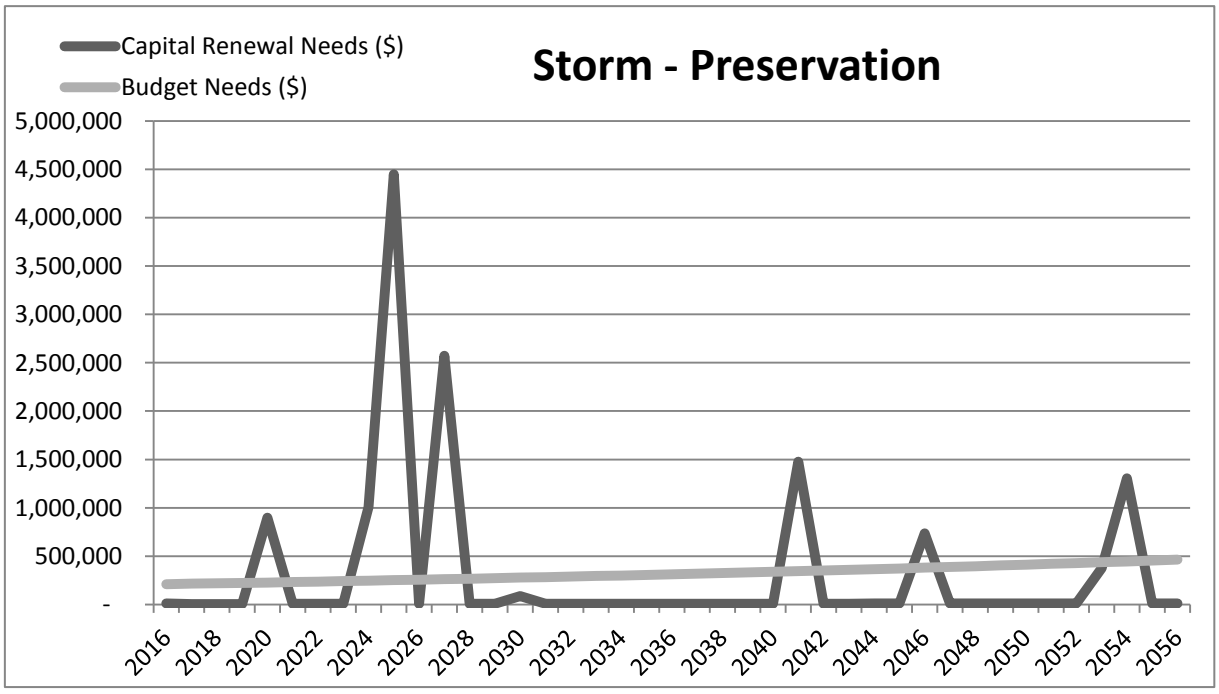


Figure 7 – Storm Water Infrastructure Renewal Investment Plan – Preservation Enhanced Renewal Practice



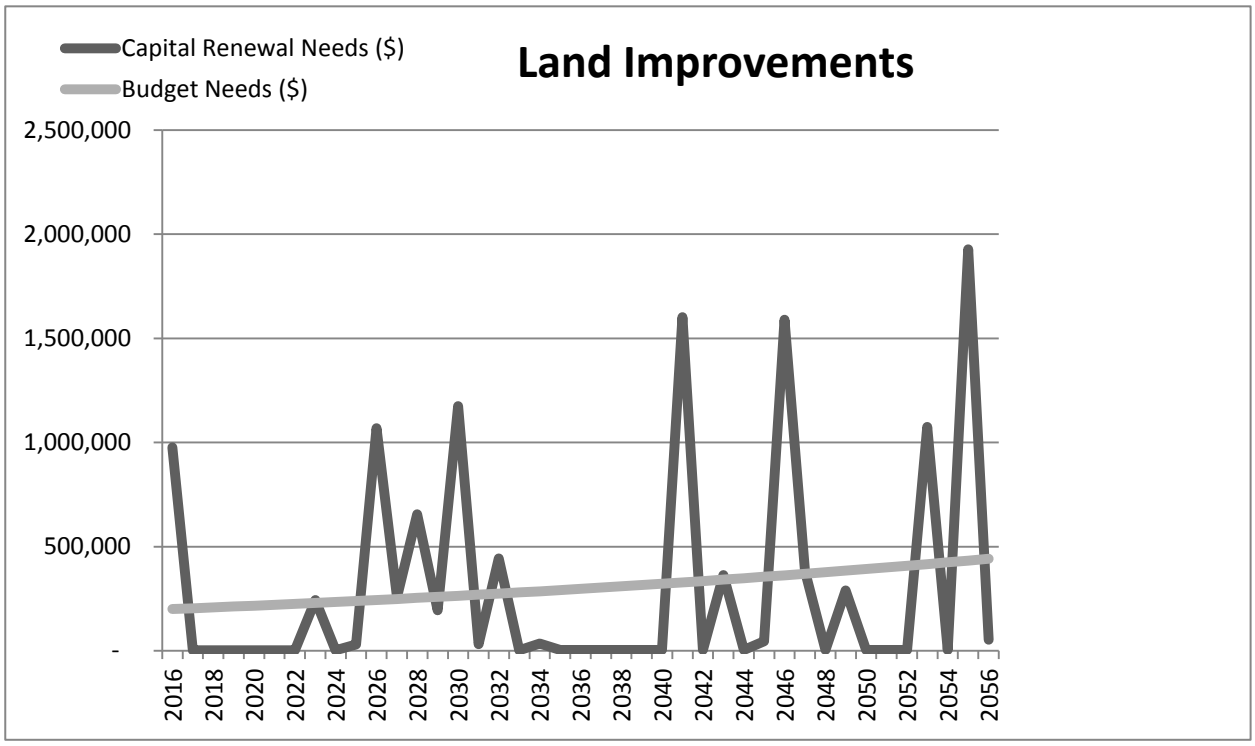
Land Improvements

Table 9 and Figure 8 present the Land Improvements Infrastructure Renewal Investment Plan. It is highlighted that the current day funding level is approximately $0.11 Million/year. In order to match forecast expenditure needs of the infrastructure life-cycle, an additional $0.09 Million/year is required to sustain the infrastructure assets in accordance with conventional replacement practices. The backlog of $0.97 Million is primarily related to parking lot rehabilitation needs.

Table 9 – Land Improvement Infrastructure Renewal Investment Plan

Land Improvements								
		Total Replacement Cost:			$ 4,203,202			
		Proportion RC for Capacity Needs:			0.05%			
Year	RSL Renewal Needs ($)	Capacity Renewal Needs ($)	Total Capital Renewal Needs ($)	Capital Renewal Budget Allocation ($)	Financial Gap ($)	Additional Funding to Balance ($)	Surplus/Deficit ($)	Reserve Balance ($)
2016	973,886	2,102	975,988	110,000	(865,988)	90,000	(775,988)	(775,988)
2017		2,144	2,144	112,200	110,056	91,800	201,856	(574,131)
2018		2,187	2,187	114,444	112,257	93,636	205,893	(368,238)
2019		2,230	2,230	116,733	114,503	95,509	210,011	(158,226)
2020		2,275	2,275	119,068	116,793	97,419	214,212	55,985
2021		2,320	2,320	121,449	119,129	99,367	218,496	274,481
2022		2,367	2,367	123,878	121,511	101,355	222,866	497,347
2023	241,712	2,414	244,126	126,355	(117,771)	103,382	(14,389)	482,958
2024		2,462	2,462	128,883	126,420	105,449	231,870	714,827
2025	27,431	2,512	29,943	131,460	101,518	107,558	209,076	923,903
2026	1,066,669	2,562	1,069,231	134,089	(935,141)	109,709	(825,432)	98,471
2027	254,589	2,613	257,202	136,771	(120,431)	111,904	(8,527)	89,944
2028	652,248	2,665	654,913	139,507	(515,406)	114,142	(401,265)	(311,320)
2029	192,287	2,719	195,006	142,297	(52,709)	116,425	63,716	(247,605)
2030	1,172,085	2,773	1,174,858	145,143	(1,029,716)	118,753	(910,963)	(1,158,568)
2031	29,153	2,828	31,981	148,046	116,064	121,128	237,192	(921,375)
2032	440,655	2,885	443,540	151,006	(292,534)	123,551	(168,983)	(1,090,358)
2033		2,943	2,943	154,027	151,084	126,022	277,106	(813,253)
2034	31,787	3,002	34,789	157,107	122,318	128,542	250,861	(562,392)
2035		3,062	3,062	160,249	157,188	131,113	288,301	(274,092)
2036		3,123	3,123	163,454	160,331	133,735	294,067	19,975
2037		3,185	3,185	166,723	163,538	136,410	299,948	319,923
2038		3,249	3,249	170,058	166,809	139,138	305,947	625,870
2039		3,314	3,314	173,459	170,145	141,921	312,066	937,936
2040		3,380	3,380	176,928	173,548	144,759	318,307	1,256,243
2041	1,597,763	3,448	1,601,211	180,467	(1,420,745)	147,655	(1,273,090)	(16,847)
2042		3,517	3,517	184,076	180,559	150,608	331,167	314,320
2043	359,172	3,587	362,759	187,758	(175,001)	153,620	(21,382)	292,938
2044		3,659	3,659	191,513	187,854	156,692	344,546	637,484
2045	40,761	3,732	44,493	195,343	150,850	159,826	310,676	948,160
2046	1,585,014	3,807	1,588,821	199,250	(1,389,571)	163,023	(1,226,548)	(278,389)
2047	378,305	3,883	382,188	203,235	(178,953)	166,283	(12,670)	(291,059)
2048		3,961	3,961	207,299	203,339	169,609	372,948	81,888
2049	285,728	4,040	289,768	211,445	(78,323)	173,001	94,678	176,566
2050		4,121	4,121	215,674	211,554	176,461	388,015	564,581
2051		4,203	4,203	219,988	215,785	179,990	395,775	960,356
2052		4,287	4,287	224,388	220,101	183,590	403,690	1,364,046
2053	1,070,081	4,373	1,074,454	228,875	(845,579)	187,262	(658,317)	705,729
2054		4,460	4,460	233,453	228,993	191,007	420,000	1,125,729
2055	1,922,930	4,549	1,927,480	238,122	(1,689,358)	194,827	(1,494,531)	(368,802)
2056	47,828	4,640	52,469	242,884	190,416	198,724	389,139	20,337
TOTAL	12,370,086	131,581			(5,614,565)			

Figure 8 – Land Improvements Infrastructure Renewal Investment Plan



Buildings

Table 10 and Figure 9 present the Buildings Infrastructure Renewal Investment Plan. It is highlighted that the current day funding level is approximately $1.05 Million/year. In order to match forecast expenditure needs of the infrastructure life-cycle, an additional $0.68 Million/year is required to sustain the infrastructure assets in accordance with conventional replacement practices. The backlog of $8.59 Million includes one building structure (i.e. River Runner), but primarily consists of internal building components and systems.

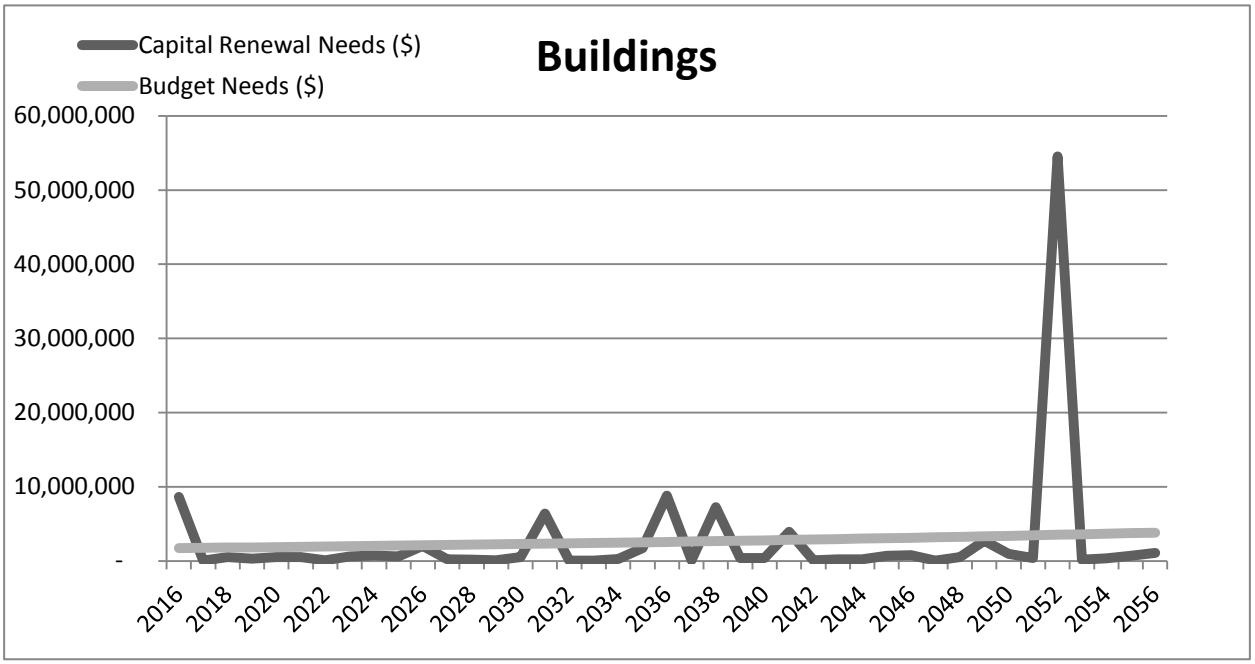
Building renewal investment calculations have the potential to create overlap, particularly concerning aging structures. Individual systems, such as roofing or heating systems, will require significant maintenance or replacement investments several times of the economic service life of a typical building structure. While individual systems are revamped or completely replaced, such system replacement does not eliminate the requirement to ultimately replace the entire building, and all the systems contained therein, even when such systems might be relatively new. Complete building replacement, however, has the effect of resetting the economic age of each sub-system to zero, and resets the investment clock on those systems. Building investment decisions can therefore become considerably more complex. Such complexity will often lead to a decision to do nothing, as the building placement versus sub-system replacement approach is often defereed and delayed. The “do-nothing” approach, however, will lead to accelerated deterioration of the building and sub-system assets.

Jasper’s internal operations personnel have developed an extensive preservation enhancing list to address sustaining the facilities. The approach is not based on life-cycle optimization methodology, as would commonly apply for roadways and piping systems. However, the approach used is expert based, and very much appropriate for the Buildings asset group.

Table 10 – Buildings Infrastructure Renewal Investment Plan

Buildings								
		Total Replacement Cost:			$ 75,353,568			
		Proportion RC for Capacity Needs:			0.05%			
Year	RSL Renewal Needs ($)	Capacity Renewal Needs ($)	Total Capital Renewal Needs ($)	Capital Renewal Budget Allocations ($)	Financial Gap ($)	Additional Capital Renewal Funding to Balance ($)	Surplus/Deficit ($)	Reserve Balance ($)
2016	8,593,173	37,677	8,630,850	1,050,000	(7,580,850)	680,000	(6,900,850)	(6,900,850)
2017	5,100	38,430	43,530	1,071,000	1,027,470	693,600	1,721,070	(5,179,781)
2018	476,805	39,199	516,004	1,092,420	576,416	707,472	1,283,888	(3,895,892)
2019	251,156	39,983	291,139	1,114,268	823,130	721,621	1,544,751	(2,351,141)
2020	500,058	40,783	540,840	1,136,554	595,713	736,054	1,331,767	(1,019,374)
2021	492,420	41,598	534,018	1,159,285	625,267	750,775	1,376,042	356,667
2022	31,533	42,430	73,963	1,182,471	1,108,508	765,790	1,874,298	2,230,966
2023	545,626	43,279	588,904	1,206,120	617,215	781,106	1,398,322	3,629,287
2024	691,865	44,144	736,009	1,230,242	494,233	796,728	1,290,962	4,920,249
2025	564,758	45,027	609,785	1,254,847	645,062	812,663	1,457,725	6,377,974
2026	2,000,674	45,928	2,046,602	1,279,944	(766,658)	828,916	62,258	6,440,232
2027	172,829	46,846	219,675	1,305,543	1,085,868	845,495	1,931,362	8,371,594
2028	144,580	47,783	192,363	1,331,654	1,139,291	862,404	2,001,695	10,373,290
2029	53,920	48,739	102,659	1,358,287	1,255,628	879,653	2,135,281	12,508,571
2030	452,864	49,714	502,578	1,385,453	882,875	897,246	1,780,120	14,288,691
2031	6,324,235	50,708	6,374,943	1,413,162	(4,961,782)	915,190	(4,046,591)	10,242,100
2032	15,101	51,722	66,823	1,441,425	1,374,602	933,494	2,308,096	12,550,196
2033	14,002	52,757	66,759	1,470,253	1,403,494	952,164	2,355,659	14,905,855
2034	194,241	53,812	248,053	1,499,659	1,251,605	971,207	2,222,813	17,128,668
2035	1,668,558	54,888	1,723,446	1,529,652	(193,795)	990,632	796,837	17,925,505
2036	8,734,836	55,986	8,790,822	1,560,245	(7,230,577)	1,010,444	(6,220,133)	11,705,372
2037	22,735	57,105	79,840	1,591,450	1,511,609	1,030,653	2,542,262	14,247,634
2038	7,176,438	58,248	7,234,685	1,623,279	(5,611,407)	1,051,266	(4,560,140)	9,687,494
2039	341,824	59,412	401,237	1,655,744	1,254,508	1,072,291	2,326,799	12,014,293
2040	317,348	60,601	377,949	1,688,859	1,310,910	1,093,737	2,404,648	14,418,940
2041	3,869,359	61,813	3,931,172	1,722,636	(2,208,536)	1,115,612	(1,092,924)	13,326,017
2042	21,754	63,049	84,803	1,757,089	1,672,286	1,137,924	2,810,210	16,136,227
2043	170,689	64,310	234,999	1,792,231	1,557,232	1,160,683	2,717,915	18,854,142
2044	166,786	65,596	232,382	1,828,075	1,595,693	1,183,896	2,779,589	21,633,731
2045	613,993	66,908	680,902	1,864,637	1,183,735	1,207,574	2,391,310	24,025,041
2046	731,790	68,246	800,036	1,901,930	1,101,893	1,231,726	2,333,619	26,358,660
2047		69,611	69,611	1,939,968	1,870,357	1,256,360	3,126,717	29,485,377
2048	442,867	71,003	513,870	1,978,768	1,464,897	1,281,488	2,746,385	32,231,762
2049	2,630,809	72,423	2,703,232	2,018,343	(684,889)	1,307,117	622,228	32,853,990
2050	862,083	73,872	935,955	2,058,710	1,122,755	1,333,260	2,456,014	35,310,005
2051	313,727	75,349	389,077	2,099,884	1,710,807	1,359,925	3,070,732	38,380,737
2052	54,454,793	76,856	54,531,649	2,141,882	(52,389,767)	1,387,123	(51,002,644)	(12,621,907)
2053	112,357	78,394	190,751	2,184,719	1,993,969	1,414,866	3,408,835	(9,213,072)
2054	288,633	79,961	368,594	2,228,414	1,859,820	1,443,163	3,302,983	(5,910,090)
2055	620,599	81,561	702,160	2,272,982	1,570,822	1,472,026	3,042,849	(2,867,241)
2056	993,618	83,192	1,076,810	2,318,442	1,241,632	1,501,467	2,743,099	(124,142)
TOTAL	106,080,537	2,358,944			(42,698,957)			

Figure 9 – Buildings Infrastructure Renewal Investment Plan



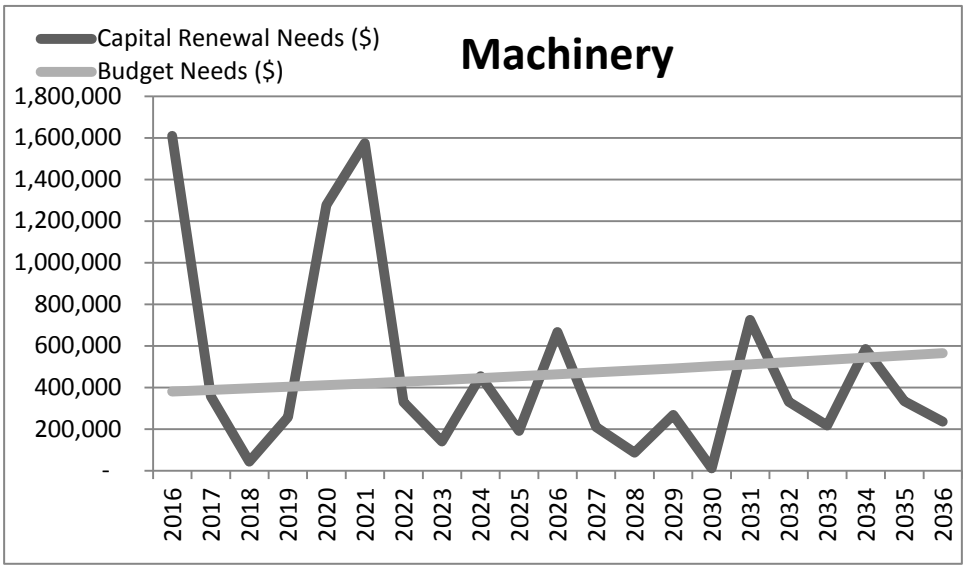
Machinery

Table 11 and Figure 10 present the Machinery Infrastructure Renewal Investment Plan. It is highlighted that the current day funding level is approximately $0.18 Million/year. In order to match forecast expenditure needs of the infrastructure life-cycle, an additional $0.20 Million/year is required to sustain the infrastructure assets in accordance with conventional replacement practices. The backlog of $1.61 Million is relatively significant for the size of the asset group.

Table 11 – Machinery Infrastructure Renewal Investment Plan

Machinery and Equipment								
		Total Replacement Cost:			$ 4,991,785			
		Proportion RC for Capacity Needs:			0.05%			
Year	RSL Renewal Needs ($)	Capacity Renewal Needs ($)	Total Capital Renewal Needs ($)	Capital Renewal Budget Allocations ($)	Financial Gap ($)	Additional Capital Renewal Funding to Balance ($)	Surplus/Deficit ($)	Reserve Balance ($)
2016	1,607,408	2,496	1,609,904	180,000	(1,429,904)	200,000	(1,229,904)	(1,229,904)
2017	354,227	2,546	356,773	183,600	(173,173)	204,000	30,827	(1,199,077)
2018	41,184	2,597	43,780	187,272	143,492	208,080	351,572	(847,505)
2019	254,218	2,649	256,866	191,017	(65,849)	212,242	146,393	(701,112)
2020	1,274,079	2,702	1,276,781	194,838	(1,081,943)	216,486	(865,457)	(1,566,569)
2021	1,571,016	2,756	1,573,772	198,735	(1,375,037)	220,816	(1,154,221)	(2,720,790)
2022	326,551	2,811	329,362	202,709	(126,653)	225,232	98,579	(2,622,211)
2023	137,030	2,867	139,897	206,763	66,867	229,737	296,604	(2,325,606)
2024	450,554	2,924	453,479	210,899	(242,580)	234,332	(8,248)	(2,333,855)
2025	188,847	2,983	191,830	215,117	23,287	239,019	262,305	(2,071,550)
2026	663,071	3,042	666,113	219,419	(446,694)	243,799	(202,895)	(2,274,445)
2027	207,340	3,103	210,443	223,807	13,364	248,675	262,039	(2,012,406)
2028	83,281	3,165	86,447	228,284	141,837	253,648	395,485	(1,616,921)
2029	264,904	3,229	268,133	232,849	(35,284)	258,721	223,438	(1,393,484)
2030	7,430	3,293	10,723	237,506	226,783	263,896	490,679	(902,805)
2031	721,200	3,359	724,559	242,256	(482,302)	269,174	(213,129)	(1,115,933)
2032	327,155	3,426	330,581	247,101	(83,480)	274,557	191,077	(924,856)
2033	213,406	3,495	216,901	252,043	35,142	280,048	315,191	(609,666)
2034	581,841	3,565	585,406	257,084	(328,322)	285,649	(42,673)	(652,338)
2035	330,713	3,636	334,349	262,226	(72,123)	291,362	219,239	(433,099)
2036	231,957	3,709	235,666	267,471	31,805	297,189	328,994	(104,104)
TOTAL	9,837,413	64,352			(5,260,768)			

Figure 10 – Machinery Infrastructure Renewal Investment Plan



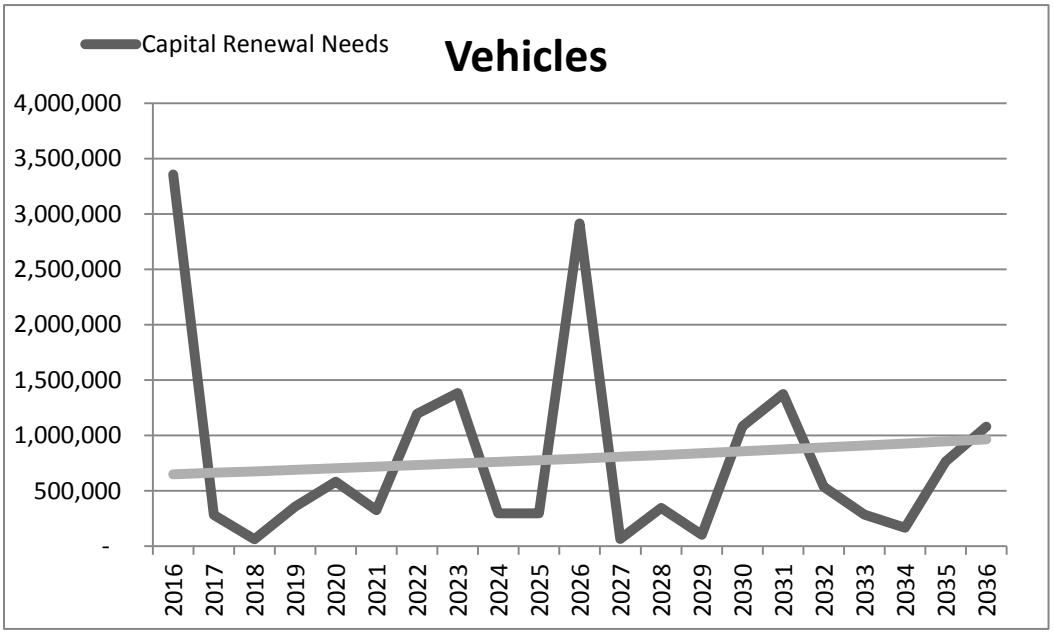
Vehicles

Table 12 and Figure 11 present the Machinery Infrastructure Renewal Investment Plan. It is highlighted that the current day funding level is approximately $0.05 Million/year. In order to match forecast expenditure needs of the infrastructure life-cycle, an additional $0.60 Million/year is required to sustain the infrastructure assets in accordance with conventional replacement practices. The backlog of $3.35 Million is significant for the size of the asset group.

Table 12 – Vehicles Infrastructure Renewal Investment Plan

Vehicles								
		Total Replacement Cost:			$ 8,918,308			
		Proportion RC for Capacity Needs:			0.05%			
Year	RSL Renewal Needs ($)	Capacity Renewal Needs ($)	Total Capital Renewal Needs ($)	Capital Renewal Budget Allocations ($)	Financial Gap ($)	Additional Capital Renewal Funding to Balance ($)	Surplus/Deficit ($)	Reserve Balance ($)
2016	3,352,324	4,459	3,356,783	50,000	(3,306,783)	600,000	(2,706,783)	(2,706,783)
2017	277,709	4,548	282,257	51,000	(231,257)	612,000	380,743	(2,326,040)
2018	56,861	4,639	61,500	52,020	(9,480)	624,240	614,760	(1,711,280)
2019	352,267	4,732	356,999	53,060	(303,939)	636,725	332,786	(1,378,494)
2020	578,900	4,827	583,727	54,122	(529,606)	649,459	119,854	(1,258,640)
2021	322,255	4,923	327,179	55,204	(271,975)	662,448	390,474	(868,167)
2022	1,190,556	5,022	1,195,577	56,308	(1,139,269)	675,697	(463,572)	(1,331,739)
2023	1,378,423	5,122	1,383,545	57,434	(1,326,111)	689,211	(636,899)	(1,968,638)
2024	290,842	5,225	296,066	58,583	(237,483)	702,996	465,512	(1,503,125)
2025	292,795	5,329	298,124	59,755	(238,370)	717,056	478,686	(1,024,440)
2026	2,910,744	5,436	2,916,180	60,950	(2,855,230)	731,397	(2,123,834)	(3,148,273)
2027	58,766	5,544	64,310	62,169	(2,142)	746,025	743,883	(2,404,390)
2028	340,301	5,655	345,957	63,412	(282,544)	760,945	478,401	(1,925,990)
2029	97,020	5,768	102,789	64,680	(38,109)	776,164	738,055	(1,187,934)
2030	1,078,278	5,884	1,084,162	65,974	(1,018,188)	791,687	(226,501)	(1,414,435)
2031	1,368,075	6,001	1,374,077	67,293	(1,306,783)	807,521	(499,262)	(1,913,697)
2032	531,560	6,121	537,682	68,639	(469,043)	823,671	354,629	(1,559,068)
2033	280,048	6,244	286,292	70,012	(216,280)	840,145	623,865	(935,204)
2034	160,363	6,369	166,732	71,412	(95,320)	856,948	761,628	(173,575)
2035	757,694	6,496	764,190	72,841	(691,350)	874,087	182,737	9,161
2036	1,072,671	6,626	1,079,297	74,297	(1,005,000)	891,568	(113,431)	(104,270)
TOTAL	16,748,454	114,972			(15,574,260)			

Figure 11 – Vehicles Infrastructure Renewal Investment Plan



3.3 Long Range Funding Plan

The infrastructure renewal investment plans for each of the asset groups are compiled and summarized in Table 13.

Table 13 – Long Range Funding Plan - 2016

			Conventional		Preservation Enhanced	
Asset Group	Replacement Cost ($M)	Current Budget Allocation ($M/yr)	Backlog ($M)	Capital Renewal Needs ($M/yr)	Backlog ($M)	Capital Renewal Needs ($M/yr)
Roadways	57.10	0.71	4.07	1.41	4.52	1.22
Water	45.70	0.31	6.25	0.94	6.25	0.94
Sanitary	41.60	0.11	1.29	0.89	3.90	0.52
Storm Water	31.00	0.02	-	0.82	0.01	0.21
Land improvements	4.20	0.11	0.97	0.20	0.97	0.20
Buildings	75.40	1.05	8.59	1.73	8.59	1.73
Machinery	5.00	0.18	1.61	0.38	1.61	0.38
Vehicles	8.90	0.05	3.35	0.65	3.35	0.65
TOTAL	**268.90**	**2.54**	**26.13**	**7.02**	**29.20**	**5.85**

Note * Shaded cells indicate preservation enhancements not currently explored in these asset groups

The funding plan is based on current day dollar value and assumes 2 percent annual escalation for all groups. The plan includes two scenarios. The first scenario is conventional replacement or renewal of infrastructure at the end of its service life. The second scenario takes a preliminary look at the providing mid-life preservation enhancement treatments that will extend the infrastructure service life. These practices are typically applied to through optimization modeling to the engineering assets major infrastructure groups (i.e. roadways, pipelines, etc.). The

application can be made to the other infrastructure groups as well, but is not typically practiced today as part of a clearly defined strategy. Given the preservation enhanced solution will save a minimum of $1.17 Million/year (i.e. 7.02 - 5.85), it is assumed this is the preferred alternative in deriving the long-term funding needs.

The total infrastructure renewal budget allocation is approximately $2.54 Million/year. The capital renewal needs is $5.85 Million/year. This is an increase of $3.31 Million/year (130%). This includes addressing the current backlog of $29.2 Million.

It is recognized that doubling the annual funding allocation to infrastructure renewal is not realistic under any municipal funding model; especially given the limited propensity for tax increases. With the financial challenges currently faced by higher level governments (i.e. Provincial and Federal), the probability of additional external revenues is slight.

Off-site levies, local improvement levies, increased user fees, and utility rates may be used in part to increase municipal revenues. However, they all tap into the same rate payer. A utility funded service should be designed on a user pay system for which the system is self sustaining and self balancing. There is merit to conducting a utility rate review that should include capital renewal within the rate structure. For recreation facilities, if they are currently underfunded, increasing associated user fees may be valid in making these facilities self-sustaining as well.

Table 14 illustrates current Municipality of Jasper budget revenues in comparison to additional capital renewal allocation needs. It is recognized there is overlap between the asset groups and the budget categories. However, this provides an indication of relative magnitude of service fee, utility rates, or property tax increases required to meet the capital renewal funding needs. The following additional funding needs are based on the Preservation Enhanced scenario.

Table 14 – Capital Renewal Funding Needs to Current Budget Revenue Comparisons

Asset Groups	Additional Funding Need ($ Million)	Budget Category	2015 Budget Revenues ($ Million)	Increase (%)
Roadways Machinery Vehicles	1.22-0.71 = 0.51 0.38-0.18 = 0.20 0.65-0.05 = 0.60 1.31	Municipal Taxes	6.84	16
Water Sanitary Wastewater Storm Wastewater	0.94-0.31 = 0.63 0.52-0.11 = 0.41 0.21-0.02 = 0.19 1.23	Utilities	3.17	28
Buildings Land Improvements	1.73-1.05 = 1.68 0.20-0.11 = 0.09 1.77	Culture and Recreation (i.e. user fees)	1.14	61

In order to meet the capital renewal needs, the indication is that property taxes may need to be increased by 16%, utility rates increased by 28%, and recreation user fees increased by 61%.

Recognizing a challenging funding issue, the following Moving Forward Strategy may be able to address some additional processes that may further reduce the funding needs and help to close the financial gap.

4. Moving Forward Strategy

From the above discussions on the additional capital renewal funding needs, it is recognized that reasonable increases in taxes, utility rates and user fees alone will not address the financial gap. This dilemma is not unique to the Municipality of Jasper. It is a national and international issue. For this reason, there is industry best practices developed through the National Research Council (NRC) and housed by the Federation of Canadian Municipalities (FCM) to help municipalities realistically address their own respective infrastructure deficits.

The following sections include a few areas the Municipality may wish to move forward that may improve overall infrastructure management practices that is proven to reduce the expenditure needs over the infrastructure life cycle.

4.1 Inventory and Maintenance Management

Appendix A contains the inventory and analysis data files. In those data sets contains information on each asset for each of the eight infrastructure groups. Contained in that information are the physical attributes, age, theoretical service life and replacement cost. Some of these assets are linked to the Municipality's Geographic Information System (GIS). This would include those in the Water, Sanitary Wastewater and Storm Wastewater asset groups. Each asset segment is tagged with a spatial identification number so information can be referenced through mapping media as well as tabular data sets.

Moving forward, it would be valuable for the Municipality to include the assets for all its asset groups, with the exception of vehicles and machinery. In addition, a maintenance management component should be added to the GIS attribute structure to include historic maintenance and renewal works. So after any work completed on any piece of infrastructure, the records show for that particular asset segment, what was done, when, the cost, and if the asset was renewed to a near new condition state. Reaching near new condition state occurs when the asset is replaced or undergoes a major rehabilitation.

More comprehensive maintenance management systems include also schedules for routine maintenance, etc. However, getting the inventory and record of the historic works would be a good first step. This can be also tied to housing condition data for Infrastructure optimization analysis.

4.2 Engineering Assets Infrastructure Life-Cycle Optimization

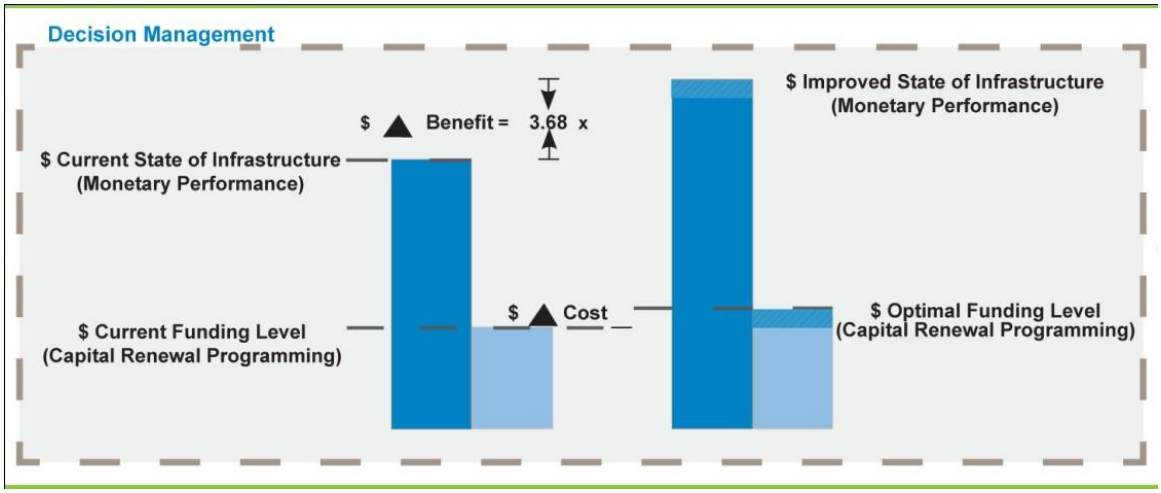
The practice of infrastructure life-cycle optimization is the heart and soul of asset management. It involves taking condition data for a network of infrastructure assets and modeling their deterioration over time through its respective life cycle. Throughout the infrastructure life-cycle, the model introduces of a variety of maintenance, mid-life preservation, and rehabilitation treatments. Various treatments have varying impact of renewal give the condition state. They have varying costs. Within each infrastructure segment, through its life-cycle, there could be thousands of possible combinations. The objective is to minimize costs through the life-cycle while providing infrastructure sustainability.

The practice of infrastructure life-cycle optimization analysis is generic to all infrastructure assets. In practice, the main infrastructure group is pavements. Pavement Management Systems were the origin of this methodology. Today, the practice is starting to evolve to sidewalks, water distribution and wastewater collection (i.e. sanitary and storm). For Jasper, this would primarily include the Engineering Assets group.

Fundamentally, there are two components to achieving this. The first involves conducting the condition assessment. This could be completed manually or through automated technologies. For the roadway network, the mobilization to bring in automated condition measuring services may be greater than having trained personnel manually measure the roadway distress ratings. For the wastewater pipes, sewer photography is the only means to capture the internal pipe distress measurement. Once the condition data is collected, it then has to be compiled to a "severity" and "extend' format for each of the condition distresses measured.

The second component is completing a life-cycle computer model. The first process is developing all the model parameters suited to the Municipality of Jasper. This includes deterioration probabilities and rates, threshold levels and triggers, unit costs, and treatment strategies. The model is calibrated to first emulate the existing status quo. Then the model is run testing a variety of treatment strategies over the infrastructure life cycle. At the end the recommended solution will be the strategy that minimizes costs over the infrastructure life cycle while working within available budget constraints. Limiting the budge limits can impact the optimal solution. However, the application is proven to return a rather significant return on infrastructure investment. Applied to the City of Prince Albert, the optimal solution realized a 368 percent return on infrastructure investment (ROII) over a five year period. Part of the modeling decision process revolves around valuation or monetary performance of the infrastructure asset. As example, if one invests an additional $ 1 in doing the right repair and the value of the infrastructure goes up by $3.68, that is a good decision. It means you have to spend less on your infrastructure assets later. This is equivalent to money in the bank, which has the potential to further reduce the financial gap illustrated above in the Long Range Funding Plan.

Figure 12 – Infrastructure Life-Cycle Modeling Decision Management – City of Prince Albert



Appendix B illustrates in more depth the infrastructure life-cycle optimization process. It revolves around a Pillar System's technology and process. Similar application was used in developing the Alberta State of the Infrastructure Report.

4.3 Fleet and Equipment Management

During the initial project phases of capturing the inventory and respective data, it was noticed the Municipality does not use a fleet management system or related methodology. The practice of fleet management can range from sophisticated fleet management systems, used commonly in larger municipalities to spreadsheet applications common to small and medium sized municipalities. The following illustrates some principals that Jasper may wish to apply to its Vehicles and Machinery asset groups. As these two groups appear to have the highest proportional backlog to value of assets, fleet management may provide a proactive approach to both timely replacement as well as developing unit rates that may in part be used to develop a revolving fund to self sustain the vehicles and machinery inventory. Fleet management works on the two principles of "Managing the Individual Units" and "Managing the Fleet as a Program".

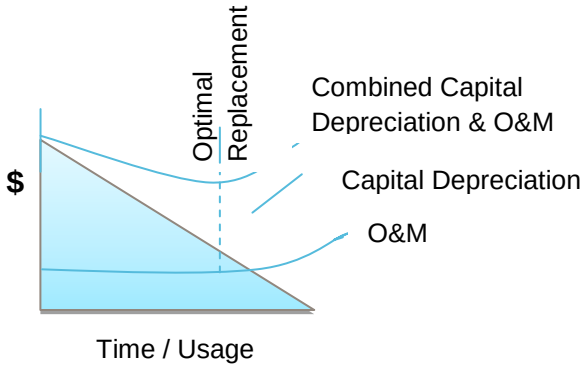
Managing the Individual Units

Each piece of equipment has two primary cost components as follows:

1. Capital cost depreciation. This is the annualized purchase cost over time (or usage) to the end of service life; for which there is a modest salvage value. The annualized cost is typically straight-line depreciated based on a pre-determined discount rate.
2. Operations and maintenance cost (O&M). Operations costs (i.e. fuel) are relatively constant through the equipment life; but can improve on replacement with new technology. The maintenance costs are typically quite minimal on new equipment; but can exponentially increase over time, depending on the make/brand of the equipment (i.e. Cat vs. Komatsu).

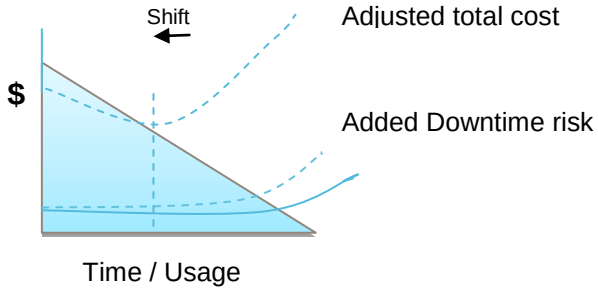
The strategy is to replace equipment at the time in the infrastructure life where the cumulative costs are a minimum. Most of the capital depreciation occurs in the early years of the equipment life. However, the O&M costs occur later in the equipment life. Therefore, there is typically a point in between where the total costs reach a minimum and begin rising again as the equipment gets older. Like other infrastructure, this too is the “sweet spot”. This is typically the target for equipment replacement, as illustrated in Figure 13.

Figure 13 - Fleet Management “Sweet Spot”



Further adding to the cost of the equipment is the downtime cost associated with risk of downtime. This risk is dependent on spare units and other time loss factors. As such, it increases the O&M costs and adds pressure for equipment replacement even sooner, as illustrated in Figure 14.

Figure 14 - Adjusted Fleet Management “Sweet Spot”



All of this information is used to determine the appropriate charge out rates for the unit. Excessive charge-out rates result in higher expenditures to the road which may defer road work. Under charge-out rates will result in a negative equipment reserve balance affecting unit replacement cycles.

The following was observed with respect to Jasper's current fleet management system:

- There was no record of O&M Costs for each unit
- There was no allowance for downtime (i.e. reliability) risk
- The term was always measured in years for all equipment types, when actual practice on many units is more reliably measured in hours
- There was no record of charge-out rates

Therefore, there is indication that the replacement cycles could be optimized and used to set the charge-out rates if historic fleet management records were maintained.

Managing the Fleet Program

Typical fleet management practices maintain the fleet systems as a self funding reserve by charging an hourly rate for the equipment to the management unit they are serving. This hourly rate becomes an expenditure to the specific operations or capital program and it also builds a credit in the equipment reserve. The overall reserve balance is used to fund equipment replacement. The reserve balance needs to be sufficient to meet the optimal equipment replacement cycles.

Based on the information available, it would appear equipment is not being operated on a revolving fund (i.e. self-funded reserve). There is no process in place to charge vehicles and machinery usage to where it is being used so its revolving fund can be credited for on-going O&M costs and timely capital replacement. The following will help the Municipality in moving forward with a relatively simple, but effective fleet management program.

- Track expenditures (depreciation, O&M, downtime risk) for each unit.
- Calculate charge-out rates for the individual units based on tracked and projected expenditures.
- Charge equipment to the program (i.e. Operations Roads, Operations Wastewater, etc) where it is used; and that the program receiving the equipment usage is realizing the credit back to the equipment reserve (i.e. revolving fund).
- Use the equipment reserve to manage the fleet as a self-sustaining entity.

Looking at the fleet system as a whole, this will identify whether the equipment reserve is balanced for the charge out rates; as such determines if unit rates should increase or decrease. On the individual equipment level, it will also determine the optimal timeline for equipment replacement; thereby addressing the excessive backlog that currently exists. In application, this will eliminate general fund needs to fund Machinery and Vehicle assets; as actual expenditures will be paid for via the revolving fund accumulation through usage. By managing and optimizing the fleet system, the overall program costs and capital renewal needs should decline over time.

4.4 Facilities Assets

In the buildings group, the Municipality currently does very comprehensive work identifying the maintenance and renewal needs, time-lines, and estimated expenditure for the individual facility components within each of its twenty facility structures.

In improving on this practice, any asset group can undertake formal condition assessments and life-cycle optimization modeling as discussed above. The Government of Alberta has performance measures and condition rating criteria applied to its facilities structures (i.e. schools, hospitals, post-secondary institutions, etc.). Pillar Systems optimization technology illustrated adaptability to those in the Alberta State of the Infrastructure Report. Applying infrastructure optimization methods is a little more comprehensive due to the numerous components. Application on that from may not be sought late after application to the more conventional asset groups (i.e. Roadways, Water, Sanitary, and Storm).

The current practice the Culture and Recreation Department is currently doing with its twenty facility structures is encouraged to continue. However, as there is more capital renewal needs than available funding, a common practice is to apply a risk assessment to each item. This is based on three risk components. The first is identifying the risk of deferred implementation. The second is to address the severity of the consequence. This is done through a severity rating (e.g. low, medium, high) and sometimes quantified monetary impact (e.g. $3 Million structural damages and liability risk due to failed roof repair). The third component is the probability of that occurrence. This can be addressed as a percent or probability rating (e.g. low, medium, high). Looking at the combined severity-probability of risk occurrence, this can be an instrumental component in capital renewal budget programming and priority-setting.

The current maintenance and renewal programming completed for the Culture and Recreational Facilities were not identified for Water Treatment Facilities and Wastewater Treatment Facilities. It would be prudent to include these other facilities in a similar manner.

4.5 Budget Programming

Based on Table 14 above, in order to address the capital renewal needs to attain infrastructure sustainability would require a 16% increase in municipal taxes, a 28% increase in utility rates, and a 61% increase in culture and recreational fees. These proportions are approximate and subject to some variation. In addition, further detailed asset management initiatives (i.e. condition rating and life-cycle optimization modeling) is expected to further reduce the additional expenditure needs based on fundamental asset management principals of "*doing the right things to the right infrastructure at the right time*". Until such further analysis is completed, it would be prudent to work towards incremental revenue increases. The amount of revenue increase should start somewhere between current annual increases, which is typically the cost of inflation, and to those rate increases described in Table 14. Based on annual asset management reviews and further analysis, budget revenues and capital renewal expenditures adjusted accordingly.

One key finding of Jasper's current budget programming is the intermixing of spending crossing the revenue streams. Associated management of such programs is more effective when such groups are self-sustaining and balanced. As example would be the Utility services which should be completely self-funded. It has its own revenue stream. Expenditures should all fall within this management unit and not cross over with the tax base operations. Utilities should have its own assets for this the utility rates sufficient in itself to provide infrastructure sustainability. The same premise could be used for the Vehicles and Machinery asset group, which could also be a self-sustaining entity. Managing infrastructure sustainability is attained through equipment usage charged to other management units and associated revenue captured in an equipment reserve or revolving fund for the services provided. Then infrastructure sustainability becomes self policing within these self-sustaining management units.

4.6 Implementation Plan

Based on the above discussion, Table 15 illustrates the sequence of events and associated external cost in moving forward to addressing the Long Range Funding Plan and attaining Infrastructure Sustainability.

Table 15 – Implementation Plan

Item	Time	Estimated Cost	Comments
2016 Budget Plan	November, 2015	$0	Based on preliminary capital renewal needs revenue increases ranging between: • Municipal Taxes (4% – 16%) • Utility Rates (4% - 28%) • Culture and Recreation User Fees (4% - 61%)
Water Main Break History Condition Rating Assessment and Performance Measures	March, 2016	$8,000	Desktop analysis
Sanitary and Storm Flush, Sewer Photography, and Performance Measures	May – June, 2016	$126,000	Based on pipes with a TSL < 30 years. This would include 9600 m of sanitary sewer and 1000 m of storm sewer. Price estimated at $10/m for flush, CCTV photography and post data processing plus $16,000 for condition rating interpolation and forecasting.
Utility Rate Review * Key component to 2017 budget preparation	July, 2016	$15,000	To make certain utility rates meet not only operating needs but contain provision for capital renewal.
Roadway and Sidewalks Condition Rating	August-September, 2016	$20,000	Assumes manual condition rating for both roadways and sidewalks. Add $8000 to upgrade to automated pavement condition rating.
Engineering Assets (Roadways, sidewalks, water distribution, and wastewater (sanitary and storm) collection) Life-Cycle Optimization Analysis * Key component to 2017 budget preparation	February - October, 2016	$24,000	Based on minimizing costs of the infrastructures life-cycle, providing infrastructure sustainability, realistic budget allocations, and detailed treatment scheduling of all listed infrastructure assets within these groups. A key component is expected to include new preservation enhancing treatments (i.e. sewer liners, etc) designed to minimize capital renewal costs over the life cycle.
Facilities Risk Management Enhancement to Restricted Funds Workbooks * Key component to 2018 budget preparation	January, 2017	$5,000	Enhancement to existing Culture and Recreation capital renewal facilities programming
Water and Wastewater Treatment Plants and Pumping	March, 2017	$8,000	Inspection and deficiency/preventative maintenance listing with internal Operations staff

Facilities Internal Components Assessment and Capital Renewal Programming * Key component to 2018 budget preparation			
Fleet Management System (Vehicles and Machinery Asset Groups) * Key component to 2018 budget preparation	April 2017	$10,000	Based on conventional fleet management principles within a relatively simple spreadsheet environment.
Project Management (15%)	January 2016 to December 2017	$32,400	This may be internal management salary costs attributed to this initiative or an outsourced Owner's Engineer to manage the delivery of works listed above.
2017 Budget Plan	November, 2016	$0	Based on results attained in the above implementation planning components.
2018 Budget Plan	November, 2017	$0	
TOTAL		**$248,400**	

5. Conclusions and Recommendations

The following summarizes key conclusions and recommendation with respect to the given Jasper Asset Management Study.

5.1 Conclusions

- The computed replacement cost value of its infrastructure assets is $268.9 Million. This is significantly greater than the $84.5 Million compiled acquisition costs stated in the Municipality's 2014 Tangible Capital Assets Financial Statements.
- The Municipality of Jasper appears to be running an infrastructure deficit in all eight of its asset groups. Additional funding needs to bridge the financial gap is approximately $3.31 Million/year to $4.48 Million/year depending on the Municipality's decision to implement a proactive preservation enhanced approach or conventional replacement approach within the infrastructure renewal program.
- To address the Long Range Funding Plan needs will require approximately the following increase to existing revenue streams:
  - Municipal Taxes – 16%
  - Utility Rates – 28%
  - Culture and Recreation User Fees – 61%
- It is recognized that sharp tax/rate/fee increases would not be appropriate and that a gradual progressive approach be considered.
- It is recognized that post report asset management measures including condition assessments, life-cycle optimization modeling, risk management, and fleet management will contribute to further reduction in capital renewal funding needs and associated tax/rate/fee increases.

- A moving forward implementation plan beginning January 2016 and concluding December 2017 provides a period of the required assessment and analysis to derive budget programs and detailed work plans that will minimize costs while ensuring sustainability over the infrastructure life-cycle.
- Delivery of this plan should be carefully scoped as not all asset management systems and delivery thereof are created equal. Request for Proposal (RFP) development should reference Best Practices in the field of Asset Management and those practices that will maximize the Return on Infrastructure Investment (ROII) to the Municipality.
- The implementation plan may be managed internal to the Municipality of Jasper outsourcing each component; or managed and delivered in its entirety through the services of an Owner's Engineer.

5.2 Recommendations

i. That for budget year 2016, the Municipality of Jasper discusses and implements reasonable tax, utility rate, and user fees increases as a preliminary step to addressing the capital renewal funding needed to attain infrastructure sustainability.

ii. That for the period of January 2016 to December 2017, the Municipality of Jasper use the Implementation Plan to complete the needed analysis to develop a detailed Long Range Capital Plan that will maximize the ROII; and that the Municipality allocate $248,400 to complete those engineering works.

iii. That the Municipality of Jasper incorporates the detailed assessment results applied within the Long-Range Infrastructure Capital Plan for application in the 2017 and 2018 Budgets and beyond; and that this plan is used as a guide in addressing further tax, utility rate, and user fees increases

Appendix A

Inventory and Analysis Data

Appendix B

Infrastructure Life-Cycle Optimisation Modeling

Infrastructure Life-Cycle Optimization Model

The Infrastructure life-cycle optimization model works through numerous life-cycle combinations of events and determines the path that meets the desired objective functions including minimizing program expenditures and maximizing asset valuation and performance. .

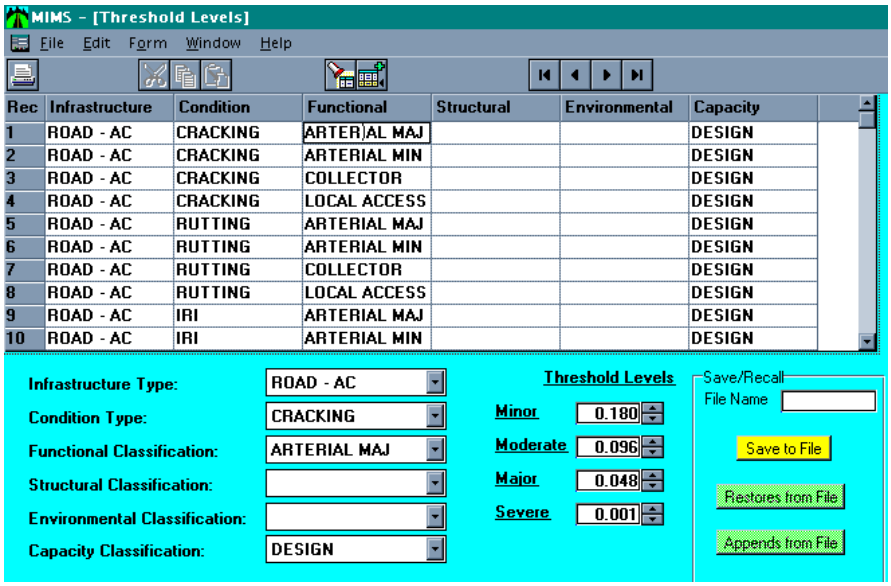
The severity (good, fair, poor) and extent (%) format for performance ratings (physical condition, utilization, and functional adequacy) are also the basis for evaluation within the optimization model. In addition, the optimization model can incorporate asset valuation as a measure of performance to provide a dollar to dollar comparison of changes in funding envelope expenditures to changes in the performance of the assets.

The input model parameters include three critical areas of importance. The first is threshold levels. Threshold levels are tolerance levels of extent established by the infrastructure management team. Threshold levels are established at the severity and extent level representative of the infrastructure's classification (functional, structural, environmental, and capacity)

The following figure illustrates typical threshold levels of asphalt concrete road infrastructure representing the variations in functional use of the road system. In this example the major arterial roads should have the highest level of service. As a result, lower extent levels for each severity group (minor=18.0%, moderate=9.6%, major=4.8%, severe=0.1%) would be tolerated. Conversely, the local access road receives the lowest level of service. Therefore, higher threshold levels of extent would be tolerated within each of the severity groups (i.e. minor=32.0%).

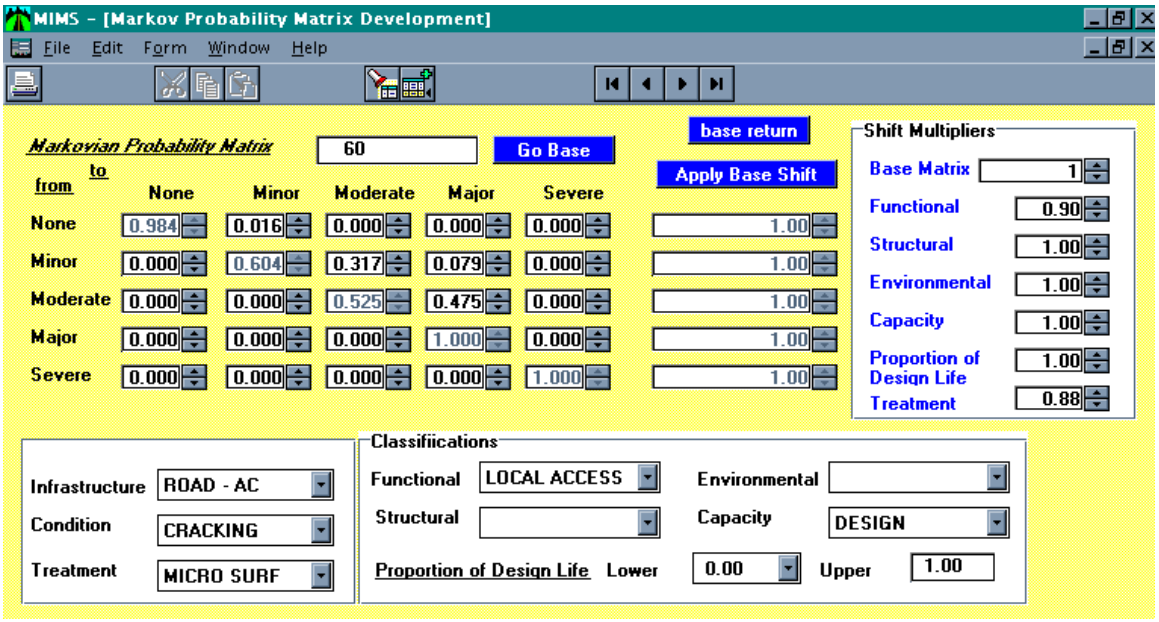
Threshold levels alone do not trigger specific treatment mitigation or establish specific operations procedures. Threshold levels of extent will work with the measured and simulated condition data to provide an index which is used for strategizing treatment options indicative to the current state of the infrastructure and level of service required for its specific classification. The index is used only as a decision making measure by the agency's infrastructure management team in strategizing treatment options. The index is not used in any of the modeling processes for treatment mitigation, costing, or deterioration.

Figure B-1 - Typical Threshold Levels of Extent



The second are deterioration probabilities uniquely defined for the various infrastructure types and conditions affecting the infrastructures.

Figure B-2 - Typical Deterioration Probability Matrix



The deterioration probabilities determine the rate of performance change over time using principles of Markovian probabilistic modeling.

Figure B-3 - Markovian Simulated Performance Extent Calculation

Extent Levels within each Severity Rating

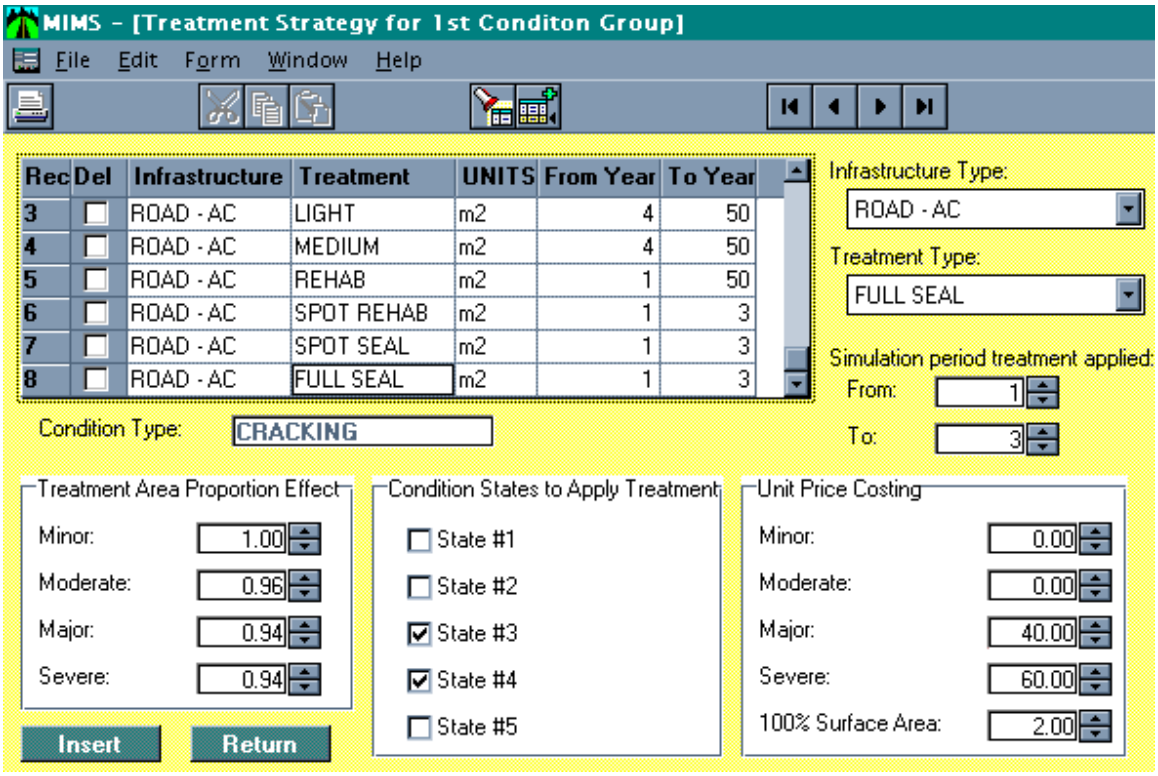
Year	None	Minor	Moderate	Major	Severe	Index
Y_0	E_{01}	E_{02}	E_{03}	E_{04}	E_{05}	I_0
Y_1	$E_{01}*P_{1} + E_{02}*P_{21} + E_{03}*P_{31} + E_{04}*P_{41} + E_{05}*P_{51}$	$E_{01}*P_{12} + E_{02}*P_{22} + E_{03}*P_{32} + E_{04}*P_{42} + E_{05}*P_{52}$	$E_{01}*P_{13} + E_{02}*P_{23} + E_{03}*P_{33} + E_{04}*P_{43} + E_{05}*P_{53}$	$E_{01}*P_{14} + E_{02}*P_{24} + E_{03}*P_{34} + E_{04}*P_{44} + E_{05}*P_{54}$	$E_{01}*P_{15} + E_{02}*P_{25} + E_{03}*P_{35} + E_{04}*P_{45} + E_{05}*P_{55}$	I_1

Applied to the Provincial performance standards, the noted severity levels of minor, moderate, major, and severe, would relate to the good, fair, and poor. As such, applied to each performance measure (physical condition, utilization, and functional adequacy), the actual extents of good, fair, and poor would adjust over time depending on natural deterioration relationships and resulting events to maintain and renew the infrastructure as determined in the treatment strategy model parameters.

The third major model parameter is the treatment strategies. During the various periods in an infrastructure's life-cycle, treatment strategies determine what event should be tested and what the effect will be on the performance if

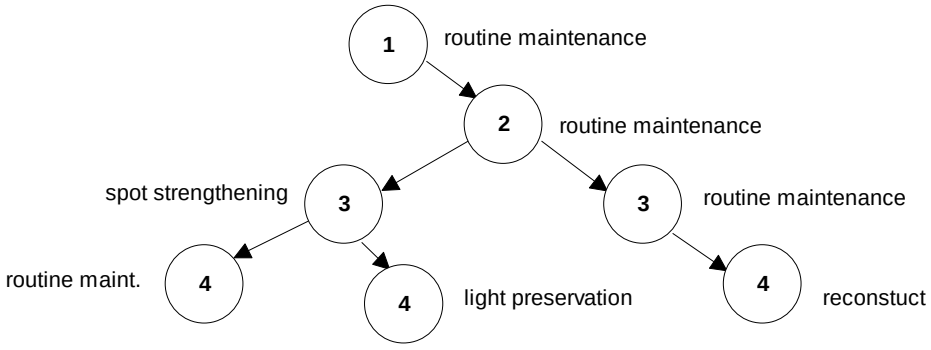
implemented. In addition, it will determine the cost to apply the event and the resulting change in asset valuation (i.e. monetary measure of improvement of performance).

Figure B-4 - Treatment Strategy



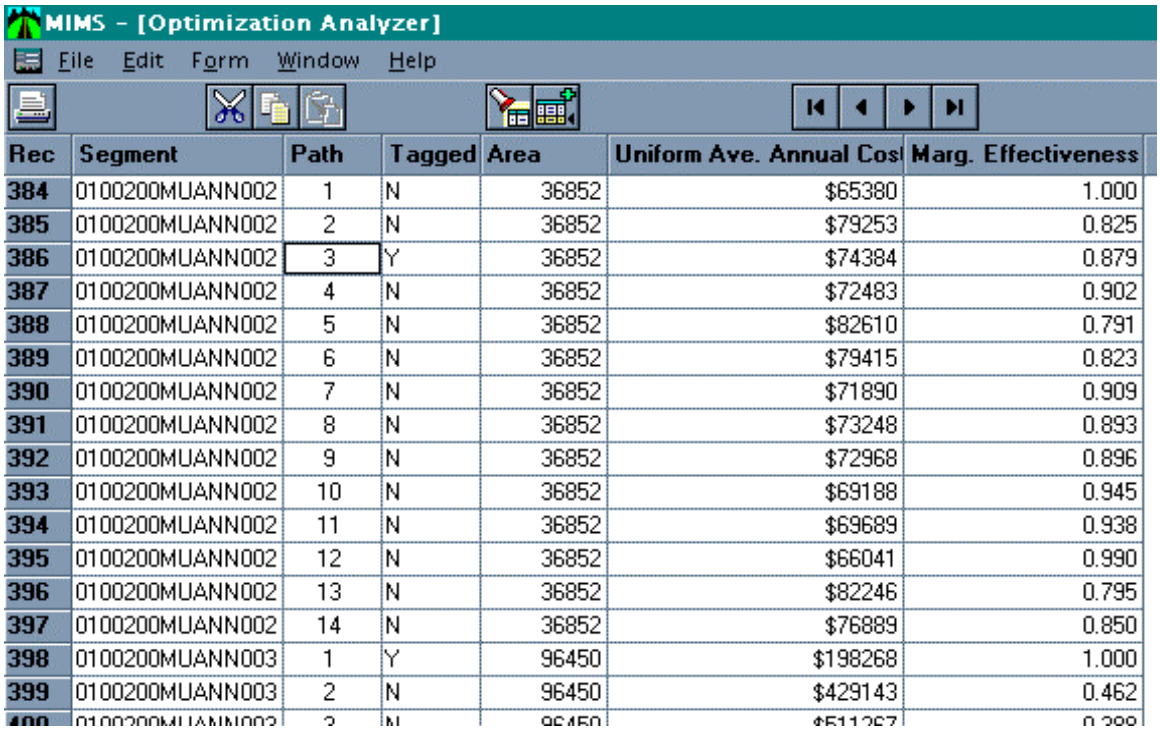
Within the strategy, maintenance and renewal treatment events would be applied at select stages in the infrastructure's life. In addition, unit pricing is also applied including the effect the treatment has on performance. Each year in the life-cycle modeling, treatment options are accumulated like branches on a tree.

Figure B-5 - Treatment Branches and Paths



Each treatment branch is analyzed based on the uniform average annual cost for the life-cycle. The numerous alternatives determine a marginal effectiveness value for each infrastructure and is subsequently stacked so all infrastructures of all funding envelopes are prioritized and compete for capital maintenance and renewal funding on an equitable basis.

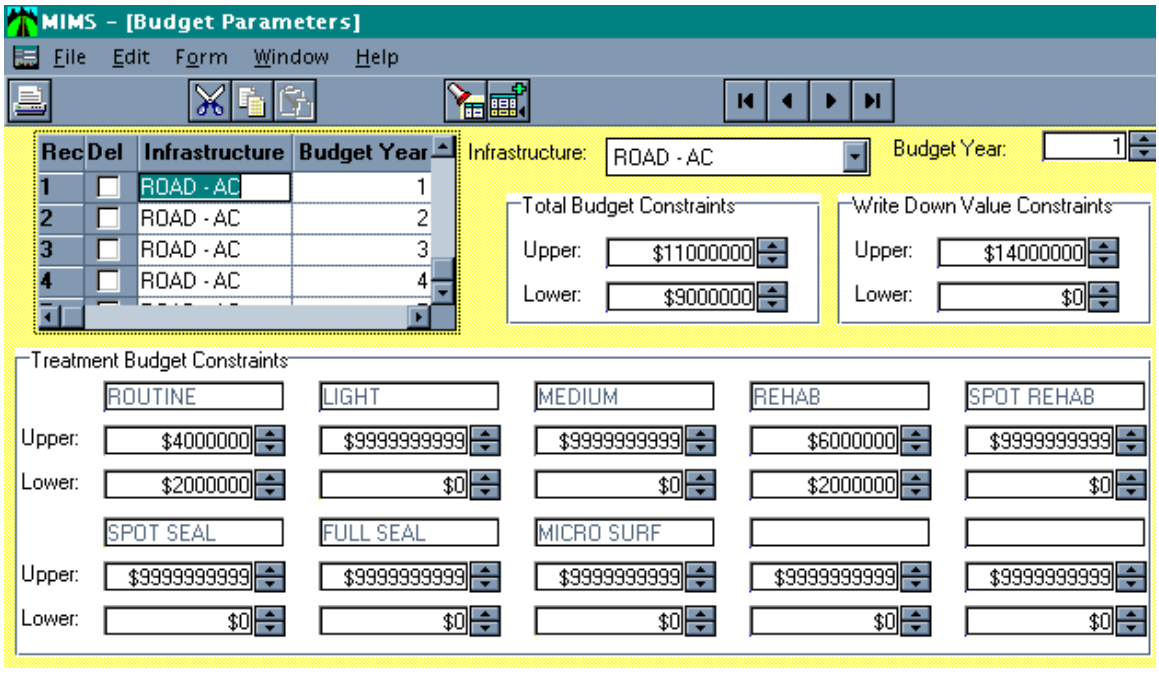
Figure B-6 - Marginal Effectiveness



Rec	Segment	Path	Tagged	Area	Uniform Ave. Annual Cos	Marg. Effectiveness
384	0100200MUANN002	1	N	36852	$65380	1.000
385	0100200MUANN002	2	N	36852	$79253	0.825
386	0100200MUANN002	3	Y	36852	$74384	0.879
387	0100200MUANN002	4	N	36852	$72483	0.902
388	0100200MUANN002	5	N	36852	$82610	0.791
389	0100200MUANN002	6	N	36852	$79415	0.823
390	0100200MUANN002	7	N	36852	$71890	0.909
391	0100200MUANN002	8	N	36852	$73248	0.893
392	0100200MUANN002	9	N	36852	$72968	0.896
393	0100200MUANN002	10	N	36852	$69188	0.945
394	0100200MUANN002	11	N	36852	$69689	0.938
395	0100200MUANN002	12	N	36852	$66041	0.990
396	0100200MUANN002	13	N	36852	$82246	0.795
397	0100200MUANN002	14	N	36852	$76889	0.850
398	0100200MUANN003	1	Y	96450	$198268	1.000
399	0100200MUANN003	2	N	96450	$429143	0.462

On a network level, for each program planning year, targets may be established for budget limits, asset valuation limits, and performance limits. The network level targets provide annual program stability and work within the required funding envelope constraints and strategic management targets.

Figure B-7 - Budget, Asset Valuation, and Performance Constraints



The modeling output produce reports indicating resulting optimal budget levels and corresponding asset valuation and performance for each infrastructure type within the funding envelope. The following table summarizes the report outputs for a municipal infrastructure case.

Figure B-8 - Optimization System Output - Municipal Infrastructure Example

Program Budget ($ Millions)

Program Year	Water Mains	Domestic Sewerage	Storm Sewerage	Roads	Bridges	Sidewalks	**Total**
1	$ 13.20	$ 7.80	$ 5.30	$ 52.00	$ 4.20	$ 0.23	**$ 82.73**
2	$ 15.10	$ 7.90	$ 6.00	$ 48.00	$ 4.40	$ 0.25	**$ 81.65**
3	$ 16.00	$ 8.10	$ 5.90	$ 45.50	$ 3.90	$ 0.24	**$ 79.64**
4	$ 16.50	$ 8.00	$ 6.10	$ 41.90	$ 3.80	$ 0.28	**$ 76.58**
5	$ 16.50	$ 7.90	$ 6.20	$ 45.10	$ 4.20	$ 0.19	**$ 80.09**

The asset valuation component of the analysis is quite significant in the decision management process. For the roads program of the above example, the following illustrates the impact of the change in asset valuation in comparison to forecast program expenditures.

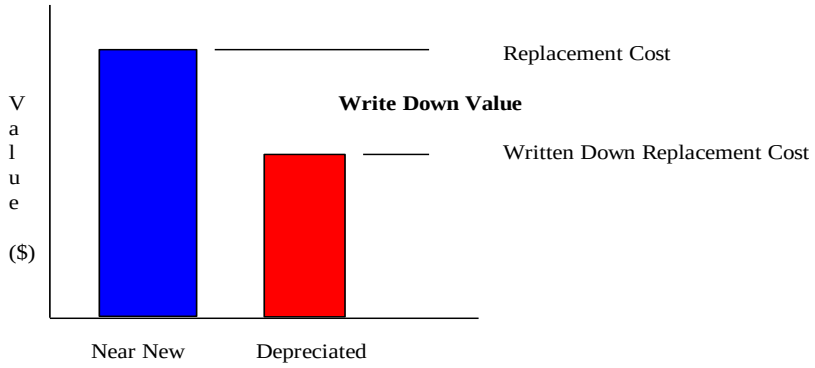
Figure B-9- Roads Program with Asset Valuation

Program Year	Roads Budget	Budget Change	Write Down Value	WDV Change
1	$ 52.00		$ 107.30	
2	$ 48.00	$ (4.00)	$ 106.80	$ (0.50)
3	$ 45.50	$ (2.50)	$ 106.90	$ 0.10
4	$ 41.90	$ (3.60)	$ 120.30	$ 13.40
5	$ 45.10	$ 3.20	$ 119.90	$ (0.40)

* $ in Millions

Note that asset valuation is represented by the write down value. The write down value is the difference between the infrastructure's replacement value/cost and the written down replacement value/cost. Therefore, the higher the write down value, the lower the level of performance.

Figure D-13 - Asset Valuation



In the above example, over the five-year program period, the overall savings in expenditures in comparison to the base year (year 1) is $27.5 M. Within this period, the value of the infrastructures declined by $12.6 M. Therefore, the net gain over the five-year program period is $14.9 M. Conversely, another scenario may indicate that an increase in annual expenditures will result in a corresponding greater increase in the value of the assets. Such would also be a good programming decision.

Model Parameters

The selection or development of the actual strategic management model and the optimization systems model will dictate what model parameters will need to be developed to drive the model.

Fundamental to most systems are the requirements for following model parameter developments. The selected systems for implementation will dictate more specifically the format and specifics, and they would include several other parameters specific to the model. The following highlight the main areas of importance.

- Deterioration relationships – This may be direct performance versus time. In some models, the relationship is in a form of probabilities of going from once condition state to another.
- Performance Targets or Threshold Levels – Are used provide a variable level of service between infrastructure types and functional use.
- Events or Treatment Strategies – This would identify what maintenance and renewal action is triggered at what condition state in the infrastructure's life cycle. Typically, this would also include the affect in terms of renewed performance.
- Unit Costing – This would be the cost of applying the maintenance and renewal treatment.

Model parameters are typically derived from two sources. One source is though operations and management personnel specific to the ministry and funding envelope. Processes exist to tap into the expert knowledgebase to build upon model parameters in which no quantifiable information is available.

The second source is through historic data. Typically, custom-based software is developed to tap into the variety of information sources through relational database practices. Deterioration relationships are often determined through comparing annual changes in performance for each infrastructure segment within the inventory repository. Unit costing information is often obtained through maintenance management systems and other unit rate compilation exercises.

The actual initial development and annual update of model parameters is not an absolute science. Model parameters input to models involves subjective review of all information sources and subsequent model calibration as part of a pre-modeling reality check.